The *Whistler*

Features

Channel-billed Cuckoo
Topknot Pigeon
Rufous Scrub-bird
Spiny-cheeked Honeyeater
Black Kite
Black-necked Stork
Nocturnal surveys on Ash Island
Analyses of long-term studies

An annual publication of the

Hunter Bird Observers Club

Affiliated with BirdLife Australia

Number 14
2020

The *Whistler* is the scientific journal of the Hunter Bird Observers Club Inc.

ISSN 2208-9845 (electronic copy); ISSN 1835-7385 (hard copy)

All papers are peer-reviewed prior to publication.

The aims of the Hunter Bird Observers Club (HBOC), which is affiliated with BirdLife Australia, are:

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

HBOC is administered by a **Committee**.
Executive: Vice-President: Mick Roderick, Secretary: Marg Clarke, Treasurer: Helen McCall.
Committee Members: Liz Date-Huxtable, Lucas Grenadier**,** Andrzej Karpiel, Rob Kyte,
Robert McDonald and Kristy Peters.

Publication of **The *Whistler*** is managed by a team:
Alan Stuart (Joint Editor), Neil Fraser (Joint Editor)
Liz Crawford (Production Manager), Rob Kyte (Cover design)

Printed by NCP Printing, Newcastle

Authors wishing to submit manuscripts for consideration for publication should consult **Instructions for Authors** on page 90 and then submit their manuscripts to the **Editors** at whistler@hboc.org.au

© Hunter Bird Observers Club Inc. PO Box 24, New Lambton NSW 2305 **www.hboc.org.au**

Front cover: Topknot Pigeon *Lopholaimus antarcticus* - Photo: Steve Merrett
Back cover: Black Kite *Milvus migrans* - Photo: Alwyn Simple
Spine: Sharp-tailed Sandpipers *Calidris acuminata* - Photo: Rob Palazzi

The *Whistler* is proudly supported by

Newcastle Coal INFRASTRUCTURE GROUP

Hunter Bird Observers Club
Affiliated with BirdLife Australia

Editorial

Welcome to Issue **14** of *The Whistler*. Here we present a wide selection of ornithological papers from the Hunter Region which will be of interest to readers, with six in-depth articles, seven short notes and a book review.

Three of the articles illustrate the importance of using long-term record sets to establish the status of species. Alan Stuart has presented a detailed analysis of 17 years of shorebird and waterbird surveys in Port Stephens. The article confirms decreasing national and international population trends for migratory waders that use Port Stephens. There is also some good news with increasing population trends for some threatened endemic species. The article further highlights the importance of Port Stephens to many shorebirds and waterbirds.

A second article by Alan Stuart uses a ten-year record set to establish Rufous Scrub-bird population trends in the Gloucester Tops. The article also addresses the impact of bush fires on the population of this little-known species which is predicted to be significantly impacted by future climate change.

An article by David Turner presents an analysis of records from surveys undertaken 27 years apart in Booti Booti National Park. This article fills an information gap for this area which has not previously been described in *The Whistler* articles and is under-represented in the general ornithological literature. A decrease in number of species over the period is documented as well as some changes in species diversity.

Three of the articles demonstrate how records from the Birdata database can be used in different ways to study the status of species in our region. The database was established over 20 years ago and provides researchers with a multi-generational time frame for assessing bird species population trends. An article by Mike Newman addresses the problem of determining changes in abundance for 17 uncommon woodland species with low reporting rates in the region. Mike has applied statistical techniques to a combination of Birdata record types to demonstrate their decreasing trends. This is a novel approach and we anticipate it will generate debate as to how to address the study of record-poor species.

Dan Williams has used Birdata records to develop time-variant distribution maps of the eastern range expansion of Spiny-cheeked Honeyeater within the region. This technique could also be used to demonstrate seasonal movements or sporadic irruptions of species. Neil Fraser has used historical records from Birdata and other sources to analyse the relationship between the occurrence of Australian Painted-snipe in the Hunter Region and weather-related events such as long-term drought, drought-breaking rains and floods. The article highlights the importance of permanent wetlands in the Lower Hunter as a refuge for the species during drought and for breeding when conditions are suitable.

An article by Chad Beranek also reports observations of Australian Painted-snipe in the region and describes a novel approach to detect them nocturnally. The article includes nocturnal observations of another cryptic species, Australian Little Bittern.

Over recent years, birdwatchers in the region have had the privilege of observing some previously absent species begin to reclaim their historically-lost habitat or extend their range in the region. Three articles in this issue describe such changes. A note by Kim Pryor reports a second successful breeding attempt by Black Kite in the region while an article by Ann Lindsey documents the third confirmed breeding record by Black-necked Stork in the Hunter Estuary. Both occurrences can be attributed in part to the rehabilitation of Hexham Swamp. The third article, by Neil Fraser, adds knowledge about the range extension of Beach Stone-curlew in Port Stephens, with a new breeding record of the species from Corrie Island, part of the Myall Lakes Ramsar site. The note also highlights the importance of this locality to other threatened species with reports of successful breeding by Australian Pied Oystercatcher and Little Tern.

Three short notes illustrate the importance of basic field observation to understanding behaviour of some species. Tom Kendall describes birds foraging on Fennel, probably for medicinal purposes. Backyard observations of juvenile Channel-billed Cuckoos by Adam and Rebecca Fawcett show that you don’t have to leave home to undertake basic research. David Turner has documented the second confirmed breeding record for Topknot Pigeon in the region.

In this issue we also review Volume 3 of the *Atlas of the birds of NSW and the ACT*. This is the final volume of this Whitley Award winning resource and includes an analysis of data from all three volumes. This shows that over 50% of resident or regional migrant species in NSW and ACT exhibited a significant population decrease over the 20-year Atlas period. This is most pronounced amongst woodland birds. The analysis reinforces the results of Mike Newman's above article. It also reminds us that it is only through the recording, analysis and publication of information, that support for the conservation of threatened and declining species, and their habitat, can be achieved.

Thank you to the many individuals who have laboured to produce articles for this edition of *The Whistler*, or who have contributed in other ways towards its publication.

Neil Fraser and Alan Stuart
Joint Editors

Juvenile Channel-billed Cuckoo: some behavioural observations

Adam Fawcett and Rebecca Fawcett

Peace Haven, 776 Rockvale Road, Armidale NSW 2350, Australia Adam.m.fawcett@gmail.com

Received 17 September 2019, accepted 15 January 2020, published on-line 17 January 2020.

The concurrent presence in a suburban environment of a juvenile Channel-billed Cuckoo *Scythrops novaehollandiae* with its Pied Currawong *Strepera graculina* host parents and two other juveniles with their Australian Raven *Corvus coronoides* host parents allowed opportunities to compare behaviour. Observations documented included some begging and feeding behaviour of the juvenile cuckoos and their host parents, interactions between the host and juvenile birds, the weaning strategies adopted by the host species, and interactions with an adult Channel-billed Cuckoo.

INTRODUCTION

The Channel-billed Cuckoo *Scythrops novaehollandiae* is the largest Australian cuckoo and a breeding migrant, regularly observed during the spring and summer months on the east coast of NSW (Higgins 1999). The species is easily identified from its body and bill shape, size, flight patterns and raucous call. An obligate nest parasite, the species is well known for using larger passerine species, in particular ravens, crows and currawongs, as hosts to raise its young (Higgins 1999).

While there are a number of documented observations of the general behaviour (Brooker & Brooker 1989; Kellam 1974; Kloot & Wardlaw 2002), courtship (Merrett 2014), host species (Brooker & Brooker 1989; Goddard & Marchant 1983; McAllan 1995) and parasitic behaviour (Brooker & Brooker 1989; Goddard & Marchant 1983) of the Channel-billed Cuckoo, there are only a small number of documented observations of the interactions between the host species and still-dependent juvenile cuckoos (Wood & Wood 1991; Wood 2004).

From December 2016 to March 2017, two pairs of host parents raised Channel-billed Cuckoo chicks near our house in Newcastle. This allowed many opportunities to observe some of the behaviours of the juvenile birds and their host parents. In this note, we report the main observations.

METHODS

Observations were made at and near our residence in Addison Road, New Lambton (32º 55'S 151º 42'E), near Newcastle NSW. This is a leafy urban environment with numerous tall native and introduced trees and shrubs within adjacent backyards, leading into Blackbutt Reserve to the west. Approximately 210 m to the south-east is Regent Park, an urban greenspace fringed by Port Jackson Fig trees *Ficus rubiginosa*.

Our observations were opportunistic, more frequently occurring in the morning and mid to late afternoon although not confined to those periods.

OBSERVATIONS

A pair of Pied Currawong *Strepera graculina* was actively foraging for food within our backyard during the week 18-25 December 2016. Whilst not an unusual observation, it coincided with contact calls being made by a juvenile bird about two properties away (~25 metres). We could not see the juvenile nor a nest, due to the density of the tree canopy. However, we often heard feeding noises after foraging, and so we concluded that the calling bird was a nestling. The pair of currawongs foraged across most substrates, searching the eucalypt canopy, foraging on the ground, hawking from the air, and foraging in shrubs and smaller trees for insects. Both birds were observed foraging on a large infestation of Bronze Orange

Bug *Musgraveia sulciventris* within two citrus trees in our yard. The currawongs predated extensively on them, returning to feed the juvenile bird immediately after foraging. We had never before seen birds of any species feeding on these insects.

On 27 December 2016 we first saw a juvenile Channel-billed Cuckoo, which was being fed by both of the currawongs. Sometime during the preceding days, the juvenile had moved into trees with dense cover within our yard, where it mostly stayed hidden from our sight. The juvenile cuckoo was not quite as large as the currawongs. It had a less well-developed bill than an adult cuckoo and there was no obvious orbital ring or bare skin between the mandibles and eye. The eye was dark in colour as opposed to the red of an adult Channel-billed Cuckoo. Its plumage had a distinctive fawn to buff colour across the chest and head with lighter patches on the wings and back. The juvenile made persistent loud begging calls to the host parents, which fed it frequently. The begging calls were triggered by almost any movement of the hosts, particularly when they were close by.

We saw the juvenile Channel-billed Cuckoo on a daily basis over the next week. The juvenile mostly remained in the dense cover provided by the eucalypts. At most it ranged within three suburban backyards (~25 metres) and usually stayed in approximately the same place for long periods of time (2-3 hours) with the host currawongs returning to feed it at intervals of *c*. 2-10 minutes. Its movements seemed clumsy, suggesting it was recently fledged. It rarely flew, making only occasional and ungainly 2-5 m flights between adjacent trees.

On 5 January 2017, we received a report of two juvenile Channel-billed Cuckoo being hosted by a pair of Australian Raven *Corvus coronoides* *c*. 300 m from our yard (A. Stuart pers. comm.). Later that same day, we saw these four birds in our front yard. The newly arrived juvenile cuckoos had similar buff-coloured plumage to the original juvenile but overall, they seemed to be more mature. For example, they were more mobile, were less ungainly in their movements and they seemed to us to be larger birds.

Over the next two weeks (8 to 22 January 2017), the currawong-hosted Channel-billed Cuckoo continued to inhabit our yard and adjacent properties. It became more confident and adventurous with its flight and moved further from the cover of the denser vegetation. The juvenile also became more and more demanding of its host parents. On several occasions we observed it chasing the currawongs along tree limbs immediately after being fed, and begging with increasing vigour and volume. Both currawongs fed the juvenile cuckoo and they were constantly foraging.

During these two weeks, we often saw the raven-hosted cuckoo youngsters, and sometimes they were in the vicinity of the currawong-hosted cuckoo. However, we saw no interactions between the two pairs of host parents nor between their two sets of chicks. The raven-hosted cuckoos were commonly in more open habitat, following their surrogate parents with constant contact calls and food begging behaviour. Perhaps as a result of the nature of the habitat, they were more frequently harassed by other bird species, in particular the Noisy Miner *Manorina melanocephala* and the Australian Magpie *Gymnorhina tibicen*.

Throughout the observation period, some adult Channel-billed Cuckoo were often in the neighbourhood. During January, one of these adult birds flew into trees near the currawong-hosted Channel-billed Cuckoo, with the local bird species reacting strongly to its presence. The juvenile cuckoo immediately ceased making calls to its host parents; staying quiet and still within the foliage where it was perched. As soon as the adult cuckoo flew off, the juvenile bird resumed its calling and begging behaviour with its surrogate parents.

During the last week of January and in early February 2017, the currawong-hosted cuckoo became increasingly demanding. It followed one or other of its host parents closely, begging loudly. Close scrutiny of the bird at this point revealed that the fawn colour of its plumage was starting to disappear. It was patchy across its head and chest with white patches on wings and back still showing evidence of this colouration. Its bill and body size had grown substantially but its eye colour was still dark.

The two raven-hosted cuckoos were present less frequently during this period, although still seen at least weekly. These juvenile birds were tending to follow one each of their host parents, with the two ravens usually foraging separately.

By the last week of February 2017, the raven-hosted cuckoos had all but lost the fawn colouring from their head and chest, while retaining the tint on the lighter patches of their back and wings.

Their eye colour remained dark. We also noted that the Australian Raven host parents were becoming indifferent to the attention given them by the two juvenile cuckoos. Overall, they were less responsive than previously to begging behaviour and they often ignored the young cuckoos, opting to forage for themselves instead.

At this stage, the pair of host Pied Currawong was foraging over a greater area within the neighbourhood, including Regent Park and neighbouring streets, with their juvenile cuckoo always following them. All three birds regularly returned to our neighbourhood most evenings, foraging for food within shrubs and trees and from the ground, as in the preceding weeks. On a number of occasions, we saw the currawongs "false feed" the cuckoo despite not having caught food or undertaken foraging activity for some time. On those occasions, the currawong would insert its empty beak into the open gape of the cuckoo. Both of the currawongs appeared noticeably slimmer in body size by comparison with other currawongs in the area.

During the first week of March 2017, the Pied Currawong pair and their Channel-billed Cuckoo were only sighted once; however, we could still hear the begging and contact calls of the juvenile bird all the week. In the following week, the currawongs came to our yard of an evening but without their cuckoo. There was no sign of the young Channel-billed Cuckoo and no begging or contact calls were heard. It was evident that the currawongs were foraging for food for themselves and they continued to forage in this manner across the neighbourhood.

Late during this same week, a Channel-billed Cuckoo landed in trees in our yard. It was a sub-adult bird based on the presence of some remaining small buff patches of plumage and a dark eye. The bird perched quietly in the trees for some time, ignoring the Noisy Miner alarm calls. It is possible that this was the cuckoo hosted by the currawongs, still moving around the neighbourhood where it was raised. If that was the case, it was our last observation of the currawong-hosted Channel-billed Cuckoo.

The raven-hosted cuckoos were not seen or heard at all in March, which suggests that these birds already were fully independent. The pair of ravens was still in the area but they were without their two young cuckoos.

DISCUSSION

During the summer of 2016-2017, we were able to observe the behaviour of a young Channel-billed Cuckoo and its Pied Currawong host parents closely and compare these observations with those of two other young cuckoos and their Australian Raven host parents. Both of the Pied Currawong host parents shared the feeding duties for their surrogate offspring throughout the observation period. Initially, the currawongs brought food to the young bird but as it aged and became more confident and mobile, it began to follow one or other of the adults. Both of the ravens also were tending to both of their young cuckoos, although they often would pair off i.e. one cuckoo was each with one raven. This is similar to observations made by Wood (2004) and as described by Higgins (1999).

The currawong-hosted cuckoo was mainly sedentary immediately after fledging but it became more active as it became older. Similar to observations by Wood & Wood (1991), this juvenile bird made constant contact calls to the host parents, as did the two raven-hosted cuckoos. As the currawong-hosted cuckoo became more mobile, it began to habitually follow its host parents. On several occasions the cuckoo grabbed hold of a currawong when the adult started to move away after feeding it, presumably to hassle the currawong for more food. Most commonly, the cuckoo grabbed the currawong on the wing or tail. We did not observe this behaviour by the raven-hosted cuckoos. Possibly that was because they were more developed than the currawong-hosted bird when we first saw them. However, we had fewer overall opportunities to observe that family group.

Both of the host pairs adopted similar strategies for weaning their dependant cuckoos to independence. The Australian Ravens began to ignore the begging behaviour of their pair of juvenile birds. The currawongs did the same and also started false feeding the juvenile cuckoo, with no food actually given. This behaviour has been previously reported to be used when encouraging birds to fledge from the nest (Higgins 1999) but no similar observations have been previously reported for encouraging juvenile cuckoos to become independent.

In comparison with the Pied Currawong-hosted bird, the cuckoos hosted by the pair of ravens appeared to be older based on their confidence and skill in following their host parents around the neighbourhood. Wood (2004) observed that post-fledgling independence occurred on average after 57 days for birds hosted in the Wollongong area. The raven-hosted cuckoos became independent approximately two weeks earlier than the Pied Currawong-hosted cuckoo, and they disappeared in late February. This was consistent with observations by Wood (2004) for early fledged birds. By contrast, the Pied Currawong-hosted bird was a late fledgling which became independent by mid-March, similar to observations by Wood & Wood (1991).

Throughout the observation period, some adult Channel-billed Cuckoo were resident within the neighbourhood. These adult birds were often flying overhead, either as a single pair or, and commonly, as three individuals interacting and duetting loudly. They were also frequently observed moving around and feeding on the Port Jackson Fig trees on Regent Street and other fruit trees locally. Apart from the one visit to our yard in January, we saw no interactions between any adult Channel-billed Cuckoo and the juvenile birds. While it has been suggested that the adult Channel-billed Cuckoo gather the young for migration (Higgins 1999) we did not notice this to occur for the young birds in our study.

CONCLUSIONS

We observed the behaviour of two concurrent sets of Channel-billed Cuckoo fledglings and their host parents throughout the 2016-17 summer. All observations made were opportunistic within suburban backyards in New Lambton, NSW, with a single juvenile cuckoo hosted by a pair of Pied Currawong and a pair of juvenile cuckoos hosted by an Australian Raven pair.

Observations included feeding behaviour undertaken by the host parents including begging and aggressive harassment of the host birds by the juvenile cuckoo. A single close encounter was observed between one of the juvenile cuckoos and an adult Channel-billed Cuckoo. However, no direct interactions between adult Channel-billed Cuckoo present in the area and juvenile birds were observed.

Weaning strategies included false feeding of juvenile birds and lack of response to begging behaviour by both host bird species. Weaning of juvenile cuckoos to independence occurred in late February for the raven-hosted birds and mid-March for the currawong-hosted bird.

ACKNOWLEDGEMENTS

We thank our neighbours, Carol and Norbert Ruppe, for sharing with us their observations of the pair of juvenile Channel-billed Cuckoo during this study. We are also grateful to Dr James Shields for his sage advice and comments on the draft manuscript, and to an anonymous referee who made several helpful comments.

REFERENCES

Brooker, M.G. and Brooker, L.C. (1989). Cuckoo hosts in Australia. *Australian Zoological Reviews* **2**: 1-67.

Goddard, M.T. and Marchant, S. (1983). The parasitic habits of the Channel-billed Cuckoo *Scythrops novaehollandiae* in Australia. *Australian Birds* **17**: 65-72.

Higgins, P.J. (Ed). (1999). 'Handbook of Australian and New Zealand Birds Volume 4: Parrots to Dollarbird'. (Oxford University Press: Melbourne.)

Kellam, J.W. (1974). Channel-billed Cuckoo in Central Victoria. *Australian Bird Watcher* **5**: 201-204.

Kloot, T. and Wardlaw, B. (2002). Behaviour of the Channel-billed Cuckoo *Scythrops novaehollandiae. Australian Bird Watcher* **19**: 201-202.

Merrett, S. (2014). Channel-bill Cuckoos performing a previously undescribed courtship display. *The Whistler* **8**: 61-62.

McAllan, I.A.W. (1995). Young Channel-billed Cuckoo being fed by Little Ravens. *Australian Bird Watcher* **16**: 82-81.

Wood, I. and Wood, C. (1991). Channel-billed Cuckoo and multiple broods. *Australian Birds* **25**: 23-24.

Wood, K.A. (2004). The Channel-billed Cuckoo at Wollongong New South Wales: Notes on migration, abundance and breeding. *Australian Field Ornithology* **21**: 89-106.

A breeding record for Topknot Pigeon in the Hunter Region

David Turner

23 Murray Avenue, Forster, NSW 2428, Australia dnt1@y7mail.com

Received 20 September 2019, accepted 25 November 2019, published on-line 23 January 2020.

This note documents a breeding record of Topknot Pigeon *Lopholaimus antarcticus* in Booti Booti National Park in 1986. The sighting of a pre-fledged Topknot Pigeon in Booti Booti National Park was only the second confirmed breeding record for the species in the Hunter Region.

On 1 November 1986, I was approached by a camper at The Ruins camping ground in Booti Booti National Park, to rescue a bird that was sitting on the mast of his yacht. He claimed the bird had been "blown out of a nest". The Ruins camping ground is approximately 17 km south of Forster on the Mid-North coast of NSW (32º 18.64'S, 152º 31.19'E).

The bird was a pre-fledged Topknot Pigeon that did not try to fly or attempt to get away when I caught it. I placed it in a tree to photograph it then, by means of an extension ladder I was able to place the bird into a Paperbark Tree *Melaleuca quinquenervia* close to what appeared to be the nest it had "fallen" from. The nest was approximately 10 m above the ground and bulky, unlike pigeon nests I had seen previously that tended to be frail. After a short period an adult Topknot Pigeon came and perched alongside the bird. A few days later the bird and the adult had gone.

Pre-fledged Topknot Pigeon found in The Ruins camping ground 1 November 1986.

In 1986 large flocks of Topknot Pigeons were recorded in the Booti Booti National Park in March and September to November. In July and August birds were observed in low numbers. By the end of September a flock of 50 birds was recorded. On 23 October 1986 a flock of 200+ was noted. On 13 November 1986 a flock of 100+ was still present in the park. However, by the beginning of December all Topknot Pigeons had left the area.

Frith (1982, p. 141), in describing the breeding behaviour of Topknot Pigeon in Australia, found that "In late August, the flock moved on but the mated pairs (several attended by flying young) remained". This is contrary to my findings where the flock appeared to wait for the young bird to "mature" before moving on.

The first confirmed breeding record of Topknot Pigeon in the Hunter Region was reported by Gogerley (1925) who found a number of nests with eggs and a chick at Wallis Lake. He stated that thousands of the birds came to Wallis Lake in 1925. Gogerley found Topknot Pigeons nesting in June as well as October. His paper infers that they were found on his property *Ellerslie* but does not state this. The paper only states the months when he found the birds nesting not the year(s). *Ellerslie* is on the south-western shore of Wallis Lake and is approximately 4 km west of The Ruins camping ground. It is adjacent to what is now known as Wallingat National Park and both the property and the park would most likely have contained suitable nesting habitat for Topknot Pigeon.

On the subject of Topknot Pigeon nests, Gogerley (1925, p. 277) stated: "Almost all the nests I have seen have been bulky…" therefore the assumption I made about the nest in which I placed the young bird appeared correct. However, on 8 November 1986 I found that the nest I had placed the bird near, was that of Grey Butcherbirds *Cracticus torquatus* with two fledglings. Another nest was found lower in the tree that was relatively frail that was then considered more probably the actual Topknot Pigeon's nest.

Gogerley (1925) also found a nest with two eggs occupied by a Wonga Pigeon *Leucosarcia melanoleuca*. On the ground beneath the nest the remains of a Topknot Pigeon egg was found leading him to assume that the nest had previously been occupied by a Topknot Pigeon.

Gogerley (1925, p. 227) said "In many cases I have been able to see into the nests by standing in the saddle when on horse-back" whereas Frith (1982, p. 141) said "The nests reported were 30m or more above the ground". Higgins & Davies (1996) stated that nests are usually in the crown of a tree. There is obviously much variation in both the nest size and structure and its height above ground. However the use of a *Melaleuca* sp. tree at Booti Booti National Park is in agreement with Gogerley (1925, p. 276) who said "The first nest was built in a paper-bark tree" He also reported finding nests in a brush box tree, a lilli-pilli tree, a forest oak and in a parasitic fig tree.

According to Higgins & Davies (1996, p. 1014), the breeding season for Topknot Pigeons in NSW is "eggs, late Oct., early Nov. and Dec". This record conforms to that time frame.

Morris (2010) mistakenly reported the first Hunter Region breeding record for Topknot Pigeon based on a report from Stuart (2006). This record at Branxton on 25 August and 29 September 2005 was of a Topknot Pigeon on a nest but did not confirm eggs or chicks. Stuart (2006, p. 41) included the comment: "Although it is likely that the birds bred, this is not considered to be a definite breeding record." Morris (2010) was also apparently unaware of the earlier report of Gogerley (1925).

REFERENCES

Frith, H.J. (1982). 'Pigeons and Doves of Australia'. (Rigby Publishers: Adelaide)

Gogerley, J.F.H. (1925). Early Breeding of the Top-knot Pigeon *(Lopholaimus antarcticus), Emu – Austral Ornithology*, **24**:4, 276-277, DOI: 10.1071/MU924276

Higgins, P.J. and Davies, S.J.J.F. (Eds) (1996). 'Handbook of Australian, New Zealand & Antarctic Birds: Volume 3: Snipe to Pigeons'. (Oxford University Press: Melbourne.)

Morris, A.K. (2010). *Australian Birds, Journal of the N.S.W. Field Ornithologist Club Vol 34 No.2 Annual Bird Report 2005,* p.29.

Stuart, A. (Ed.). (2006). Hunter Region of New South Wales Annual Bird Report Number **13** (2005). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

Comparison of bird species recorded in surveys of Booti Booti National Park undertaken 27 years apart

David Turner

23 Murray Avenue, Forster, NSW 2428, Australia dnt1@y7mail.com

Received 18 February 2019, accepted 19 January 2020, published on-line 3 March 2020.

Two sets of 3-year duration bird surveys were undertaken in Booti Booti National Park with an interval of 27 years. A total of 206 species were recorded, of which 22 species are listed as either vulnerable or endangered under the *Biodiversity Conservation Act 2016* (NSW; BC Act) and the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth; EPBC Act).

The northern boundary of Booti Booti National Park is situated approximately 7 km south of Forster on the Mid North Coast of New South Wales. It contains a wide variety of habitats including wetlands, heath, forest and rainforest within its 1586 ha and has an equally diverse bird population.

A total of 188 species were recorded during the first survey period (1985-1988) and 167 species during the second (2012-2015). This represented an 11.2% decline in the number of species between the two surveys. No obvious reasons can be attributed to these changes. Changes could be a combination of environmental factors such as weather changes, feral animals and fire management or surrounding residential developments.

Over the two sets of surveys, 55 species were recorded breeding. Whilst the first set of surveys found 48 breeding species, there were only 20 species found breeding during the second set of surveys. This is a reduction of 58.3%. Interesting breeding records included Topknot Pigeon *Lopholaimus antarcticus* during the first set of surveys and Osprey *Pandion haliaetus*, classed as vulnerable under the BC Act, during the second. Australian Pied Oystercatcher *Haematopus longirostris,* considered endangered under the BC Act, and the Australian Pelican *Pelecanus conspicillatus* were found to be breeding during both sets of surveys.

INTRODUCTION

Booti Booti National Park (BBNP) was originally set aside as Booti Booti State Recreation Area (BBSRA) on 30 September 1977 and consisted of ~800 ha. In 1992, it was re-dedicated as National Park, with the inclusion of additional estate to a total of 1586 ha. Situated between Forster to the north, Pacific Palms to the south, the Pacific Ocean to the east and Wallis Lake to the west, the park also includes eight islands within Wallis Lake: Shepherd, Little Snake, Snake, Pelican, Coomba, Black Rocks, Earps and Booti (**Figures 1** and **2**).

BBNP is dominated by three elevated headlands, Cape Hawke (224 m), Booti Hill (169 m) and Charlotte Head (96 m) (**Figure 2**). Cape Hawke, in the north, is joined to Booti Hill and Charlotte Head, to the south, by a low-lying isthmus. Ramsay (1987) stated: *"The isthmus forms a barrier between Wallis Lake and the Pacific Ocean. The clays and cemented sands underlying the isthmus contain a perched aquifer which results in large swampy areas between the drier well-drained dune ridges. The headlands comprise sandstone and siltstone conglomerate which have resulted in unstable coarse soils which are very susceptible to erosion if disturbed"* (Ramsay 1987, p.5).

Griffith *et al.* (1999) gave a general description of BBNP and Yahoo Nature Reserve (Yahoo Nature Reserve covers the whole of Yahoo Island and is not part of Booti Booti National Park) as a *"... complex mosaic of sedgelands, heathlands, swamp forests, dry forests, wet forests and rainforest",* also noting that *"A total of 46 different vegetation communities occur within the reserves..."* (p. 27). Moreover, in this complex mosaic, *"Four communities contain threatened plant species. Six of the 46 communities are not known to be reserved elsewhere in northern NSW... An additional nine communities are considered to* *have high conservation significance as coastal wetland vegetation."* (p. 27).

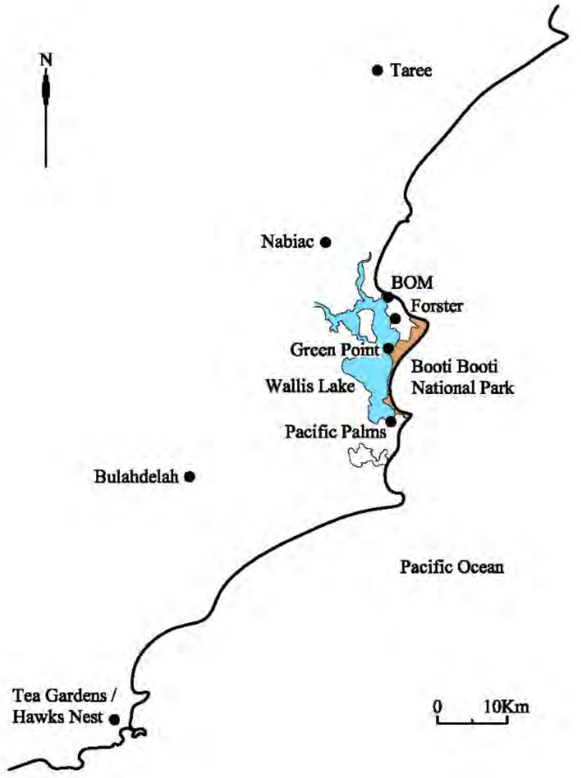


Figure 1. Locality sketch

As BBSRA, the reserve was managed for recreational activities (fishing, swimming, camping), but with regard for intrinsic conservation values (Griffith *et al*. 2000). Between 1969 and 1975, the area behind Seven Mile Beach was mined for heavy minerals and the area behind Elizabeth Beach was also mined between 1969 and 1970 (Griffith *et al*. 2000). Following mining, disturbed areas were rehabilitated with introduced plant species such as Bitou Bush *Chrysanthemoides monolifera* ssp. *rotundata* and non-endemic species such as Horse-tailed Sheoak *Casuarina equisetifolia* ssp. *incana* (Griffith *et al*. 2000). Numerous small cabins were available for hire in the Santa Barbara picnic area from approximately the mid-1950s through to the late 1970s (D. Hartmann pers. comm.). Early on during this tenure, numerous Norfolk Island Pines *Araucaria heterophylla* were planted and remain today.

Prior to the area being set aside as park, very little is known of the fire history of the area. Cape Hawke was last known to have burnt in a wildfire around 1955 (R. Underwood pers. comm.). Photos showed that all vegetation on top of Cape Hawke was completely destroyed. Today, stumps of trees over 2 m in diameter can still be seen near the summit. Apart from Cape Hawke, most of the park would have been burnt, by either hazard reduction or wildfire, at least twice during the period 1985 to 2015 (pers. obs.).

The nearest Bureau of Meteorology (BOM 2016) recording station (No. 60013) is located adjacent to Forster breakwall, ~7 km north of the northern park boundary on The Lakes Way. Average rainfall for the area is 1226 mm (years 1896 to 2015) from an average of 89 rain days per year. The highest day-time temperature recorded is 43˚ (December 2004) with a December mean of 28.2˚ (1999 to 2016). Conversely, the lowest temperature recorded was 2˚ (August 2012) with a July mean of 6.9˚ (1999 to 2016).

Objectives

The main objective for this paper is to document the birdlife of a sizable area within the Hunter Region for which little information has been reported previously, the Booti Booti National Park. The availability of results from a set of surveys carried out in the 1980s as well as from a more recent set of surveys also allowed the opportunity for comparisons of the two data sets and to consider what changes in the National Park's birdlife have occurred across an interval of approximately three decades. Although the survey methodologies were not exactly the same in the two sets of surveys, they were similar enough for indicative conclusions about changes to be made and for reasons to be considered when there appeared to have been significant changes.

METHODS

The initial set of surveys of BBSRA was undertaken between June 1985 and May 1988 with surveys conducted in all 36 months (**Table 1**). The surveys were carried out opportunistically while carrying out functions as the onsite National Parks and Wildlife Service ranger within the reserve. Identifications were made either audibly or visually with use of binoculars and occasionally a telescope.

Between September 2012 and August 2015, a second set of surveys was undertaken across the expanded BBNP footprint, with surveys made in 35 of the possible 36 months (**Table 1**). These surveys were mostly carried out in the morning, commencing within one hour after sunrise and lasted for ~three hours. Occasional surveys were also undertaken at other times of the day and evening during the second survey period.

Figure 2. Booti Booti National Park

The various habitat areas were visited in a random fashion, with some areas visited many times while others only once during the year. The entire length of Seven Mile Beach was walked following storm events to search for seabird beach wrecks.

Birds were recorded either within the park, flying over the park or observed from within the park (e.g. out to sea from the beach). Additionally, birds were also recorded within the village of Green Point, the tourist facilities of Camp Elim and Tiona and The Lakes Way road reserve, which are all bordered by the park (**Figure 2**). Several access tracks / fire trails were closed between surveys and hence were no longer accessible during the second survey. Access to the islands within BBNP (Wallis Lake) was not practical on a regular basis but waterbirds on the islands were able to be recorded from viewing points on the mainland using binoculars.

For seasonal migration comparisons, the following months have been combined: winter (June, July and August) and summer (December, January and February). For inclusion as a summer migrant, a species needed to be recorded a minimum of four times during summer and at least five times more frequently than any winter records (Newman 2007). For a winter migrant, this is reversed.

Breeding records were based on the following criteria: active visible nest, feeding of a dependent juvenile, observing a recently fledged juvenile or repeated visits to a nest (e.g. termitarium by a kingfisher or bank hole by pardalote) or small patch of vegetation (e.g. clump of grass by a fairy-wren) with food.

The observation frequency of each species was statistically tested between each survey set using the Yates-corrected Chi-squared test (Fowler & Cohen 1994). Where the expected frequency of any species was less than 5 in either survey set, species were omitted from further testing, due to insufficient observations. For one degree of freedom, Chi-squared results between 3.84 and 6.62 are considered to be 'Significant', while over 6.63 the result is 'Highly Significant'.

During the period between June 1988 and October 2006, I continued to document bird observations whilst working in BBSRA / BBNP. Supplementary records were also sourced from observations reported by visiting birdwatchers, in forums such as bird club newsletters and Hunterbirding.

RESULTS

From the surveys, 206 species of birds were recorded, with 21 more species recorded during the first survey (n = 188; 1985 to 1988) than the second (n = 167; 2012 to 2015). The observation of a further eight supplementary species, increased this total to 214, of which 22 are listed as vulnerable or endangered under the *Biodiversity Conservation Act 2016* (NSW; BC Act) or vulnerable, endangered or critically endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth; EPBC Act) (**Table 2**). Full details of the species recorded and their seasonal Reporting Rates are presented in the **Appendix**; some highlights are presented below.

The average number of species recorded monthly during the first survey was slightly less than those recorded during the second, being 71 (range 18-110) and 75 (range 43-99) respectively (**Table 1**).

Table 1. Summary of monthly totals of birds recorded during two sets of *c*. 3 year-duration surveys in Booti Booti NP.

Month	Survey 1					Survey 2				
	1985	1986	1987	1988	Average	2012	2013	2014	2015	Average
January		85	75	80	80		87	81	76	81
February		62	67	58	62		63	87	79	76
March		110	69	53	77		49	79	82	70
April		75	69	62	69		80	43	79	67
May		65	51	59	58		69	79	63	70
June	74	70	65		70		63	59	68	63
July	83	80	18		60		83	79	75	79
August	74	67	43		61		50	74	83	69
September	105	67	72		81	63		94		79
October	87	83	64		78	99	96	56		84
November	95	84	54		78	65	94	84		81
December	69	71	82		74	68	87	98		84
Total	n = 36				**71**	n = 35				**75**

Table 2. Species recorded in Booti Booti NP listed as threatened under the *Biodiversity Conservation Act 2016* (NSW; BC Act) or the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). E = endangered, V = vulnerable, CE = critically endangered, E1 = endangered and V1 = vulnerable.

Species	BC Act		EPBC Act		
	E	V	CE	E1	V1
Wompoo Fruit-dove *Ptilinopus magnificus*		Yes			
Rose-crowned Fruit-Dove *Ptilinopus regina*		Yes			
White-throated Needletail *Hirundapus caudacutus*					Yes
Australian Pied Oystercatcher *Haematopus longirostris*	Yes				
Sooty Oystercatcher *Haematopus fuliginosus*		Yes			
Eastern Curlew *Numenius madagascariensis*	Yes		Yes		
Bar-tailed Godwit *Limosa lapponica*					Yes
Red Knot *Calidris canutus*				Yes	
Curlew Sandpiper *Calidris ruficollis*	Yes		Yes		
Sooty Tern *Onychoprion fuscatus*		Yes			
Little Tern *Sternula albifrons*	Yes				
Black-browed Albatross *Thalassarche melanophris*		Yes			Yes
Gould's Petrel *Pterodroma leucoptera*		Yes		Yes	
Black-necked Stork *Ephippiorhynchus asiaticus*	Yes				
Osprey *Pandion haliaetus*		Yes			
Little Eagle *Hieraaetus morphnoides*		Yes			
White-bellied Sea-Eagle *Haliaeetus leucogaster*		Yes			
Masked Owl *Tyto novaehollandiae*		Yes			
Glossy Black-Cockatoo *Calyptorhynchus lathami*		Yes			
Little Lorikeet *Glossopsitta pusilla*		Yes			
White-fronted Chat *Epthianura albifrons*		Yes			
Varied Sittella *Daphoenositta chrysoptera*		Yes			
Dusky Woodswallow *Artamus cyanopterus*		Yes			
Totals	**5**	**15**	**2**	**2**	**2**

Species recorded in 80% or more of each of the surveys have been considered as resident within the dataset (refer **Appendix**: available at www.hboc.org.au/the-whistler-volume-14/). Of the resident 34 species during survey one, seven were recorded in all surveys (*n* = 36) with an additional seven species only absent from one survey (*n* = 35). Similarly, during survey two, 43 species are considered resident with nine recorded in 100% of survey months (*n* = 35) and a further six absent from one survey only (*n* = 34). From these two data sets, 27 species were classed as resident across both surveys. A total of 55 species were recorded breeding within or immediately adjacent to the park (**Table 3**).

Table 3. Species recorded breeding within or immediately adjacent to Booti Booti NP.
S1 = Survey one; S2 = Survey two.

Species	S1	S2	Species	S1	S2
Black Swan	Yes		Striped Honeyeater		
Pacific Black Duck	Yes		Brown Honeyeater		Yes
Australian Wood Duck	Yes		White-cheeked Honeyeater	Yes	Yes
Brown Quail			Little Wattlebird	Yes	
Topknot Pigeon	Yes		Red Wattlebird	Yes	
Eastern Koel	Yes		Yellow-faced Honeyeater	Yes	
Channel-billed Cuckoo	Yes		Noisy Miner	Yes	
Tawny Frogmouth	Yes	Yes	Striated Pardalote	Yes	
Purple Swamphen	Yes	Yes	Brown Gerygone		Yes
Australian Pied Oystercatcher [E]	Yes	Yes	Yellow Thornbill	Yes	
Masked Lapwing	Yes	Yes	Varied Sittella [V]	Yes	
Australian Pelican	Yes	Yes	Black-faced Cuckoo-shrike	Yes	
White-faced Heron	Yes		Golden Whistler	Yes	
Eastern Osprey [V]		Yes	Australasian Figbird	Yes	Yes
White-bellied Sea-Eagle [V]	Yes		Olive-backed Oriole	Yes	Yes
Whistling Kite	Yes	Yes	Pied Currawong	Yes	

Table 3. Species recorded breeding within or immediately adjacent to Booti Booti NP (cont.).
S1 = Survey one; S2 = Survey two.

Species	S1	S2	Species	S1	S2
Rainbow Bee-eater	Yes	Yes	Australian Magpie	Yes	
Dollarbird	Yes		Grey Butcherbird	Yes	
Azure Kingfisher	Yes		Dusky Woodswallow [V]	Yes	
Sacred Kingfisher	Yes		White-breasted Woodswallow	Yes	Yes
Laughing Kookaburra	Yes	Yes	Willie Wagtail	Yes	
Yellow-tailed Black-Cockatoo	Yes		Grey Fantail	Yes	
Little Corella		Yes	Leaden Flycatcher	Yes	Yes
Scaly-breasted Lorikeet	Yes		Eastern Yellow Robin		Yes
Green Catbird	Yes		Golden-headed Cisticola	Yes	
Satin Bowerbird	Yes		Welcome Swallow	Yes	
Variegated Fairy-wren	Yes	Yes	Silvereye	Yes	
Superb Fairy-wren	Yes	Yes			

Although 39 species recorded during the first survey period were absent from the second, 31 of these could be classed as vagrant or occasional visitors with recording rates less than 12% and a further five species were recorded less than 40% of the time. Of the remaining three species Brown Quail *Synoicus ypsilophorus* and Golden-headed Cisticola *Cisticola exilis* were recorded moderately often, 50% and 44% respectively, while Dusky Woodswallow *Artamus cyanopterus* was a breeding resident with a 92% recording rate. Conversely, 18 species recorded during the second survey period were absent during the first. Occasional visitors comprised 11 species, with four species in less than 40% of survey months while the remaining three, namely Little Corella *Cacatua sanguinea*, Brown Honeyeater *Lichmera indistincta* and Pied Butcherbird *Cracticus nigrogularis* were recorded greater than 60% of survey months. Moreover, the Pied Butcherbird is now classed as a resident species with a recording rate of 80%.

During survey one, 21 species were classed as either winter (n = 7) or summer (n = 14) migrants to BBSRA / BBNP. During survey two, the number of species considered to be seasonal migrants dropped to 14, being two and 12 respectively. Combining both survey periods, six species, Eastern Koel *Eudynamys orientalis*, White-throated Needletail *Hirundapus caudacutus*, Dollarbird *Eurystomus orientalis*, Rufous Whistler *Pachycephala rufiventris*, White-breasted Woodswallow *Artamus leucorynchus* and Rufous Fantail *Rhipidura rufifrons* were summer migrants (**Table 4**).

Table 4. Species recorded as either summer or winter migrants to Booti Booti NP with a comparison to the 2017 Hunter Region Annual Bird Report (ABR) (Stuart 2018). Altitudinal migrant (AM), bird of passage (BOP), resident (R), summer migrant (SM) and winter migrant (WM).

Species	Survey 1		Survey 2		Status ABR
	Summer	Winter	Summer	Winter	
Topknot Pigeon *Lopholaimus antarcticus*				Yes	R
Eastern Koel *Eudynamys orientalis*	Yes		Yes		SM
Channel-billed Cuckoo *Scythrops novaehollandiae*	Yes				SM
Fan-tailed Cuckoo *Cacomantis flabelliformis*				Yes	R
White-throated Needletail *Hirundapus caudacutus*	Yes		Yes		SM
Pacific Golden Plover *Pluvialis fulva*			Yes		SM
Bar-tailed Godwit *Limosa lapponica*	Yes				SM
Sharp-tailed Sandpiper *Calidris acuminata*			Yes		SM
Great Egret *Ardea alba*		Yes			R
Little Egret *Egretta garzetta*		Yes			R
Rainbow Bee-eater *Merops ornatus*	Yes				SM
Dollarbird *Eurystomus orientalis*	Yes		Yes		SM
Sacred Kingfisher *Todiramphus sanctus*	Yes				SM
Nankeen Kestrel *Falco cenchroides*		Yes			R
Green Catbird *Ailuroedus crassirostris*			Yes		R
Striped Honeyeater *Plectorhyncha lanceolata*			Yes		R

Table 4. Species recorded as either summer or winter migrants to Booti Booti NP with a comparison to the 2017 Hunter Region Annual Bird Report (ABR) (Stuart 2018). Altitudinal migrant (AM), bird of passage (BOP), resident (R), summer migrant (SM) and winter migrant (WM) (cont.).

Species	**Survey 1**		**Survey 2**		**Status ABR**
	Summer	**Winter**	**Summer**	**Winter**	
Striated Pardalote *Pardalotus striatus*		Yes			R
Brown Gerygone *Gerygone mouki*		Yes			R
Cicadabird *Edolisoma tenuirostris*	Yes				SM
Rufous Whistler *Pachycephala rufiventris*	Yes		Yes		SM
Olive-backed Oriole *Oriolus sagittatus*	Yes				R
White-breasted Woodswallow *Artamus leucorynchus*	Yes		Yes		SM
Spangled Drongo *Dicrurus bracteatus*		Yes			WM / BOP
Rufous Fantail *Rhipidura rufifrons*	Yes		Yes		SM
Leaden Flycatcher *Myiagra rubecula*	Yes				SM
Black-faced Monarch *Monarcha melanopsis*			Yes		SM
Rose Robin *Petroica rosea*		Yes			AM
Golden-headed Cisticola *Cisticola exilis*	Yes				R
Tawny Grassbird *Cincloramphus timoriensis*			Yes		R
Total	**14**	**7**	**12**	**2**	

The Chi-squared test produced 14 significant and 19 highly significant changes (**Table 5**) to the status of species over both sets of surveys. Some of these changes are easily accounted for as I lived in the park during the first set of surveys. Several species were resident around the house or called at dusk and dawn and consequently were recorded regularly. Conversely, as a park ranger carrying out duties, appropriate time was not spent identifying birds with unfamiliar calls and were more likely under recorded. Additionally, not all areas of the park were visited on a regular basis whilst undertaking these duties and, as such, birds requiring more specialised habitat requirements will have also been under recorded.

Over such a long time span, range extensions or contractions may have occurred or are occurring with some species. Park management techniques can impact species both positively and negatively, as do changes to land use adjacent to the park. My ability at identifying calls during the preceding interval also matured, resulting in an increased recording rate of some vocally and anatomically similar species.

Further commentary on these changes is made in the individual order / family accounts within the discussion section of the paper.

Table 5. Results of Chi-squared test between two sets of *c*.3-year duration bird surveys in Booti Booti NP. Survey 1 (S1) is from June 1985 to May 1988 and Survey 2 (S2) is between September 2012 and August 2015.

Species	**Number of Records**		χ^2	**Statistical Significance**
	S1	**S2**		
Pacific Black Duck *Anas superciliosa*	27	13	3.87	Significant
Australian Brush-turkey *Alectura lathami*		11	9.38	Highly Significant
Brown Quail *Synoicus ypsilophorus*	18		15.58	Highly Significant
Brown Cuckoo-Dove *Macropygia phasianella*	5	16	5.05	Significant
Pheasant Coucal *Centropus phasianinus*	22	2	14.51	Highly Significant
Pied Stilt *Himantopus leucocephalus*	1	18	13.93	Highly Significant
Pied Cormorant *Phalacrocorax varius*	17	31	3.90	Significant
Osprey ^{V} *Pandion haliaetus*	4	27	16.24	Highly Significant
Black-shouldered Kite *Elanus axillaris*	25	8	7.31	Highly Significant
Brahminy Kite *Haliastur indus*	2	23	16.57	Highly Significant
Nankeen Kestrel *Falco cenchroides*	14		11.71	Highly Significant
Little Corella *Cacatua sanguinea*		22	20.65	Highly Significant
Australian King-Parrot *Alisterus scapularis*	26	10	5.84	Significant
Eastern Rosella *Platycercus eximius*	36	19	4.22	Significant
Rainbow Lorikeet *Trichoglossus moluccanus*	5	33	19.96	Highly Significant

Table 5. Results of Chi-squared test between two sets of *c*.3-year duration bird surveys in Booti Booti NP. Survey 1 (S1) is from June 1985 to May 1988 and Survey 2 (S2) is between September 2012 and August 2015 (cont.).

Species	Number of Records		χ^2	Statistical Significance
	S1	S2		
Green Catbird *Ailuroedus crassirostris*	35	18	4.39	Significant
Satin Bowerbird *Ptilonorhynchus violaceus*	33	9	11.96	Highly Significant
White-throated Treecreeper *Cormobates leucophaea*	12	27	5.43	Significant
Superb Fairy-wren *Malurus cyaneus*	17	35	6.05	Significant
Brown Honeyeater *Lichmera indistincta*		24	22.70	Highly Significant
New Holland Honeyeater *Phylidonyris novaehollandiae*	18	33	4.25	Significant
Striated Pardalote *Pardalotus striatus*	13	1	8.34	Highly Significant
Brown Gerygone *Gerygone mouki*	14	29	4.96	Significant
Brown Thornbill *Acanthiza pusilla*	16	33	5.69	Significant
Pied Butcherbird *Cracticus nigrogularis*		28	26.81	Highly Significant
Dusky Woodswallow [V] *Artamus cyanopterus*	33		30.14	Highly Significant
Forest Raven *Corvus tasmanicus*	2	12	6.04	Significant
Magpie-lark *Grallina cyanoleuca*	6	32	17.16	Highly Significant
Black-faced Monarch *Monarcha melanopsis*	2	14	7.88	Highly Significant
Australasian Pipit *Anthus novaeseelandiae*	14	4	4.25	Significant
Golden-headed Cisticola *Cisticola exilis*	16		13.65	Highly Significant
Tree Martin *Petrochelidon nigricans*	10	1	5.60	Significant
Common Myna *Acridotheres tristis*		13	11.42	Highly Significant

DISCUSSION

The original survey (1985-1988) was initiated to record a baseline avifauna list for BBSRA. Living and working within the reserve during the first survey period potentially influenced results in favour of more cryptic and locally isolated populations.

The following paragraphs provide some commentary on the observations of the various orders / family groups of birds recorded during both survey periods and generally within BBSRA / BBNP between 1985 and 2015. Details about the records for every species are presented in the **Appendix**.

Ducks (Anseriformes): Moderately represented by six species with three recorded breeding. Two species, Chestnut Teal *Anas castanea* and Australian Wood Duck *Chenonetta jubata*, recorded slight decreases in recording rates between surveys. This was in contrast to Grey Teal *Anas gracilis*, which although recorded a substantial increase, was not actually statistically significant. Australian Wood Duck was a common breeding resident, in the vicinity of The Ruins campground, prior to the second survey, but is now predominately confined to the Cape Hawke valley and adjacent residential areas. The increase in records of Grey Teal between the first and second survey period is partly due to an area of the park being visited more regularly during the second period. The decline in observation rates of the Pacific Black Duck *Anas superciliosa* between surveys was however statistically significant but cannot be explained, except for a lower rainfall during S2 resulting in less patches of water being available for the species. Pacific Black Duck was also recorded breeding during the first survey period.

Brush-turkey & Quails (Galliformes): Two species of quail, Stubble *Coturnix pectoralis* (only recorded once) and Brown were recorded during the first survey only. Brown Quail was a moderately common species along The Lakes Way, north of Green Point Drive in the first set of surveys, but changes to mowing patterns of the road verges by the local Council may have influenced its recording rate in the second set of surveys. Additionally, the increased presence of wild dogs *Canis sp.* and Red Fox *Vulpes vulpes* may have impacted the bird's abundance within the park. The lack of sightings during the second survey period resulted in a highly significant statistical change. During June 2016, subsequent to the second set of surveys, three coveys of Brown Quail were observed, including one covey with dependent chicks.

Grebes (Podicepiformes): Recorded in the first survey only and only on three occasions, the

Australasian Grebe *Tachybaptus novaehollandiae* was a vagrant within the park.

Pigeon & Doves (Columbiformes): This order was well represented with 12 species recorded during the surveys and one, Rose-crowned Fruit-Dove *Ptilinopus regina*, outside them (D. Ongley 10/2016 via Hunterbirding). Four species, White-headed Pigeon *Columba leucomela*, Brown Cuckoo-Dove *Macropygia phasianella*, Wonga Pigeon *Leucosarcia melanoleuca* and Brown-capped Emerald-Dove *Chalcophaps longirostris*, showed substantial increases in recording rates between the first and second surveys. There are no obvious reasons for these increases except better awareness of them. Both being cryptic, the Wompoo Fruit-Dove *Ptilinopus magnificus*, only recorded once during the first set of surveys, and Rose-crowned Fruit-Dove may have been under recorded. Although recorded breeding on one occasion during November 1986, by the presence of a dependent juvenile, the Topknot Pigeon *Lopholaimus antarcticus* was observed as a winter migrant during S2. This winter status could be more accurately redefined as a food migrant, with birds feeding on the fruits of Cabbage Palms *Livistona australis*, which predominately ripen during autumn and winter months. A breeding record of Topknot Pigeon is considered unusual in the Hunter Region (Turner 2020); the only other known record is from Gogerly (1925).

Cuckoos (Cuculiformes): Another well-represented order with nine species recorded. Recording and change rates within this group varied substantially. Both Horsfield's Bronze-Cuckoo *Chalcites basalis* and Black-eared Cuckoo *C. osculans* are considered vagrants with very low recording rates and Pallid Cuckoo *Heteroscenes pallidus* was recorded in the first survey only, again at low rates. Pheasant Coucal *Centropus phasianinus* was moderately common (61% RR) during the first survey, with only a couple of sightings during the second. This decrease is statistically highly significant. Similar to Brown Quail above, the Pheasant Coucal is predominately a ground-dwelling bird and potentially has been impacted by increased predation. In contrast, recording rates for Brush Cuckoo *Cacomantis variolosus* increased from the first to the second survey. Although recorded consistently between surveys, Fan-tailed Cuckoo *Cacomantis flabelliformis* was classed as a winter migrant during the second survey. My residing within the park during the first survey may account for the more consistent recording rate during that period. Additionally, Higgins (1999) states that reduced records in the Australian Capital Territory during November to February may be the result of movement or a reduction in calling. Moreover, within Forster, to the north of the park, there was a strong preference for autumn, winter and spring records (A. Carlson unpub. data January 2001 to April 2006). Regarded as a 'common resident' in the Hunter Region by Stuart (2018, p. 21), the Fan-tailed Cuckoo may show some nomadic movements locally.

Frogmouths & Swifts (Caprimulgiformes): Tawny Frogmouth *Podargus strigoides* was recorded in low numbers during both sets of surveys; however, within the village area of Green Point, a resident pair has been breeding consistently over many years (A. Carlson pers. comm.). Although classed as a summer migrant during both surveys, the White-throated Needletail recorded a moderate decrease between surveys 1 and 2. Tarburton (2014) summarised these decreases on a state-by-state and national scale prompting a revision of the conservation status to Vulnerable under the EPBC Act in 2019.

Rails (Gruiformes): Buff-banded Rail *Hypotaenidia philippensis* and Dusky Moorhen *Gallinula tenebrosa* were both recorded in single surveys only being survey 1 and 2 respectively. With reasonable expanses of suitable habitat within the park, which are not easily accessible, and their cryptic nature, Buff-banded Rails may easily be under-recorded. Although recording rates increased moderately between the first and second surveys, the Purple Swamphen *Porphyrio porphyrio* is also probably under-recorded within the park. Observations of adults with small dependent chicks on several occasions confirmed breeding by this species.

Waders, Gulls & Terns (Charadriiformes): Although well represented by 30 species, including one, being the Painted Button-quail *Turnix varius* which was recorded between surveys, many (n = 19) were recorded as vagrants only in either or both of the two surveys. This order does however contain both Australian Pied *Haematopus longirostris* and Sooty Oystercatcher *H. fuliginosus*, listed as endangered and vulnerable respectively, and Curlew Sandpiper *Calidris ferruginea* and Little Tern *Sternula albifrons* both listed as endangered under the BC Act 2016 and the EPBC Act 1999. Both Australian Pied Oystercatcher and Masked Lapwing *Vanellus miles* were recorded as breeding. Masked Lapwing was observed in all months during both survey periods and along with Silver Gull *Chroicocephalus* *novaehollandiae* and Crested Tern *Thalasseus bergii* are considered resident species. Caspian Tern *Hydroprogne caspia* is known to utilise Pelican Island periodically, and as this island was not accessed routinely, the true status of this species within the park was not determined. Higgins & Davies (1996) suggests that, in some Australian sites seasonal patterns appear consistent with passage, which concurs with Stuart (2018, p. 42) who lists them as 'common bird of passage' within the Hunter Region. Pied Stilt *Himantopus leucocephalus* was recorded statistically highly significantly more during the second survey period than the first. Again, this is mostly due to an area of the park being visited more regularly during the second survey.

Penguins (Sphenisciformes): Little Penguin *Eudyptula minor*. One bird was found on the southern boundary of the park on 22 January 1987. The bird had a broken leg and died a short time after being rescued. This bird was considered to be north of its usual distribution (Marchant & Higgins 1990). The nearest breeding colony was on Statis Rock, Seal Rocks approximately 12 km to the south (Holmes 1977), however no recent breeding records are known from that location.

Albatross, Petrels & Shearwaters (Procellariformes): Predominately this group of birds dominate the mid to open ocean and require additional knowledge to separate species when viewing from the coast. Seven Mile Beach was walked following storm events to search for beach-wrecked birds for identification. While recording rates of the six species observed within this order were all low, counts, especially beach wrecks, could number in the hundreds.

Herons, Egrets, Ibis & Cormorants (Pelecaniformes): 18 species were recorded within this diverse group of water-dependent birds which includes the endangered Black-necked Stork *Ephippiorhynchus asiaticus* (BC Act 2016). A colony of Australian Pelican *Pelecanus conspicillatus* bred on Pelican Island, within Wallis Lake (Turner 1993), for many years prior to relocating to adjacent, but less suitable, Snake Island (Stuart *et al.* 2012). Pelican Island is an exposed sand island which is now subject to inundation during higher tides. Observations and estimates of the breeding events could be made from the village of Green Point. A second species, White-faced Heron *Egretta novaehollandiae*, was also recorded breeding within the park. Of the 18 species observed within this order, only the two recorded breeding are regarded as resident during both surveys, while Pied Cormorant *Phalacrocorax varius* is considered resident during the second survey period. The statistically significant increase in Pied Cormorant records could be related to a breeding colony that exists at Forster (pers. obs.). All four cormorant species are resident within Wallis Lake, adjacent to the park. Two species, Great Egret *Ardea alba* and Little Egret *Egretta garzetta* were considered winter migrants during the first survey period, even though the recording rates were similar between each survey period (n = 50, S1 and n = 63, S2; n = 33, S1 and n = 43, S2, respectively).

Kites, Eagles & Goshawks (Accipitriformes): Of the nine species recorded during the surveys, three were observed breeding. This includes Osprey *Pandion haliaetus* and White-bellied Sea-Eagle *Haliaeetus leucogaster* which are listed as vulnerable under the BC Act 2016. The third species, Whistling Kite *Haliastur sphenurus*, regularly nested in the Norfolk Island Pines within the Santa Barbara Picnic area. Two species, Osprey and Brahminy Kite *Haliastur indus* showed statistically highly significant increases in observation rates. In particular, the increase in observations of Brahminy Kite correlates with the southern expansion of its range as noted by Stuart (2018). Conversely, observations of Black-shouldered Kite *Elanus axillaris* recorded a statistically highly significant decrease between the surveys, as land use adjacent to the park slowly changed from cleared farmland to residential dwellings. Pacific Baza *Aviceda subcristata* and Grey Goshawk *Accipiter novaehollandiae* were recorded outside of the two survey periods.

Owls (Strigiformes): Barn Owl *Tyto alba* and Southern Boobook *Ninox boobook* were recorded during either one or both surveys. The substantial reduction in recording rates of the Boobook most likely is related to my residing within the park during the first survey. Boobooks are resident in the Cape Hawke valley, adjacent to the northern end of the park, and would most likely utilise the park for foraging at times. Masked Owl *Tyto novaehollandiae* was reported in 1985 (T. Rose pers. comm.) and has been recorded recently in the Cape Hawke valley using both the NP and the rural residential properties adjacent to it (pers. obs.).

Bee-eater, Dollarbird & Kingfishers (Coraciiformes): All five species observed within this order were recorded breeding. Only the Laughing Kookaburra *Dacelo novaeguineae* is classed as resident and hence a non-migrant. Rainbow Bee-eater *Merops ornatus*, Dollarbird

Eurystomus orientalis and Sacred Kingfisher *Todiramphus sanctus* were either summer migrants during one or both survey periods. Although not explained, the substantial reduction in observations of Azure Kingfisher *Ceyx azureus* between surveys is also reflected by reduced observations of the species within Forster, to the north of the park (pers. obs.).

Falcons (Falconidae): Although well represented by four species, they were all recorded at relatively low rates. Similar to the Black-shouldered Kite, Nankeen Kestrel *Falco cenchroides* also recorded a statistically highly significant decrease between the surveys, again with land use adjacent to the park slowly changing being the most plausible reason. Two Brown Falcon *Falco berigora* were present at commencement of the first set of surveys, however both became road-kill victims, one in July 1985, one month into the first survey period, and the second, in the middle of 1987. This species has only been sighted sporadically since then.

Cockatoos, Parrots & Lorikeets (Psittaciformes): Of the 13 species recorded during the two surveys, the single sighting of Budgerigar *Melopsittacus undulatus*, is classed as an aviary escapee. Yellow-tailed Black-Cockatoo *Zanda funereus* and Scaly-breasted Lorikeet *Trichoglossus chlorolepidotus* were recorded as breeding residents during both surveys. Although Eastern Rosella *Platycercus eximius* was considered resident during the first survey, a 54% observation rate during the second set of surveys resulted in a statistically significant decrease. Similarly, Australian King-Parrot *Alisterus scapularis* also recorded a statistically significant decrease in observations, with both species common residents within nearby residential areas. Conversely, Rainbow Lorikeet *Trichoglossus moluccanus* and Little Corella both recorded statistically highly significant increases in observations, which correlates to increases for Rainbow Lorikeet generally along the east coast through the provision of long-flowering flora species in residential gardens (Forshaw & Cooper 2016).

Passeriformes

Bowerbirds (Ptilonorhynchidae): Satin Bowerbird *Ptilonorhynchus violaceus* and Green Catbird *Ailuroedus crassirostris* were observed breeding in the park and both were recorded in more than 90% of months during the first set of surveys. However, during the second set of surveys, both species were observed substantially less, with statistical highly significant and significant decreases calculated respectively. Living in the park during the first survey period certainly influenced observations of Satin Bowerbird in particular, with a resident male attending a bower within 20 m of the garden. Reduced Catbird records during the second set of surveys resulted in the species being recorded as a summer migrant. A cryptic species, Catbirds are often recorded by call and in Brisbane, Woodall (1997) recorded increased call rates during the spring / early summer period, which correlates with the summer migrant status for the species during the second set of surveys. Observations of Regent Bowerbird *Sericulus chrysocephalus* remained consistent across both surveys.

Treecreepers Climacteridae): White-throated Treecreeper *Cormobates leucophaea* was the only species observed within this family with recordings increasing statistically significantly between the first and second set of surveys. This change correlates with my improved audible identification of the species.

Fairy-wrens (Maluridae): Two of the four wren species recorded were also observed breeding, being Variegated *Malurus lamberti* and Superb Fairy-wren *M. cyaneus*. Both species also went from moderate observations to resident status between surveys. The increase of Superb Fairy-wren records, which was statistically significant, is related to my increased ability to identify females without seeing an accompanying male. The increase in records of Southern Emu-wren *Stipiturus malachurus* from the first to the second survey periods was helped by the presence of a second person during some of the surveys with hearing able to detect the higher-pitched calls of this species.

Honeyeaters (Meliphagidae): Another well represented family with 18 species recorded during surveys and White-eared Honeyeater *Nesoptilotis leucotis* observed between surveys. Seven species were recorded breeding and one species, White-fronted Chat *Epthianura albifrons*, is listed as vulnerable (BC Act 2016). However, White-fronted Chat was not observed during the second survey period and the decline of this species within the park between surveys also correlated with the decline in observations of the species in the Forster Keys area north-west of the park (pers. obs.). Two species recorded statistical increases in recording rates, being Brown Honeyeater highly significantly, which was also recorded breeding, and New Holland Honeyeater *Phylidonyris novaehollandiae* significantly. Although Striped Honeyeater *Plectorhyncha lanceolata* observations increased between surveys from vagrant to low/ moderate status, the change was not statistically significant. Immediately north-west of BBNP in the Pipers Bay area, Striped Honeyeater is considered a breeding resident (A. Carlson unpub. data June 2012 to date). Although White-cheeked *Phylidonyris niger*, Tawny-crowned *Glyciphila melanops* and Yellow-faced Honeyeater *Caligavis chrysops* were observed consistently across both sets of surveys, total numbers of each species were noticeably less during the second survey period. For White-cheeked and Tawny-crowned Honeyeater, inappropriate fire regimes may be contributing to changes in floral diversity required for each species. Known for their large migrating flocks heading north during autumn (Stuart 2018), Yellow-faced Honeyeater does not appear to use BBNP as a conduit in the same numbers as previously. Another species recorded consistently during both surveys and breeding, Noisy Miners *Manorina melanocephala* are now confined to the park edges abutting residential development. Sightings of Little Friarbirds *Philemon citreogularis* in Green Point in September and October 1985 were and still are unusual for a coastal area of the Hunter Region (Stuart 2018).

Pardalotes (Pardalotidae): Both Spotted Pardalote *Pardalotus punctatus* and Striated Pardalote *P. striatus* were observed during the surveys. Although Striated Pardalote was recorded breeding during the first survey period, it was also classed as a winter migrant during the same period. It also recorded a statistically highly significant decrease from the first to the second set of surveys, although it was regularly observed in Forster to the north. Spotted Pardalote was recorded consistently across both surveys.

Gerygones, Scrubwrens & Thornbills (Acanthizidae): A reasonably well-represented family with nine species recorded including two species breeding. Four species, Brown Gerygone *Gerygone mouki*, White-browed Scrubwren *Sericornis frontalis* and Yellow *Acanthiza nana* and Brown Thornbill *A. pusilla*, were classed as resident during the second survey period. Two species, Brown Gerygone and Brown Thornbill, also showed statistically significant increases in recording rates between the two surveys. This is most likely due to observations of both species during S1 being made during working hours and time did not permit following the birds to positively identify them. Brown Gerygone was classed as a winter migrant during the first survey period.

Sittella (Neosittidae): A single species family, Varied Sittella *Daphoenositta chrysoptera*, which is listed as vulnerable under the BC Act 2016, was recorded at low levels during both survey periods and breeding during the first set of surveys.

Cuckoo-shrikes & Trillers (Campephagidae): Three of the five species observed within this family are considered vagrants. Black-faced Cuckoo-shrike *Coracina novaehollandiae* was observed breeding and classed as resident during both surveys. Cicadabird *Edolisoma tenuirostris* was considered a summer migrant during the first set of surveys.

Whistlers and Shrike-thrushes (Pachycephalidae): Both Golden Whistler *Pachycephala pectoralis* and Grey Shrike-thrush *Colluricincla harmonica* were classed as resident during both surveys with Golden Whistler also observed breeding. Similar to its status within the Hunter Region (Stuart 2018), Rufous Whistler *Pachycephala rufiventris* was recorded consistently across both surveys as a summer migrant.

Shrike-tit (Falcunculidae): Another single species family with Crested Shrike-tit *Falcunculus frontatus* recorded in low numbers during both survey periods.

Whipbird (Psophodidae): The only locally endemic species within the family, Eastern Whipbird *Psophodes olivaceus* was classed as a resident during both sets of surveys.

Figbird & Orioles (Oriolidae): Both Australasian Figbird *Sphecotheres vieilloti* (Turner 1995) and Olive-backed Oriole *Oriolus sagittatus* were recorded breeding within the park. The Figbird was recorded consistently between the two surveys at a level just below resident status. The Oriole was classed as a summer migrant during the first survey period. Classed a 'usual resident' within the Hunter Region (Stuart 2018, p. 91) orioles are considered to be 'partially migratory and partially resident' (Higgins *et al*. 2006, p. 368) or 'locally nomadic in response to food-supply fluctuations' (Walther & Jones 2008). Similar to the Topknot Pigeon, Olive-backed Orioles could more accurately be considered food-source nomads rather than summer migrants.

Currawongs, Butcherbirds & Woodswallows (Artamidae): Half of the six species observed within this family are considered breeding residents. A comparison of records between the first (1977-1981) and second (1998-2007) national Birds Australia atlases indicates that some species are extending their range southward at a rate of roughly 150-200 km per decade possibly due to climate change (Silcocks & Sanderson 2007). Pied Butcherbird is one such species, which was not recorded during the first survey period but was found to be resident during the second, a highly significant statistical increase. Conversely, the vulnerable (BC Act 2016) Dusky Woodswallow, was a breeding resident during the first survey and not recorded during the second resulting in a statistically highly significant decline. Observations of the summer breeding migrant White-breasted Woodswallow reduced moderately between the first and second survey periods.

Drongo (Dicruridae): Another single species family, Spangled Drongo *Dicrurus bracteatus* was recorded consistently during both sets of surveys and as a winter migrant during S1.

Fantails (Rhipiduridae): Two of the three species observed, Willie Wagtail *Rhipidura leucophrys* and Grey Fantail *R. albiscapa*, were resident and had breeding records. The third species, Rufous Fantail, was a summer migrant with a single breeding record (A. Carlson pers. comm.).

Crows & Ravens (Corvidae): Torresian Crow *Corvus orru* was classed as a resident species across both surveys. Both Forest Raven *C. tasmanicus* and Australian Raven *C. coronoides* were recorded in low numbers during both sets of surveys, however records of these two species within the park may be under-estimated due to my ability to differentiate their calls. A small increase between survey sets was statistically significant for Forest Raven, a result of better call recognition. Torresian Crows are possibly 'expanding their range' (Stuart 2017, p. 96) and may be progressively pushing Australian Ravens out of the area.

Flycatchers & Monarchs (Monarchidae): Increasing its recording rate between surveys, highly significantly statistically, Magpie-lark *Grallina cyanoleuca* was considered a resident species during the second survey. Although not recorded breeding during either survey, they have been observed breeding regularly within the village of Green Point (A. Carlson pers. comm.) adjacent to the park. Leaden Flycatcher *Myiagra rubecula* was observed moderately as a summer migrant and recorded breeding during both survey periods. Black-faced Monarch *Monarcha melanopsis* recorded a statistically highly significant increase in recording rates and Restless Flycatcher *Myiagra inquieta* was observed within the park outside of the two survey periods.

Robins (Petroicidae): Three robin-type species were observed during both surveys with Eastern Yellow Robin *Eopsaltria australis* considered as a breeding resident. Rose Robin *Petroica rosea* was recorded as a winter migrant during the first survey period but only at low rates during the second. The winter migrant status along the coast correlates with Stuart's (2018, p. 97) classification as a 'usual resident' but an 'altitudinal migrant' within the Hunter Region.

Mistletoebird (Dicaeidae): Mistletoebird *Dicaeum hirundinaceum* was recorded at low rates during both survey periods.

Finches (Estrildidae): Only two finch species were observed with one, Zebra Finch *Taeniopygia guttata*, a White-winged variant, probably an aviary escapee. The second, Red-browed Finch *Neochmia temporalis* was classed as a resident species during both surveys.

Pipits (Motacillidae): Australasian Pipit *Anthus novaeseelandiae* was observed at medium and low levels respectively, during the first and second surveys, resulting in a statistically significant decrease. Generally observed along road verges and within the Pipers Bay wetland area during the first survey, altered slashing regimes along the road verge has been detrimental for this species.

Cisticolas (Cisticolidae): Mostly recorded in spring and summer, when the bird is most vocal (Higgins *et al*. 2006), the Golden-headed Cisticola was not recorded during the second survey. This resulted in a highly significant decline statistically. Located in semi-grazed grassland inside the park on the park's northern boundary, between surveys, cattle were removed from the area allowing regeneration of remanent rainforest vegetation in some sections. The Cisticola is still present in semi-grazed grassland just north and west of the park, in southern Forster / Pipers Bay, but this land is earmarked for development in the future, which will severely impact its long-term outlook.

Songlarks and Grassbirds (Locustellidae): Occupying similar habitat to the Cisticola, the Tawny Grassbird *Cincloramphus timoriensis* was recorded consistently at low to medium levels during both surveys. The second species observed within this family, Brown Songlark *C. cruralis*, was sighted only once during the first survey period.

Reed-Warblers (Acrocephalidae): The only species observed within this family, Australian Reed-Warbler *Acrocephalus australis* was recorded as an incidental observation only during the first survey period.

Martins and Swallows (Hirundinidae): Represented by two species only, Welcome Swallow *Hirundo neoxena* was recorded as a breeding resident during both surveys. The decline in Tree Martins is statistically significant and consistent with Higgins *et al.* (2006, p. 1556) 'Comparison of data in Aust. Atlas (1997-81) and Aust. Atlas (1998-2002) … declines were recorded … on and E of the Great Divide in se. QLD and NSW'.

White-eyes (Zosteropidae): The Silvereye *Zosterops lateralis* was recorded at resident status during both sets of surveys. The migratory patterns of Silvereye sub-species are not well understood (Higgins *et al*. 2006). However, Griffioen & Clarke (2002) suggest that the southern population, subspecies *lateralis*, migrates in a 'south Y' pattern. Such a pattern could result in a consistent transition of sub-species through the park, rather than a year-round permanent population. Close inspections of the individual birds present during surveys was not undertaken to determine which subspecies occupied the park at various times of the year.

Starlings and Myna (Sturnidae): The two Sturnidae species had a recording reversal between the two survey periods. Common Starling *Sturnus vulgaris* was recorded during the first survey only while Common Myna *Acridotheres tristis* was recorded during the second survey only, both at low/medium rates. The increase in Common Myna observations was statistically highly significant and coincides with the general northward movement of the species as indicated in Higgins *et al*. (2006, p. 1941) 'Expanded into Mid-north coast in the 1990's … though not recorded at Forster … till Dec. 2001'.

Thrushes (Turdidae): Observed predominately during winter, thrushes *Zoothera sp.* were recorded at low rates during both surveys. As the two thrush species, Bassian *Z. lunulata* and Russet-tailed *Z. heinei*, are difficult to tell apart by plumage in the field (Higgins *et al.* 2006), the most reliable identification is by call. Records of birds were generally only by brief observation and in dappled light beneath the canopy. A cryptic species, recording rates of thrushes are most likely under-estimated within the park.

CONCLUSIONS

The avifauna of Booti Booti National Park and its proximal areas has not before been fully documented. In two sets of *c.* 3-year surveys conducted approximately three decades apart, in 1985-1988 and 2012-2015, 214 species were recorded (including some species seen opportunistically by other observers, outside of the formal surveys). The relatively high species diversity demonstrates the general importance of the area for birds.

There were marked changes in the status of many species between the 1985-1988 and 2012-2015 survey periods. However, the 27-year interval between survey periods has also leap-frogged some of the incremental changes suspected to have occurred. Changes to species in the area will always occur due to environmental reasons, fire and feral animal management and development adjacent to the park.

The assignment of "migrant" status to some species requires additional work, in order to verify if Booti Booti National Park birds do vary from the generally accepted status applied to birds of the Hunter Region. Also, additional survey effort is required, to investigate the apparent changes to breeding status of some species.

ACKNOWLEDGEMENTS

I wish to acknowledge the help, in both the field and in the preparation of this paper, of Ashley Carlson. His knowledge of the area was invaluable in shaping the bones of this article. Acknowledgement is also made of *The Whistler* editors and an anonymous referee for suggested improvements.

REFERENCES

Appendix. List of species recorded in Booti Booti National Park including reporting rates. This is available on-line at www.hboc.org.au/the-whistler-volume-14/

Bureau of Meteorology (2016). *Climate Statistics for Forster-Tuncurry Marine Rescue*. Bureau of Meteorology, Canberra. Available online: www.bom.gov.au (retrieved 2 May 2016).

Fowler, J. and Cohen, L. (1994). 'Statistics for Ornithologists. BTO Guide 22'. (British Trust for Ornithology: London, United Kingdom.)

Forshaw, J.M. and Cooper, W.T (2016). 'A Natural History of Australian Parrots'. (Nokomis Editions: Buxton, Victoria, Australia.)

Gogerly, J.F.H. (1925). Early Breeding of the Top-knot Pigeon (*Lopholaimus antarcticus*), *Emu* **24 (4)**: 276-277.

Griffioen, P.A. and Clarke, M.F. (2002). Large-scale bird movement patterns evident in eastern Australia atlas data. *Emu* **102**: 99-125.

Griffith, S.J., Wilson, R. and Maryott-Brown, K. (1999). Vegetation Survey of Booti Booti National Park and Yahoo Nature Reserve for the use in fire management. (Unpublished report prepared for NSW National Parks and Wildlife March 1999.)

Griffith, S.J., Wilson, R. and Maryott-Brown, K. (2000). Vegetation and flora of Booti Booti National Park and Yahoo Nature Reserve, lower North Coast of New South Wales. *Cunninghamia* **6(3)**:645-715.

Higgins, P.J. and Davies, S.J.J.F. (Eds) (1996). 'Handbook of Australian, New Zealand & Antarctic Birds, Volume 3: Snipe to Pigeons'. (Oxford University Press: Melbourne.)

Higgins, P.J. (Ed.) (1999). 'Handbook of Australian, New Zealand & Antarctic Birds, Volume 4: Parrots to Dollarbird'. (Oxford University Press: Melbourne.)

Higgins, P.J., Peter, J.M. and Cowling, S.J. (Eds) (2006). 'Handbook of Australian, New Zealand & Antarctic Birds, Volume 7: Boatbill to Starlings'. (Oxford University Press: Melbourne.)

Holmes, N.G. (1977). Seabird Islands. Statis Rock, Sugarloaf Bay, New South Wales. *Corella* **1**: 41.

Marchant, S. and Higgins, P.J. (Eds) (1990). 'Handbook of Australian, New Zealand and Antarctic Birds, Volume 1: Ratites to Ducks'. (Oxford University Press: Melbourne.)

Newman, M. (2007). Bird population of a cattle property near Paterson, NSW – an eleven year study. *The Whistler* **1**: 21-31.

Ramsey, A. (1987). 'Booti Booti State Recreation Area Plan of Management'. (National Parks and Wildlife Service New South Wales: Sydney, July 1987.)

Silcocks, A. and Sanderson, C. (2007). Volunteers monitoring changes: The Atlas of Australian Birds. In: Olsen, P. (Ed.). The State of Australia's Birds 2007: Birds in a Changing Climate pp. 10-11. (Birds Australia: Melbourne.)

Stuart, A., Crisp, G. and Crisp, B (2012). Atypical habitat for an Australian Pelican colony. *The Whistler* **6**: 57-58.

Stuart, A. (Ed.) (2017). Hunter Region Annual Bird Report Number **24** (2016). (Hunter Bird Observers Club Inc: New Lambton, NSW.)

Stuart, A. (Ed.) (2018). Hunter Region Annual Bird Report Number **25** (2017). (Hunter Bird Observers Club Inc: New Lambton, NSW.)

Tarburton, M.K. (2014). Status of the White-throated Needletail *Hirundapus caudacutus* in Australia: Evidence for a marked decline. *Australian Field Ornithology* **31**: 122-140.

Turner, D. (1993). Pelicans of the Forster/Tuncurry Area. *Australian Birds* **27**: 2-10.

Turner, D. (1995). Colonial Nesting of Figbirds. *Australian Birds* **28**: 71-75.

Turner, D. (2020). A breeding record for Topknot Pigeon in the Hunter Region. *The Whistler* **14**: 5-6.

Walther, B. and Jones, P. (2008). Family Oriolidae (orioles and figbirds). In: del Hoyo, J., Elliott, A. and Christie, D.A. (Eds). 'Handbook of the Birds of the World, Volume 13: Penduline-tits to Shrikes', pp. 692-713. (Lynx Edicions: Barcelona, Spain.)

Woodall, P. (1997). Seasonal and Diurnal Variation in the Calls of the Noisy Pitta *Pitta versicolor*, Eastern Whipbird *Psophodes olivaceus* and Green Catbird *Ailuroedus crassirostris* in Brisbane Forest Park, Queensland. *Emu* **97**: 121-125.

Update on breeding activity by threatened shorebird species on Corrie Island, Port Stephens

Neil Fraser

8 Flannel Flower Fairway, Shoal Bay NSW 2315, Australia neil8fff@gmail.com

Received 17 January 2020, accepted 30 January 2020, published on-line 25 February 2020.

This note documents recent observations of breeding activity by three threatened shorebird species on Corrie Island, Port Stephens: Beach Stone-curlew *Esacus magnirostris*; Australian Pied Oystercatcher *Haematopus longirostris*; and Little Tern *Sternula albifrons*. Corrie Island is a relatively isolated location within Port Stephens, covering around 164 ha, situated at the mouth of the Myall River. The island is a low-lying, partly tidal landmass composed of river sand and gravel. It has been formed within the last 200 years (Thom 1965; Thom & Roy 1975) and is covered by mangrove forest. Sandy beaches and sandspits are present on the southern side of the island where they are subject to constant erosion and sediment redistribution. Large numbers of shorebirds roost along the southern side of the island and forage on surrounding tidal flats (Stuart 2004). Corrie Island is part of the Myall Lakes Ramsar site (Office of Environment and Heritage 2014). Corrie Island is located about 200 m west of the Winda Woppa sandspit and is separated from it by the east arm of the Myall River (see **Figure 1**).

Figure 1. Corrie Island showing nesting locations for Beach Stone-curlew, Australian Pied Oystercatcher and Little Tern.

Beach Stone-curlew

Beach Stone-curlew was first recorded in Port Stephens in 2006 (Stuart 2011) and a pair has been breeding on Dowardee Island in Port Stephens annually since 2011 (Murray 2019). A single bird near a nest with one egg was found on Corrie Island in October 2017 by Fraser & Stuart (2018) (see **Figure 1**). Hatching was imminent (a crack had formed in the egg) but the ultimate fate of that breeding attempt is not known. A survey of Corrie Island conducted in January 2020 by local volunteers found an adult pair of Beach Stone-curlew (P. Blair pers. comm.). This further confirms the consolidation of the southern range extension of this species in NSW.

Australian Pied Oystercatcher

Large numbers of Australian Pied Oystercatcher (150-200 birds) were first reported in Port Stephens by Stuart (2004). The number present means that Port Stephens is an Internationally Significant site for the species. Stuart (2011) showed that numbers may have increased when current records are compared with historical data. Despite the large numbers of birds in Port Stephens, there had been no confirmed breeding records until a nest was found on Winda Woppa sandspit in October 2017 (Fraser & Stuart 2018). In October that year an additional two nests were found on Corrie Island (Fraser & Stuart 2018). The locations of those nests are given in **Figure 1**.

In September and October 2019, I surveyed the southern end of Corrie Island and recorded four pairs of Australian Pied Oystercatcher on defended territories, each territory centred *c*. 400 m apart. A nest with two eggs was in one of the territories (see **Figure 1**). The spacing of pairs on Corrie Island (3.3 pair/km), is considerably less than recorded on the Worimi Conservation Lands, Stockton Beach with 0.7-0.9 pair/km (Fraser & Lindsey 2018). Marchant & Higgins (1994) report Australian Pied Oystercatcher on ocean beaches have breeding densities of 0.5-4.7 pair/km (average 2.5 pair/km). The higher density on Corrie Island could be attributed to the limited disturbance experienced by breeding pairs at this isolated locality.

A survey conducted by NPWS personnel and local volunteers in December 2019 recorded adult birds with a recently fledged juvenile on Corrie Island and adults with two recently fledged juveniles on nearby Winda Woppa sandspit (P. Blair pers. comm.).

These successful breeding records highlight the importance of Corrie Island as a modern breeding site for this species.

Little Tern

In the austral summers of 2016-2017 and 2017-2018, a colony of Little Tern successfully nested on the Winda Woppa sandspit (Fraser 2017; Fraser unpublished data). They did not nest at that site in 2018-2019 or 2019-2020, and instead the breeding colony re-located to the southern side of Corrie Island. The February 2019 Port Stephens Shorebird Survey recorded 152 Little Tern in the Corrie Island-Winda Woppa area including juvenile birds and at least 4 runners at the new breeding site (A. Stuart pers. comm.). Because of time constraints, the number of breeding pairs was not able to be estimated. However, surveys conducted by NPWS personnel and local volunteers in December 2019 and January 2020 recorded up to 30 breeding pairs with eggs, chicks, runners and recently fledged birds all present (P. Blair pers. comm.). There were 27 breeding pairs recorded on Winda Woppa in 2016-2017 and 58 pairs in 2017-2018 (Fraser 2017; Fraser unpublished data).

Factors that could have influenced the change in nesting location from Winda Woppa to Corrie Island were active construction associated with the removal of dredge spoil from the site, the extensive growth of Spinifex Grass *Spinifex sericeu* over parts of the site and the erosion of most of the southern section of the sandspit by the Myall River. Historical records indicate similar changes in location have occurred in the area previously and the species was recorded nesting on Corrie Island by Hitchcock (1959), Campion (1963) and Morris (1979). Morris recorded about 10 pairs nesting in 1972-1973 on a sandspit on Corrie Island that no longer exists, further highlighting the tenuous nature of the breeding sites preferred by this species.

CONCLUSION

Corrie Island is an isolated location in Port Stephens with difficult access. Recent surveys of the southern part of the island have shown three threatened species breeding there successfully: Beach Stone-curlew; Australian Pied Oystercatcher; and Little Tern. The Beach Stone-curlew records also point to consolidation of the species' recent range expansion in NSW. The breeding records also highlight the important role played by isolated islands within Port Stephens, such as Corrie Island and Dowardee Island, in the conservation of some threatened shorebird species.

REFERENCES

Campion, C.B. (1963). Banding the Little Tern. *Australian Bird Bander* **1**: 125-132.

Fraser, N. (2017). Observations of Little Tern nesting at Winda Woppa, Port Stephens, 2016-2017. *The Whistler* **11**: 15-25.

Fraser, N. and Lindsey, A. (2018). Some observations of Australian Pied Oystercatcher on Worimi Conservation Lands. *The Whistler* **12**: 35-42.

Fraser, N. and Stuart, A. (2018). Some recent breeding observations of threatened shorebird species in Port Stephens. *The Whistler* **12**: 61-62.

Hitchcock, W.B. (1959). A review of the 'least' terns in Australian waters. *South Australian Ornithologist* **22**: 87-106.

Marchant, S. and Higgins, P.J. (1994). 'Handbook of Australian, New Zealand and Antarctic Birds, Volume 2'. (Oxford University Press: Melbourne.)

Morris, A.K. (1979). The declining status of the Little Tern in New South Wales. *Corella* **3**: 105-110.

Murray, T. (2019). Beach Stone-curlew at Soldiers Point, Port Stephens: breeding records and behavioural observations. *The Whistler* **13**: 17-21.

Stuart, A.D. (2004). The shorebirds of Port Stephens, recent and historical perspectives. (Hunter Bird Observers Club, Special Report No. **2**.)

Stuart, A.D. (2011). Shorebird surveys of Port Stephens, New South Wales, 2004-2011 and comparison with results from previous surveys. *Stilt* **60**: 14-21.

Thom, B.G. (1965). Late Quaternary coastal morphology of the Port Stephens – Myall Lakes area NSW. *Journal of the Royal Society NSW* **98**: 23-36.

Thom, B.G. and Roy, P.S. (1975). Notes on the Quaternary Geology of the NSW coast, with special reference to the Newcastle-Port Stephens area. (Geological Survey of New South Wales, Department of Mines, Report GS 1975/293.)

Office of Environment and Heritage, (2014). Statement of Management Intent. Bushy Island, Corrie Island, One Tree Island and Snapper Island nature reserves. (NSW National Parks & Wildlife Service.)

The Whistler **14 (2020)**: 25 - 27

Of Fennel and birds

Tom Kendall

3 Slade Close, Rankin Park, NSW 2287, Australia thomask07@optusnet.com.au

Received 12 January 2020, accepted 7 February 2020, published on-line 25 February 2020.

In June 2018 while birdwatching at Medhurst Bridge near Martindale, I observed four bird species feeding in some Fennel *Foeniculum vulgare* growing alongside the road. They appeared to be eating seeds from the plants. In this note I speculate on the possible reasons the birds were doing that and provide some interesting information on Fennel and animal self-medication.

The species I saw feeding in Fennel that day were Spiny-cheeked Honeyeater *Acanthagenys rufogularis*, White-plumed Honeyeater *Ptilotula penicillata*, Striped Honeyeater *Plectorhyncha lanceolata* and Golden Whistler *Pachycephala pectoralis* (a female) (**Figure 1**). The documented diets of each species are as follows (from Menkhorst *et al*. 2017):

- Spiny-cheeked Honeyeater – nectar, insects, small vertebrates, eggs and nestlings, fruits, seeds;
- White-plumed Honeyeater – insects, lerps and nectar;
- Striped Honeyeater – nectar, insects, fruits and seeds;
- Golden Whistler – arthropods from foliage and bark.

I did not see any evidence in the Fennel plants of an insect infestation or of any spider webs. Although I cannot fully exclude the possibility that the birds were taking aphids or thrips, they seemed to me to be eating seeds. That was unusual behaviour based on the reported diets of these species (Menkhorst *et al*. 2017) and led me to pose the questions: Why were these birds, which are not normally seed eaters, eating seed? Was it for food, essential minerals or was there perhaps some other benefit?

After reviewing available information, I concluded they may have been eating the Fennel seeds for medicinal purposes. Below I outline why I reached that conclusion.

FENNEL

Fennel is a native plant of southern Europe, northern Africa and western Asia (Australian Government 2020). In Australia it is an introduced weed, growing in urban and roadside locations. It was recorded as being sown in the Colony of New South Wales in 1803. By the 1880s it had become naturalised in many parts of Australia (Australian Government 2020).

Fennel is a rich source of beta-carotene and vitamin C, as well as calcium, magnesium, iron, and lesser amounts of other metals (Merck Index 2020). It is a traditional and popular herb with a long history of use as a medicine. A series of studies showed that Fennel effectively controls numerous infectious disorders of bacterial, fungal, viral, mycobacterial, and protozoal origin (Badgujar *et al*. 2014).

A search on the Internet established that many UK and American bird species feed on Fennel, in particular birds of the Warbler family. They eat unripened seed heads and the ripe or dry seeds.

Fennel is used in some veterinary practices in Australia as a treatment for sick birds. The head veterinarian at the Sugarloaf Animal Hospital told me: *"In the Sugarloaf Animal Hospital we actually use fennel tea as a treatment for conditions such as "sour crop" where its recognised spasmolytic (relieving spasms which hold the intestines in a contracted phase thereby preventing normal peristalsis, and gently promoting contractions) and pro-kinetic effects (increasing strength and rhythm of waves of contractions of peristalsis) can help these birds recover. Interestingly these real actions are the reason it has long been used as a carminative (an agent which controls flatulence and pain associated with gastro-intestinal tract build-up of gas due to an absence of contractions). I think the common thread in the effect of fennel and the treatment of those diseases is in the*

Figure 1. Species feeding in Fennel at Medhurst Bridge in June 2018, from top: Spiny-cheeked Honeyeater, White-plumed Honeyeater, Striped Honeyeater, female Golden Whistler.

management of ileus (paralysis of the gut and absence of peristalsis). Ileus is one of the symptoms of those diseases, AND it makes those diseases worse, while the treatment of ileus will help in recovery. Fennel is probably not as profound as some medications we can use, but it almost certainly helps in cases of ileus". (M. Simpson pers. comm.).

ZOOPHARMACOGNOSY

In 1993, the term "zoopharmacognosy" was coined from the Greek roots *zoo* ("animal"), *pharma* ("drug"), and *gnosy* ("knowing") (Wikipedia 2020). The term gained traction from academic works and a popular book (Engel 2002). Zoopharmacognosy is a behaviour in which non-human animals apparently self-medicate by selecting and ingesting or topically applying plants, soils, insects, and psychoactive drugs to prevent or reduce the harmful effects of pathogens and toxins (Wikipedia 2020).

Further investigations uncovered the following extracts from articles:

"Animals wage a continuous battle against parasites using a variety of defence mechanisms, ranging from simple behavioural avoidance to complex immune responses. One poorly understood mechanism is self-medicating behaviour, i.e. defence against parasites by one species using substances produced by another." (Clayton & Wolfe 1993, p. 60)

"Medicinal herbs are used by animals and humans with the apparent prophylactic effects of reducing the likelihood or severity of illness from pathogens or parasites in the future. Medicinal herbs with anti-inflammatory, antimicrobial, immunomodul-atory and/or analgesic properties are used in a therapeutic way to treat acute infections and inflammatory conditions." (Hart 2005, p975).

"Birds, bees, lizards, elephants, and chimpanzees all share a survival trait: They self-medicate. These animals eat things that make them feel better, or prevent disease, or kill parasites like flatworms, bacteria, and viruses, or just to aid in digestion." (Shurkin 2014, p. 17339)

There are numerous specific examples, such as:

- In Kenya, elephants enter caves to access the calcium and sodium rich alkaline rocks;
- In Peru, macaws and parrots use riverbank clay to help augment a sodium-poor diet;

- In Europe and UK, some birds (such as Common Starling *Sturnus vulgaris*) choose specific plants to include in their nests (Smith 2016). The aromatic compounds in the plants boost the immune systems of the chicks and reduce their bacterial loads.

Australian bird species are susceptible to several diseases, such as Salmonellosis (bacterial infection, often begins in the intestinal tract), Trichomoniasis (protozoal infection), Aspergillosis (fungal infection), Avian tuberculosis (mycobacterium infection, uncommon in native birds), Avian pox virus (viral infection) and Lyme Disease (tick infection) (Rose 2005). They often also become infested with mites and lice. As previously noted studies showed that Fennel effectively controls similar infectious disorders of bacterial, fungal, viral, mycobacterium, and protozoal origin (Badgujar *et al*. 2014). It seems reasonable then to assume that bird species would recognise opportunities to self-medicate for these conditions.

CONCLUSIONS

Whilst I cannot be certain that the birds at Medhurst Bridge were eating Fennel seeds, they appeared to be doing so. As to why they would be eating Fennel seeds, perhaps it was for the purpose of self-medication?

ACKNOWLEDGEMENTS

Special thanks to *The Whistler's* editors for their advice and assistance with writing the article and to Mark Simpson for his input and provision of references.

REFERENCES

Australian Government (2020). Weeds of Australia. (http://www.environment.gov.au/cgi-bin/biodiversity/invasive/weeds/weeddetails.pl?taxon_id=14687). Accessed 12 January 2020.

Badgujar, S.B., Patel, V.V. and Bandivdekar, A.H. (2014). *Foeniculum vulgare* Mill: A Review of Its Botany, Phytochemistry, Pharmacology, Contemporary Application, and Toxicology. BioMed. Research Internat. DOI: 10.1155/2014/842674.

Clayton, D. and Wolfe, N. (1993). The adaptive significance of self-medication. *Trends in ecology & evolution*; DOI:10.1016/0169-5347(**93**)90160-Q

Engel, C. (2002). 'Wild Health: How animals keep themselves well and what we can learn from them'. (Harcourt Mifflin Harcourt: New York.)

Hart, B. (2005). The evolution of herbal medicine: behavioural perspectives. *Animal Behaviour* Vol **70**, Issue 5, pp. 975-989.

Menkhorst, P., Rogers, D., Clarke, R., Davies, J., Marsack, P. and Franklin, K. (2017). 'The Australian Bird Guide'. (CSIRO Publishing: Clayton South, Victoria).

Merck Index (2020). https://www.sigmaaldrich.com/life-science/nutrition-research/learning-center/plant-profiler/foeniculum-vulgare.html. Accessed 12 January 2020.

Rose, K. (2005). Common Diseases of Urban Wildlife: Birds. Australian Registry of Wildlife Health. https://arwh.org/common-diseases/birds.

Shurkin, J. (2014). Animals that self-medicate. *Proceedings of the National Academy of Sciences*, **111** (49), pp. 17339-17341; DOI: 10.1073/pnas.1419966111

Smith, J. (2016). Self Medication, Wildlife Style: How birds and other creatures use medicinal plants. Cool Green Science. The Nature Conservancy. https://blog.nature.org/science/2016/06/20/self-medication-wildlife-style-how-birds-creatures-medicinal-plants/.

Wikipedia (2020). https://en.wikipedia.org/wiki/Zoopharmacognosy. Accessed 12 January 2020.

The Whistler **14 (2020)**: 28-34

Rufous Scrub-bird population trend in the Gloucester Tops: results from 2010-2019 monitoring program

Alan Stuart

81 Queens Road, New Lambton NSW 2305, Australia almarosa@bigpond.com

Received 17 February 2020, accepted 26 February 2020, published on-line 7 March 2020.

Two measures of the status of the Rufous Scrub-bird *Atrichornis rufescens* in the Gloucester Tops are proposed: the territory density in the area surveyed, and the number of new territories found. Territory density is independent of the amount of survey effort. The number of new territories potentially can be scaled in relation to survey effort. As the Rufous Scrub-bird surveys rely upon the availability and enthusiasm of volunteers, it is important to have status indices that are not affected by the amount of survey effort able to be achieved in any particular year.

In ten years of surveys in an area of core habitat for the Rufous Scrub-bird in the NSW Gloucester Tops, the territory density has fallen from 5.3 territories km^{-2} to 2.3 territories km^{-2}. The linear trend is a 5.5% decrease in territory density each year. The loss of territories seems to be primarily associated with dry conditions in what is assumed to be the breeding season. Wild fires were also a factor.

Establishment of new male Rufous Scrub-bird territories seems to be linked with wet conditions occurring in the breeding season two years prior, with also the need for favourable conditions in the intervening period.

INTRODUCTION

The ground-dwelling, poorly flying Rufous Scrub-bird *Atrichornis rufescens* is classified as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the IUCN Red List, and as Vulnerable under the New South Wales *Biodiversity Conservation Act 2016*. The scrub-bird's very weak flight capability limits its dispersal potential and is an important contributing factor to its status as a threatened species.

There are several isolated populations in NSW and southern Queensland including a population of the southern sub-species *ferrieri* in the Barrington Tops National Park near Gloucester NSW (Stuart & Newman 2018). Every spring since 2010, a team of volunteers has monitored Rufous Scrub-bird territories in an area of known core habitat in that National Park (see **Figure 1**). The survey methodology involves teams walking along 1-km transects within a *c*. 5,000 ha section of the Gloucester Tops (approximately at 32.1° S, 151.6° E). The positions of all calling male birds are noted, and the regularly occupied sites are classified as territories (Stuart & Newman 2018). These more correctly would be termed "advertised territories". If a Rufous Scrub-bird is not heard calling from a known territory, there is no way (currently) of distinguishing whether the bird is absent or whether it is not calling.

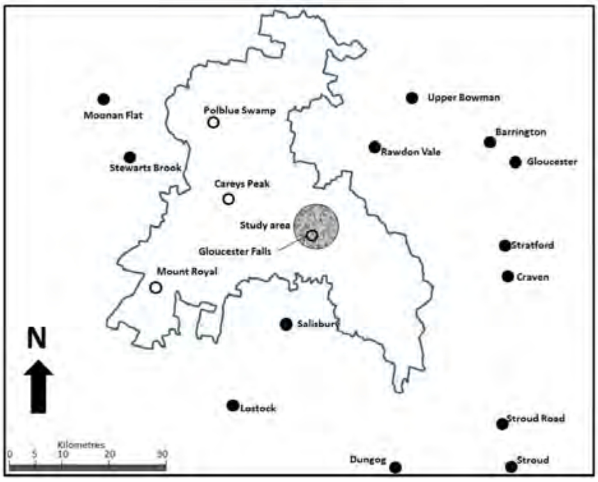


Figure 1. Barrington Tops National Park; the shaded area is where the annual spring surveys for Rufous Scrub-bird territories are carried out. (Figure reproduced from Stuart & Newman 2018).

Results from surveys in earlier years have been presented elsewhere (Newman *et al*. 2014; Stuart & Newman 2018). In this note I provide an update of recent results and an overall perspective of the 2010-2019 findings, including population trends and the consequences of wet or dry weather conditions during the breeding season. I propose two indicators for assessing the status of a Rufous Scrub-bird population: the territory density and the number of new territories found each year. The concept of Rufous Scrub-bird population territory density is not new and has been discussed elsewhere (Ferrier 1984; Newman *et al*. 2014; Stuart & Newman 2018). Its potential as the key indicator of the status of the Gloucester Tops Rufous Scrub-bird population is because it is an index that is independent of the amount of survey effort undertaken in any given year. The territory density index potentially can also be applied to other Rufous Scrub-bird populations if they are monitored systematically.

In 2019-2020, wild fires destroyed large areas of Rufous Scrub-bird habitat in NSW and Queensland (BirdLife Australia unpublished). Fortunately, any fires in the Barrington Tops National Park were minor and the core Rufous Scrub-bird habitat in the Gloucester Tops was unaffected by fire in 2019-2020.

METHODS (Annual comparisons)

The amount of survey effort in the Gloucester Tops has varied from year to year (e.g. see Stuart & Newman 2018), mainly caused by resource constraints. When there are more volunteers, more transects can be surveyed and also the same transects can be surveyed more than once. In 2010-2014, every 1-km transect was surveyed at least twice. Since 2015, only a subset of eleven 1-km transects have been surveyed twice (or more) annually whilst in 2017, when there were problems with access to the study area, those eleven transects were only surveyed once.

The probability of detecting a Rufous Scrub-bird at its territory in the Gloucester Tops in September and October whilst walking along a transect that passes by the bird's territory is 70-80% when weather conditions are favourable (Ferrier 1984, pp. 77-78). Thus, after two passes along a transect, there is 91-96% probability that the scrub-bird will be detected if it is present.

The varying survey effort complicates attempts at annual comparisons. It is not valid to compare the number of territories detected each year, because some years have involved almost twice as much habitat being surveyed. Nor is it valid to compare the annual Reporting Rates (RR, where RR is the ratio of the number 1-km transects with scrub-bird records and the number of 1-km transects surveyed). That is because the number of scrub-bird territories within many of the individual 1-km transects has varied from year to year (Stuart & Newman 2018). Other sampling biases can also affect RRs, for example if a transect with a readily detected scrub-bird (i.e. a reliable singer) is visited more frequently or less frequently in a particular year's surveys.

A more valid annual comparison would seem to be the density of territories. The territory density concept is not new, for example territory density has been analysed in several prior studies (Ferrier 1984; Newman *et al*. 2014; Stuart & Newman 2018). My reason for suggesting it as a key indicator is that territory density should be independent of survey effort, assuming that all the surveys were in areas of equivalent potential habitat. That assumption seems reasonable, since all transects are in an area of core habitat (Stuart & Newman 2018). In this note I present the annual density of Rufous Scrub-bird territories in the Gloucester Tops survey area. I have assumed that each 1-km transect samples 30 ha of scrub-bird habitat. The basis for that assumption is that calling male Rufous Scrub-birds can be heard from a distance of *c*. 150 m under favourable conditions (Ferrier 1984). The Gloucester Tops surveys are only conducted in favourable conditions, and thus each transect samples an area 300 m wide and 1 km long.

Another measure I have examined is the number of new territories found each year. Studies in the Gloucester Tops and in New England National Park (Stuart & Newman 2018; Andren 2016) have shown that there is a mixture of long-term occupied territories and territories occupied for shorter time frames (of 1-3 years). The latter are assumed to be the territories of young male birds seeking to acquire breeding habitat. Therefore, the number of new territories found each year can be used as a measure of the health of the overall scrub-bird population, particularly if considered in relation to that year's overall survey effort.

It may be the case sometimes that a young male scrub-bird replaces or displaces an older male at a long-occupied territory. That outcome would be another indicator of the health of the overall population. However, at present we have no way to identify individual scrub-birds and hence to know if such an event has happened.

Rainfall

It has previously been suggested that Rufous Scrub-bird calling activity in the Gloucester Tops is related to weather conditions, with male birds ceasing to advertise territories (or perhaps leaving their territories) when conditions in spring were abnormally dry (Newman *et al*. 2014; Stuart & Newman 2018). Those previous inferences were based on awareness of the general rainfall patterns in the Hunter Region plus personal observations of ground conditions in the Gloucester Tops. However, it is now possible to look more closely at this, as I have discovered that there is a weather station at Careys Peak approximately 15 km from the study area. The weather station at Careys Peak is at *c*. 300 m higher altitude than the study area (Bureau of

Meteorology (BOM) weather station 61413; location 32.05º S, 151.47º E, altitude 1430 m).

Rainfall at Careys Peak will be indicative of rainfall in the study area. Heavy rainfall events at Careys Peak probably were widespread, with comparable downfalls occurring in the study area. Lighter rainfall at Careys Peak may not necessarily have always been mirrored in the study area which is *c.* 15 km away. However, it seems reasonable to assume that the Gloucester Tops study area would have experienced a similar rainfall pattern to Careys Peak over the medium term (e.g. monthly).

Annual and monthly rainfall data for the Careys Peak weather station are available from the BOM website and are presented in **Table 1**. There are data from May 2009 onwards but over 2009-2011 there are several gaps in the monthly records. However, since July 2011 there are rainfall records for every day. **Table 1** shows the annual rainfall since 2012 and the amount of rain that fell in the period August to October each year for 2011-2019. The August to October period encompasses what is believed to be the breeding season for Rufous Scrub-birds in the Gloucester Tops plus the immediate lead-up to it. The calling activity of male scrub-birds increases from mid-September, remaining at a high level of activity until late January (Stuart & O'Leary 2019; Stuart 2019a). The Noisy Scrub-bird *A. clamosus* has an increased level of calling activity commencing in the lead-up to its winter breeding season (Berryman 2007); by analogy September-October is assumed to be the Rufous Scrub-bird's breeding season in the Gloucester Tops. It should be noted that there are no confirmed breeding records for Rufous Scrub-bird in the Gloucester Tops. However, two young birds were seen together in January 2019 (M. Kearns pers. comm.), which supports the assumption that breeding activities commence in spring.

Table 1. Annual rainfall recorded at the Careys Peak weather station and for the period August-October each year.

Year	Annual rainfall (mm)	Aug-Oct rainfall (mm)
2011	-	509
2012	2084	159
2013	2268	124
2014	1988	566
2015	2428	498
2016	2160	556
2017	2122	195
2018	2683	650
2019	1239	387

To find some information about the rainfall in 2009 and 2010 I used data from the Upper Allyn weather station (BOM station 61290). Although only at 315 m altitude it is the closest weather station for which I could find relevant data. For August to October 2009 and 2010 respectively, the Upper Allyn station recorded 215 mm and 294 mm of rain compared with 243 mm for the corresponding period in 2011. Therefore, in the Gloucester Tops study area, the amount of rain received in 2009 and 2010 probably was similar to the 509 mm received there in 2011 i.e. there were wet spring conditions in the Gloucester Tops in 2009 and 2010.

RESULTS

Table 2 shows, for each year, the number of kilometres surveyed (i.e. the number of 1-km transects), the number of Rufous Scrub-bird territories confirmed to be occupied, the territory density (as territories km^{-2}) and the number of new territories identified.

In 2010-2012, 20 km of transects were surveyed each spring, and 21 km of transects in 2013-2014 after the location of one of Ferrier's former survey locations was re-discovered (Stuart & Newman 2018). Only 11 km of transects were surveyed in 2015-2017. In 2018 and 2019 volunteer numbers were greater allowing additional survey effort: 20 km of transects in 2018 and 16 km in 2019.

Thirty-two Rufous Scrub-bird territories were identified in the 2010 and 2011 surveys. In the subsequent years, fewer territories have been located each year. When considered as density of territories, there were 5.3 territories km^{-2} in 2010 and 2011, and the density had decreased to 2.3 territories km^{-2} in 2019 (**Table 2**).

Two new territories were identified in 2011; there had not been any scrub-bird detected at either location in 2010. In 2013, two territories were found within a previously unsurveyed 1-km transect (Stuart & Newman 2018). For the purposes of this review, they have not been treated as new territories, since they may have been occupied for several years unbeknown to us.

In 2016, three new territories were identified. Two of those were completely new i.e. scrub-birds had never before been detected at either location in any of the 2010-2015 surveys. These territories were occupied for two and one breeding seasons respectively. The third "new" location for 2016 was near to where there was a territory occupied continuously in the 2010-2013 annual surveys. However, that territory appeared to be unoccupied (i.e. was unadvertised) in the 2014 and 2015 surveys and in many visits in other seasons of those two years (Stuart 2019b). Therefore, it seems reasonable to assume that a new male Rufous Scrub-bird claimed the old territory at some time in 2016. Further evidence to support that assumption is that the territory position was slightly relocated from the original position (Stuart 2019b). The territory has been occupied continuously over 2016-2019.

Similarly, in 2018 a scrub-bird territory was identified close to a location where there had been a territory in 2010-2015 but which apparently was unoccupied in the 2016-2017 surveys (and in many other visits in those two years). Again, I have assumed that a new male Rufous Scrub-bird had occupied the territory (and which continued to be occupied in the 2019 surveys).

Table 2. Results from annual spring Rufous Scrub-bird surveys in the Gloucester Tops.

Year	No. of 1-km transects	No. of occupied territories	Territory density (terr. km^{-2})	No. of new territories
2010	20	32	5.3	NA*
2011	20	32	5.3	2
2012	20	22	3.7	0
2013	21	20	3.2	0#
2014	21	25	4.0	0
2015	11	12	3.6	0
2016	11	13	3.9	3
2017	11	9	2.7	0
2018	20	17	2.8	1
2019	16	11	2.3	0

**The first of the annual surveys; thus, all territories were "new".*

#Two territories were found in a previously unsurveyed 1-km transect.

A subset of survey transects

The variation in the number of transects surveyed over 2010-2019 potentially complicates the analysis of results. Therefore, it is helpful to also examine the results from a consistently monitored subset of transects. There are eleven 1-km transects which have been surveyed every spring in 2013-2019. **Table 3** shows the results for those eleven transects in those seven years. Twelve territories were occupied (i.e. advertised) in 2013 while in 2019 there were seven occupied territories. The territory density was 3.6 territories km^{-2} in 2013 and 2.1 territories km^{-2} in 2019. Three new territories were discovered in 2016 and one new territory in 2018. These are the same four new territories discussed above.

DISCUSSION

Changes in territory density

The mean territory density for the ten-year study has been 3.7 territories km^{-2} (Standard Deviation 1.0 territories km^{-2}, Coefficient of Variation

Table 3. Annual territory density and number of new territories in an eleven 1-km transect subset, for which every 1-km transect was surveyed annually over 2013-2019.

Year	No. of occupied territories	Territory density (terr. km^{-2})	No. of new territories
2013	12	3.6	0
2014	11	3.3	0
2015	12	3.6	0
2016	13	3.9	3
2017	9	2.7	0
2018	8	2.4	1
2019	7	2.1	0

27.5%). At face value, these statistical data might suggest natural variation within an overall stable population. However, in looking at the trend over time, there has been a substantial decline in Rufous Scrub-bird territory density in the study since the annual surveys began in 2010. The territory density was 5.3 territories km^{-2} in the first two years of surveys while in 2019 it was nearly 60% lower, at 2.3 territories km^{-2} (**Table 2**). A similar decline is apparent in the results for the subset of eleven consistently surveyed transects (**Table 3**), for which the territory density was 42% lower in 2019 than in 2013. Comparing the periods 2013-2019 in the **Tables 1** and **2**, the decreases are very similar. Hence the changes presented in **Table 2** cannot be an artefact of the varying annual survey effort.

The changes over 2010-2019 correspond to a linear trend of a 5.5% annual rate of decline (with R^2 0.75), presented graphically in **Figure 2** (using data from **Table 2**).

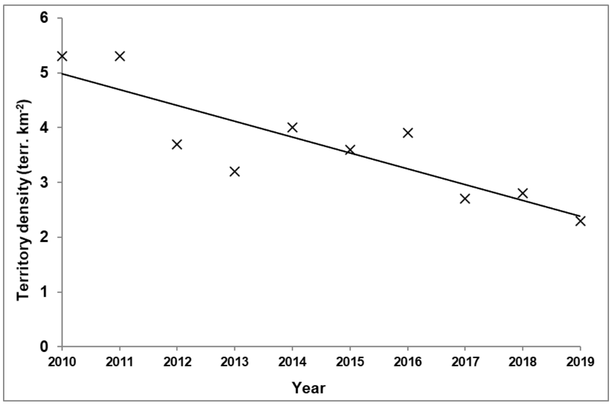


Figure 2. Annual territory densities in the Gloucester Tops survey area 2010-2019 and the linear trend.

The decline in territory density may be linked to two factors – wild fires and dry conditions. A fire in 2009 affected part of the study area. Although the burnt area was large, only one 1-km transect in the study area was affected; the final *c*. 700 m of it.

It was seven years before a new Rufous Scrub-bird territory was established in the previously burnt section of that particular transect (Stuart & Newman 2018). Unfortunately, the same area was burnt again in November 2016 as the result of another lightning strike. In the subsequent three sets of annual spring surveys, no scrub-birds have been detected in that part of the study area.

The 2009 fire might have contributed to the higher territory densities found in the 2010 and 2011 surveys, on the assumption that some scrub-birds were able to flee the fire and attempt to establish new territories in unburnt areas.

However, the consequences of dry conditions in spring seem clear. **Figure 3** shows the annual August-October rainfall received at the Careys Peak weather station and the territory density result for that year's surveys. The first two years of surveys received good amounts of spring rainfall and the Rufous Scrub-bird activity was high. In 2012 and 2013 the August to October conditions were dry (159 mm and 124 mm respectively) and the number of scrub-bird territories (analysed as territory density) decreased. In the following three wet springs, the territory density seemed stable and probably had increased slightly over the 2012-2013 situation, from 3.2 territories km^{-2} in the dry spring of 2013 rising to 4.0 territories km^{-2} in 2014 (**Table 2**). Conditions in 2017 again were dry, only 195 mm in the August to October period, and the territory density dropped to 2.7 territories km^{-2}. The density decreased even further in 2019, to 2.3 territories km^{-2} (**Table 2**). Superficially, 2019 had wetter August-October conditions, with 387 mm of rain. However, that included 183 mm falling in a single two-day period (18-19 September) i.e. the conditions for the overall period were quite dry. Also, the annual rainfall for 2019 was about half the normal amount (**Table 1**). The dry conditions prevailing all year will have limited the impact of any rain falling during the breeding season.

In Ferrier's Rufous Scrub-bird surveys in the Gloucester Tops in 1979-83, he found the territory density to be 3.3 territories km^{-2} on average (Ferrier 1984). That result is similar to the 2012-2016 territory density findings, which were in the range 3.2-4.0 territories km^{-2} (**Table 2**). We do not know the specific weather conditions in the Gloucester Tops at that time; however, all of eastern Australia was in drought in 1979-1982 (Wikipedia 2020) and so the conditions in the Gloucester Tops probably were relatively dry. Supporting that view, Ferrier presented monthly rainfall data for Chichester Dam, about 15 km south and at an altitude of 194 m. In most months during Ferrier's study the rainfall at Chichester Dam was below average and only seven months over 1979-1982 had above-average rainfall (Ferrier 1984, p. 29).

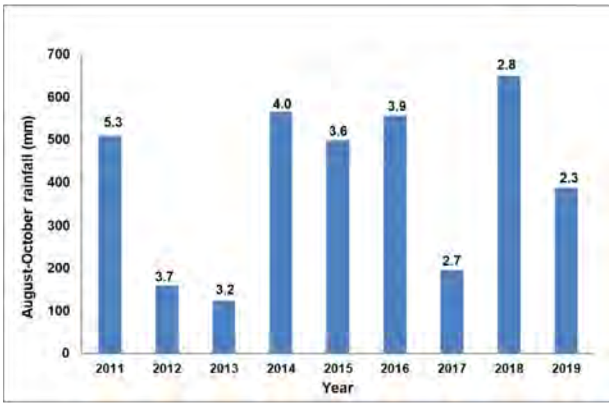


Figure 3. Annual August-October rainfall at the Careys Peak weather station and the territory density (as territories km^{-2}) found during that year's surveys (territory densities are labelled above that year's rainfall column).

The changes in territory density over 2010-2019 may be part of a natural cycle, in which a stable population oscillates around a mean. The territory density in 2010 may have represented a short-term population peak driven by favourable weather conditions in 2009-2010 and an influx of mature adults displaced by fires external to the study area and 2019 a minimum driven by extreme rainfall conditions. Alternatively, the changes since 2010 might be a harbinger of serious problems for the Rufous Scrub-bird. Ten years probably is too short a time frame to be able to differentiate between those two scenarios. The need for an ongoing monitoring program is quite clear.

Establishing new territories

Two new territories were identified in 2011, both were within transects across the Gloucester River. This followed what likely were wet conditions in 2009 and 2010. No more new territories were found until three were identified in the 2016 surveys. That followed wet August to October conditions in 2014 and 2015 (**Table 1**). There was one new territory in the 2018 surveys. Although 2017 had dry spring conditions, 2016 was wetter in the supposed breeding season, with 556 mm of rain falling over August-October.

Although little is known for certain about Rufous Scrub-bird breeding biology, the males are thought to begin breeding at two years of age (Garnett *et* *al*. 2011, p. 281). That time frame for sexual maturity matches with the pattern of new territories establishing after wet conditions occurring two years earlier. Thus, the new territories in 2011 followed wet conditions in 2009, those in 2016 align with wet conditions in 2014, and the new territory in 2018 was after wet August-October conditions in 2016.

Conditions also were wet in 2015 but there were no new territories identified in the 2017 surveys. However, 2017 had a dry August-October period and the conditions may not have been suitable for inexperienced young males to successfully maintain a territory.

Similar rainfall-linked population changes have been noted for the Grey Fantail *Rhipidura fuliginosa* at Green Wattle Creek although the situation there was more complex because of passage migrants as well as a resident population (Newman 2012). In the Green Wattle Creek case there was a one-year lag for population increases after above-average rainfall and for population decreases during dryer times. The Grey Fantail typically begins breeding when one year old (Higgins *et al*. 2006), whereas for the Rufous Scrub-bird it is two years.

CONCLUSIONS

Two indicators of Rufous Scrub-bird population status are proposed: the territory density obtained from annual surveys in the breeding season and the number of new territories found in those same surveys. Territory density is independent of the varying survey effort that is intrinsically linked with efforts by volunteers. The number of new territories found will be dependent upon the survey effort but potentially can be scaled in relation to it.

In the ten years of Rufous Scrub-bird surveys in an area of their core habitat in the Gloucester Tops, the territory density has fallen from 5.3 territories km^{-2} to 2.3 territories km^{-2}. The linear trend is a 5.5% decrease in territory density each year. Most of the overall decrease seems to be associated with the dry conditions which have prevailed in the supposed breeding season in many years since 2010. Also, wild fires have impacted some former areas inhabited by scrub-birds. Of concern is that these two processes are additive; dry conditions diminish the number of Rufous Scrub-bird territories, as do fires, and dry conditions increase the likelihood of fires occurring.

It is normal for bird populations to oscillate about a stable mean and it would be premature to conclude that the core habitat population of Rufous Scrub-bird is unstable. The first surveys in 2010 may have represented a short-term population peak driven by an influx of mature adults displaced by fires external to the study area and 2019 a minimum driven by extreme rainfall conditions. Consequently, monitoring of the Rufous Scrub-bird population in the Gloucester Tops needs to continue, in order to determine whether the present changes are part of the normal cycle of a stable population or an ongoing decline.

Recovery in territory density should be possible if weather conditions are favourable for long enough. It seems to require at least two years of favourable conditions before young male scrub-birds reach maturity and try to establish new territories. Several years of favourable conditions seemingly will be required before the scrub-bird territory densities could return to the levels found in 2010-2011.

ACKNOWLEDGEMENTS

Mike Newman was the referee for this paper and his comments were very helpful. Also, Mike developed the methodology that has been used in the Gloucester Tops Rufous Scrub-bird surveys since 2010. More than 40 people, mostly members of the Hunter Bird Observers Club, have assisted in the Gloucester Tops surveys.

REFERENCES

Andren, M. (2016). Monitoring the Rufous Scrub-bird *Atrichornis rufescens* in the New England region. *Corella* **40**: 53–60.

Berryman, A. (2007). ‘Song sharing and repertoire change as indicators of social structure in the Noisy Scrub-bird’. PhD Thesis, Murdoch University, Perth, Western Australia.

Ferrier, S. (1984). ‘The Status of the Rufous Scrub-bird *Atrichornis rufescens*: Habitat, Geographical Variation and Abundance’. PhD thesis, University of New England, Armidale, New South Wales.

Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). *The Action Plan for Australian Birds 2010*. (CSIRO Publishing: Melbourne.)

Higgins, P.J., Peter, J.M. and Cowling, S.J. (Eds) (2006). ‘Handbook of Australian, New Zealand and Antarctic Birds Volume 7: Boatbills to Larks’. (Oxford University Press: Melbourne.)

Newman, M. (2012). Fluctuations in numbers of Grey Fantails in the Hunter Region of New South Wales. *Aust. Field Ornithology* **29**: 57-76.

Newman, M., Stuart, A. and Hill, F. (2014). Rufous Scrub-bird *Atrichornis rufescens* monitoring at the extremities of the species' range in New South Wales (2010–2012). *Aust. Field Ornithology* **31**: 77-98.

Stuart, A. (2019a). Investigating Rufous Scrub-birds in the Gloucester Tops. (Presented at the Australasian Ornithological Conference, Darwin July 2019.)

Stuart, A. (2019b). Occupancy at two Rufous Scrub-bird territories in the Gloucester Tops. *The Whistler* **13**: 35-37.

Stuart, A. and Newman, M. (2018). Rufous Scrub-birds *Atrichornis rufescens* in the Gloucester Tops of New South Wales: Findings from surveys in 2010–2016. *Aust. Field Ornithology* **35**: 13-20.

Stuart, A. and O'Leary, M. (2019). A method for investigating Rufous Scrub-birds using automated recording and rapid, semi-automated data analysis. *Corella* **43**: 57-64.

Wikipedia (2020). 1979-1983 Eastern Australia drought. www.en.wikipedia.org/wiki/1979%E2%80%9383_Eastern_Australian_drought. Accessed 11 February 2020.

A review of Australian Painted-snipe records from the Hunter Region, 1966-2020

Neil Fraser

8 Flannel Flower Fairway, Shoal Bay NSW 2315, Australia neil8fff@gmail.com

Received 17 March 2020, accepted 31 May 2020, published on-line 14 June 2020.

Records of Australian Painted-snipe *Rostratula australis* from the Hunter Region were analysed and 37 occurrences were identified from 18 locations over the period 1966-2020. The majority of records were from the spring-summer period, with only a few records during autumn and winter. There have not been any winter occurrences since 1984. The annual pattern of occurrence for the region was the same as for the state as a whole.

Most of the records were from the Lower Hunter sub-region although possibly that reflects greater survey effort in that sub-region. Occurrences in the Upper Hunter sub-region were associated with watercourses. There is only one known record for the Northern Hunter sub-region.

Drought and drought-breaking rains were identified as important drivers for occurrences in the Hunter Region. Short-term flood events that recharge local wetlands were found to be a factor contributing to favourable conditions. The study has highlighted the importance of the region in providing a refuge for the species during periods of extended drought in New South Wales.

Australian Painted-snipe have been recorded more frequently in the Hunter Region in recent times. In the period spanning 1966-1997 there were 0.33 occurrences per year on average. For the period 1998-2020, there were 1.08 occurrences per year on average.

Details are provided for a breeding event in 1972 at Lenaghans Swamp. Although that is the only confirmed breeding by Australian Painted-snipe in the Hunter Region, there have been several instances of pre-breeding behaviour during the main New South Wales breeding period of October-February.

INTRODUCTION

The Australian Painted-snipe *Rostratula australis* is a nomadic waterbird that is now recognised as endemic to the Australian mainland (Lane & Rogers 2000; Baker *et al*. 2007; Christidis & Boles 2008). It was previously considered to be a subspecies of the Greater Painted-snipe *Rostratula benghalensis* which occurs in Africa and Asia.

The species is listed as endangered under the New South Wales (NSW) *Biodiversity Conservation Act 2016* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It is also listed as Endangered by the International Union for the Conservation of Nature (Herring & Silcocks 2014).

The Australian Painted-snipe mainly frequents shallow, ephemeral, freshwater wetlands. It has been reported over much of mainland Australia but is more common in eastern Australia. Although it has never been abundant, the population is reported to have experienced a substantial decline throughout most of its range, possibly by as much as 90% since the 1950s (Lane & Rogers 2000; Oring *et al*. 2004). The most recent population estimate is of 1,000-2,500 birds (Herring & Silcocks 2014). It is unclear why the population has declined, although wetland habitat loss and degradation through drainage and diversion of water for agriculture and other human uses were suggested as likely causes (Oring *et al*. 2004; Herring & Silcocks 2014).

The decline in numbers in NSW is reflected in recent Reporting Rates (RR; defined as the number of surveys in which the species was recorded divided by the total number of sites surveyed, expressed as a percentage). During the decade 1970-1979 when the first Atlas of Australian Birds was being compiled, the RR in NSW was 0.61% and in the period 1990-1998 it had fallen to 0.127% (Lane & Rogers 2000). In 2005 the RR for

Australian Painted-snipe in NSW was only 0.08% (Cooper *et al*. 2016).

Before the 1950s, Australian Painted-snipe was regularly recorded in the Riverina area of NSW / Victoria, where it often bred. Subsequently, that area has seen the greatest decline in numbers (Lane & Rogers 2000). Painted-snipe have also been reported in small numbers from elsewhere across NSW, in particular the Paroo wetlands, Lake Cowal, Macquarie Marshes, the Gwydir watercourse and along the east coast. Important coastal locations are wetlands around the Hawkesbury River and the Clarence and Lower Hunter valleys (Office of Environment and Heritage 2004). During the 2012-2013 season, relatively large numbers were reported to be temporarily using rice fields in the Riverina, indicating that the species has the ability to adapt to the changed landscape (Herring & Silcocks 2014). These authors imply that following two wet years in 2010-2012, the Riverina became an important area for the species' recovery.

Cooper *et al*. (2016: 13) describe its status as follows: 'For many years the Australian Painted-snipe was thought of as rare and declining, but since widespread rain in 2010 there was an increase in sightings in NSW, with groups of up to 70 birds being reported. This indicates that this is a 'boom and bust' species able to cope well with Australia's climate extremes by reproducing rapidly after rain, but limiting breeding activity during periods of drought'. The species is cryptic, calls rarely, feeds mainly at night, roosts in dense vegetation during the day and often freezes when disturbed (Menkhorst *et al*. 2017). These behaviours undoubtedly contribute to the low RR.

Movement patterns of the species are poorly understood and its occurrence is irregular and infrequent. Lowe (1963) stated that it appeared nomadic and its movements were largely dependent upon seasonal conditions. Comparison between winter and summer records in the Atlas of Australian Birds (Blakers *et al*. 1984), the New Atlas of Australian Birds (Barrett *et al*. 2003) and the Atlas of Birds of NSW and ACT (Cooper *et al*. 2016) indicates that the species exhibits regular seasonal movements. There are many more records across NSW from spring and summer than during autumn and winter. There is, however, uncertainty as to where the birds move to during the cooler months. Black *et al*. (2010) suggested there may be regular seasonal migration of part of the population between south-eastern Australia and central and north coastal Queensland wetlands between February and August, to exploit favourable seasonal conditions. Movements have been attributed to be in response to a number of weather-related events including moving to more productive flooded areas, moving away from drying wetlands and moving away from regions affected by drought (Lowe 1963; Schodde & Tidemann 1988; Marchant & Higgins 1993; Menkhorst *et al*. 2017).

Breeding in NSW is reported to occur from mid-August to February, mostly from October onwards. The birds form small flocks (of both males and females) during the breeding season and disperse subsequently (Marchant & Higgins 1993). The species has a particular preference for breeding habitat, choosing ephemeral freshwater wetlands, especially after heavy rains or flooding. The preferred wetlands are characterised by complex shorelines with low fringing vegetation, areas of exposed mud and very shallow water (Oring *et al*. 2004; Purnell *et al.* 2014; Rogers *et al*. 2005). This allows the birds and their young to exploit the productivity boom that follows receding floodwaters (Menkhorst *et al*. 2017). Nests are usually located among tall, rank tussocks of grass, reeds, rushes or samphire, frequently on small, muddy islands or mounds surrounded by shallow freshwater and sometimes on the shores of swamps or banks of channels (McGilp 1934; Lowe 1963; Purnell *et al*. 2014). During the non-breeding season, the species prefers a wider range of habitats including permanent freshwater, or sometimes brackish wetlands, and occasionally they are found among tall reeds (Oring *et al*. 2004).

In the Hunter Region, the Australian Painted-snipe is classified as rare (Williams 2019). The earliest record of the species in the region is from the spring of 1832, near Merriwa when an expedition led by Lieutenant Breton passed through the area. Breton noted 'In the creek we shot ducks, teal, widgeon and a few snipe, amongst which may be included the painted snipe, larger, and far handsomer than the common one' (Breton 1833). Gould (1848) recorded the species as 'tolerably plentiful in the district of the Upper Hunter, particularly in the flats of Segenhoe, Aberdeen and Scone' following heavy, widespread rain in 1839. Another early record is a skin specimen collected at Terragong, near Merriwa, in May 1905 and held in the Ornithological Collection at the Australian Museum (Australian Museum 2020). Both records are from the Upper Hunter. D'Ombrain (1944) reported an injured Painted-snipe found at West Maitland in October 1943.

The objective of this review is to:
(i) summarise and describe the known occurrences, numbers, locations and temporal distribution of records for the Hunter Region; and
(ii) determine if occurrences are related to identifiable weather events in inland NSW and/or the Hunter Region.

The Hunter Region and its sub-regions were defined by Stuart (2018) as follows:

- The area managed by Local Governments of Newcastle, Lake Macquarie, Maitland, Cessnock and Port Stephens (Lower Hunter sub-region)
- The area managed by Local Governments of Dungog and MidCoast (Northern Hunter sub-region)
- The area managed by Local Governments of Muswellbrook, Scone and Singleton and the area formerly managed by Local Governments of Merriwa and Murrurundi (Upper Hunter sub-region)
- The ocean within 100km of the coastline.

METHODS

Records of sightings of Australian Painted-snipe within the Hunter Region were obtained from the following sources: BirdLife Australia Birdata database (BirdLife Australia 2020); Eremaea Birdline; Birdline New South Wales (Eremaea Birdline 2020); Hunter Bird Observers Club (HBOC) Annual Bird Reports (Stuart 1993-2018); The Cornell Lab of Ornithology eBird online database (The Cornell Lab of Ornithology 2020); and historical records from the NSW Bird Report and HBOC Record Book (A. Stuart pers. comm.). Records were also obtained for Ornithological Collection items from the Australian Museum, Sydney (Australian Museum 2020). Occurrences were treated as being confirmed if there were reports from multiple observers and/or by obtaining information from the original observer.

The records that were considered acceptable were sorted by location and date. The number of birds recorded and the number of records for each location was compiled. When there were multiple records over time at some locations, each record was allocated to a discrete occurrence. A discrete occurrence is defined as being one or more birds recorded on one or more occasions at a single locality on a single date or a number of closely grouped dates. The discrete occurrences were sorted into monthly records and charted. The total number of birds recorded each year was also calculated and charted, with records of birds 'Present' treated as records of single birds.

Australian Painted-snipe occurrences for the Hunter Region were also sorted into records from each of the three sub-regions, for further analysis.

To determine if occurrences in the Hunter Region were related to local weather events, or to periods of drought in inland NSW, annual rainfall records were obtained from the Bureau of Meteorology (Bureau of Meteorology 2020a) for Williamtown (representing the Lower Hunter sub-region), Narrandera and West Wyalong (both representing inland NSW). Rainfall data were charted together with the number of occurrences for each year from 1966 to 2020. The linear average rainfall for the period for Williamtown and West Wyalong was calculated and plotted on the chart. The major drought periods for NSW were also plotted, these being 1972-73, 1982-83, 1991-95, 2002-09 (Millennium drought) and 2017-19 (Smith 2002; Bureau of Meteorology 2020b).

RESULTS

The earliest record found with a specific location and date was in December 1966. Throughout the Hunter Region, there have been 152 reports of Australian Painted-snipe between December 1966 and February 2020. However, many of those records were repeat observations of the same bird(s); when taking this into account there have been 37 discrete occurrences from 18 different locations. The list of locations and the dates of occurrences are summarised in **Table 1**. The majority of the locations were clustered in the Lower Hunter sub-region. There were only two occurrences in the Upper Hunter sub-region, both of them in 2012, and one occurrence in the Northern Hunter sub-region, at Tea Gardens in 2020. The two Upper Hunter records involved birds present along watercourses.

In the Lower Hunter sub-region, four locations have had multiple occurrences. The location with the longest history of Australian Painted-snipe occurrences is Kooragang Island with eleven occurrences spanning 1972-2017. Pambalong Nature Reserve has had six occurrences spanning 1984-2011 and Hexham Swamp four occurrences from 2006-2013. There have been two occurrences at Lenaghans Swamp, in 1972 and 2006. Fourteen other Lower Hunter sub-region locations have had single occurrences. The longest period for a single occurrence was seven weeks, at Pambalong Nature Reserve from August to October 1984. The number of birds present at an occurrence has varied from single birds, on many occasions, to a maximum count of 19 birds which was at Tumpoaba Reserve, Maryland in October 2012.

Table 1. Locations, dates, numbers of birds and records for Australian Painted-snipe occurrences, Hunter Region, 1966-2020.

Location	Date(s) of occurrences	No. of birds	No. of records
Lower Hunter sub-region			
Awabakal Reserve, Dudley	20/01/2003	1	1
Bunnings Swamp, Wallsend	7/01/2014 - 15/01/2014	1-11	19
Chisholm Wetlands, Maitland	24/01/2011 - 26/01/2011	1	3
East wetland, Cooranbong	29/09/2017	1	1
Ellalong Lagoon, Congewai	18/11/2011 - 21/11/2011	2	2
Grahamstown Dam, Raymond Terrace	15/07/1976 - 25/07/1976	2	2
Hexham Swamp, Hunter Wetlands National Park	11/10/2006 - 12/11/2006	1-2	2
	6/01/2009 - 19/02/2009	1-4	9
	22/01/2012 - 5/02/2012	3-4	4
	26/01/2013 - 9/02/2013	1-4	4
Irrawang Swamp, Irrawang	4/01/2003 - 6/01/2003	2	2
Kooragang Island, Hunter Wetlands National Park	22/12/1972	2	1
	31/03/1973	1	1
	12/11/1977	2	1
	10/12/1996	1	1
	16/02/2004	1	1
	2/11/2004 - 27/12/2004	1-2	12
	2/11/2011 - 4/11/2011	1-7	5
	18/01/2012 - 2/03/2012	1	7
	26/01/2013	1	2
	4/12/2013 - 27/12/2013	2	3
	13/09/2017	1	1
Lenaghans Swamp, Minmi	26/10/2006 - 17/12/2006	1-4	9
	19/11/1972 - 16/12/1972*	5-17	4
Pambalong Nature Reserve, Minmi	18/08/1984 - 5/10/1984	1-2	8
	7/09/1986	2	1
	20/12/1997 - 23/12/1997	1	2
	26/12/2000 - 3/01/2001	1-2	12
	13/10/2006 - 12/11/2006	1	5
	24/11/2011	1	1
Toronto	26/12/1966	1	1
Tumpoaba Reserve, Maryland	26/10/2012 - 28/10/2012	6-19	2
Wallis Creek Wetlands, Louth Park	11/01/1992 - 15/02/1992	1	1
Windeyer Swamp, Heatherbrae	15/10/1972 - 1/12/1972	1-8	3
Upper Hunter sub-region			
Sandy Creek, Castle Rock	29/11/2012	1	2
Widden Brook, Widden	14/11/2012	1	2
Northern Hunter sub-region			
Myall Quays, Tea Gardens	11/01/2020 - 6/02/2020	1	15

* Two nests with eggs recorded at Lenaghans Swamp, December 1972

The 37 discrete occurrences comprised records for 55 separate months but with 14 of the occurrences extending over two or more months. The distribution of monthly records is presented as a histogram in **Figure 1**. Records have been more frequent for the period from September-February (with a total of 51 records) and there has been a distinct peak for the November-January period. The highest numbers of monthly records have been in January and November (with 12 occurrences in each of those months). There have been two occurrences in March and single occurrences in July and August. Since 1966 there have been no records for the April-June period.

A total of 117 Australian Painted-snipe have been recorded in the Hunter Region since 1966. The annual distribution is presented as a histogram in **Figure 2**. The peaks have been in 1972 (with a total of 27 birds recorded in the region) and 2012 (with a total of 26 birds). For the period 2011-2014 there was a cluster comprising records for a total of 55 birds, while 2002-2009 had a smaller cluster totalling 17 birds.

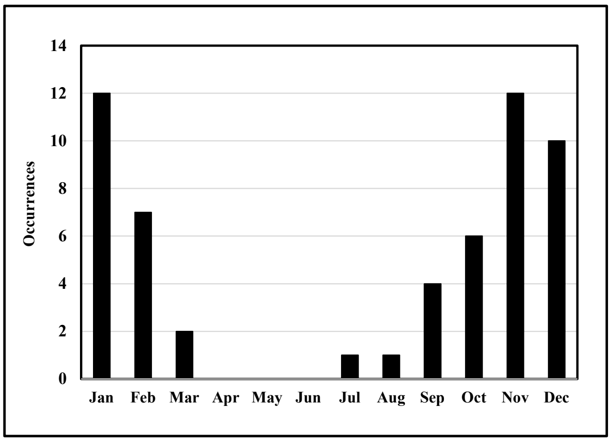


Figure 1. Monthly records of Australian Painted-snipe in the Hunter Region 1966-2020.

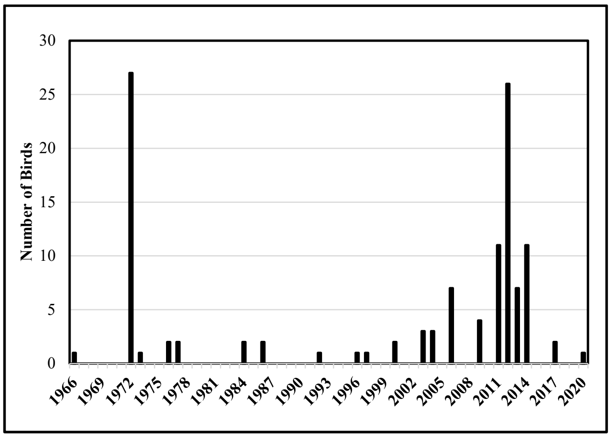


Figure 2. Annual numbers of Australian Painted-snipe in the Hunter Region 1966-2020.

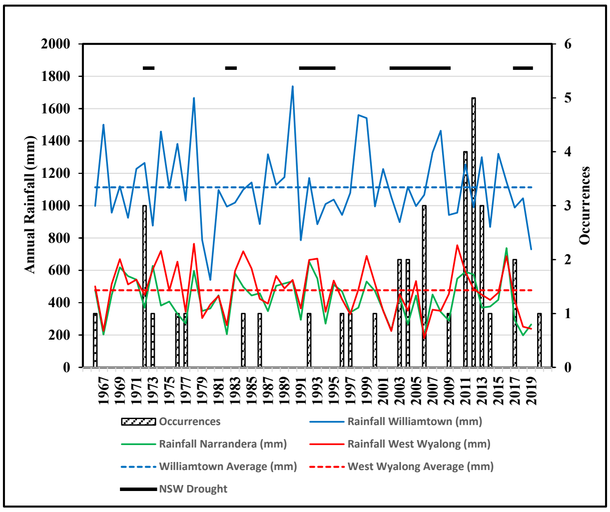


Figure 3. Australian Painted-snipe occurrences in the Hunter Region, annual rainfall records for Williamtown, Narrandera and West Wyalong and NSW drought periods, 1966-2020.

Figure 3 presents the annual Australian Painted-snipe occurrences and the corresponding rainfall records for the Lower Hunter sub-region (as measured at Williamtown) and inland NSW (at Narrandera and West Wyalong**)**. The NSW drought periods are also shown.

The three discrete occurrences in 1972 (involving 27 birds) were during the 1972-73 drought. Over this period there was above-average rainfall in the Lower Hunter sub-region and slightly below-average rainfall in inland NSW. There were no occurrences of Australian Painted-snipe in the Hunter Region during the 1982-83 drought. There was a single occurrence during the 1991-95 drought and additional single occurrences in each of the following two years. Below-average rainfall was recorded in the Lower Hunter sub-region and inland NSW during this period.

The 2002-2009 Millennium drought produced an influx of birds into the Hunter Region. There were eight occurrences (involving 17 birds) over that period, during which there was below-average rainfall in both the Lower Hunter sub-region and inland NSW. In the years immediately after the breaking of the Millennium drought there was another influx of birds in the region, with 13 occurrences (involving 55 birds) over 2011-14. The 2017-19 drought produced a single occurrence, which was in the Northern Hunter sub-region in early 2020.

Breeding record

A single breeding episode was identified, at Lenaghans Swamp in November-December 1972 (**Table 1**). On 19 November 1972, five birds were found roosting amongst water buttons *Cotula coronopifolia* and swamp oak *Casuarina glauca* around a shallow, seasonal fresh-water swamp. A subsequent survey on 10 December recorded at least 13 birds in the same area including a male that flushed from a nest which had four eggs. On another survey on 16 December, which recorded 17 birds, the original nest and eggs were still present and a male flushed from a second nest, which contained three eggs. The latter nest had been constructed within a clump of grass growing from a cow pat. On 20 December, when ten birds were recorded, there were large fragments of shell alongside the original nest. Although no chicks were seen, it was concluded that there had been a successful hatching. However, the nest with three eggs appeared to have been abandoned. On a follow-up visit on 10 January 1973, the wetland had dried out and no painted-snipe were detected (D. Gosper pers. comm.; G. Stevens pers. comm.).

DISCUSSION

A notable aspect of the Australian Painted-snipe occurrences is the clustering of locations in the Lower Hunter sub-region. There were 15 locations, compared with two locations in the Upper Hunter sub-region and one in the Northern Hunter sub-region. This imbalance in distribution of sites is probably because the majority of the larger Hunter Region wetlands are on the Hunter River floodplain where the wetlands are permanently maintained by coastal rainfall and occasional flooding from up-river. Furthermore, many of those wetlands are close to the major population centres and are readily accessible; hence they have been surveyed more often than wetlands elsewhere in the region. Some wetlands such as those on Kooragang Island have been surveyed for more than 40 years. This imbalance in effort may have resulted in a bias of records towards the Lower Hunter sub-region compared with the Upper and Northern Hunter sub-regions. The historic records from around the Merriwa, Segenhoe, Aberdeen and Scone areas and the more recent records from Widden and Castle Rock shows that the species frequents the Upper Hunter. The painted-snipe is probably under-reported in that sub-region because of the distance from major population centres and the consequent lack of regular survey effort. The single record from Tea Gardens could reflect a similar situation in the Northern Hunter sub-region.

Both of the Upper Hunter sub-region records were of birds present along watercourses. So too was the 1832 record from near Merriwa (Breton 1832). This indicates that birds visiting the Hunter Region do not necessarily restrict their presence to open wetlands if conditions are favourable.

The data also reveal an increased frequency of occurrences from the mid-1990s onwards. In 1966-1997 there were 0.33 occurrences per year on average whereas for 1998-2020, they increased to 1.08 per year on average. The latter period corresponded with the start of the Second Australian Bird Atlas (in 1998) and the subsequent establishment of the Birdata and eBird databases, all of which may have contributed to increased survey effort and introduced an element of bias. Consequently, it is unclear whether or not painted-snipe numbers have increased in the Hunter Region. However, the combination of increased frequency of occurrence and increased numbers of birds does suggest that there has been a change over the past 20 years.

The monthly records for the Hunter Region show the same pronounced seasonal pattern as for the whole of NSW. The absence of winter records for the region after 1984 may indicate a change in the species' pattern of movements, or that conditions in the Hunter Region are no longer suitable during winter. Another explanation is that there has been an overall decrease in the Australian Painted-snipe population.

Droughts and floods

As the Australian Painted-snipe is a nomadic bird with a small population spread over much of mainland Australia, single occurrences of one or two birds probably are not significant. However, multiple occurrences in a single year or clusters of occurrences over several consecutive years can be interpreted in relation to weather-related events. The 1972 influx occurred during a period of drought in NSW but with heavy rain locally at times. As measured at Williamtown, 532.6 mm of rain fell over December 1971 to January 1972 (Bureau of Meteorology 2020a). The rain produced a significant flood with a 5-10-year Average Recurrence Interval (ARI) rating in the Williams and Paterson Rivers (D. Williams pers. comm.). Both rivers are tributaries of the Hunter River. The December-January rain was followed by another 279 mm in October-November 1972. Lenaghans Swamp would have been recharged by those rain events.

Windeyer Swamp is located at Heatherbrae, immediately below the confluence of the Williams and Hunter Rivers. It also would have been recharged by the 1972 rain events. Up to eight birds were reported there over October-December 1972, dispersing from the site by the time it had dried up in January 1973.

The influx of birds during the 2002-2009 Millennium drought indicates that when severe, long-term drought affects inland NSW, Australian Painted-snipe use coastal wetlands as a drought refuge. Purnell *et al*. (2014) reported that 58% of all records of Australian Painted-snipe from 2002-2009 in eastern Australia were at permanent coastal and near-coastal wetlands. The local records seem to support that conclusion. The influx into the Hunter Region after the Millennium drought correlates with an increase in records across NSW at that time (Cooper *et al*. 2016; Purnell *et al*. 2014; Herring & Silcocks 2014). The influx accords with painted-snipe dispersing from inland ephemeral wetlands after breeding, in search of more permanent wetland habitat

(Marchant & Higgins 1993). In the period 2010-2014, only 25% of painted-snipe records in eastern Australia were from coastal and near-coastal wetlands. By comparison, between October 2010 and July 2011 high numbers were recorded at inland wetlands in the Murray-Darling basin (Purnell *et al*. 2014). The influx of numbers into the Hunter Region in 2010-2014 was in stark contrast to the reduced numbers at other coastal wetlands, which highlights the importance of the Hunter Region to the species when conditions are favourable.

In the Lower Hunter sub-region, there was a sequence of four 2-5-year ARI flood events, in December 2010, June 2011, November 2011 and March 2012 (D. Williams pers. comm.). These would have recharged the estuarine wetlands. The annual rainfall data in **Figure 3** do not reflect these shorter-term events.

The occurrences at Widden and Castle Rock in the Upper Hunter sub-region in 2012 were part of the influx of birds to the Hunter Region following the Millennium drought. The records from the Segenhoe, Aberdeen and Scone areas in 1839 also were following widespread rain (Gould 1848).

The 2020 Tea Gardens bird's disappearance coincided with a significant rainfall event commencing 7 February 2020 across much of NSW. Over the ensuing several days, Williamtown recorded 141 mm, West Wyalong 95 mm and Narrandera 61 mm (Bureau of Meteorology 2020a).

Breeding

The 1972 breeding episode at Lenaghans Swamp accords with the species' known breeding behaviour of exploiting the productivity boom around ephemeral wetlands following receding floodwaters, and then dispersing (Menkhorst *et al*. 2017).

Although there has only been one recorded breeding event in the Hunter Region, 86% of all the painted-snipe occurrences have been from the period October-February, which is the main breeding period in NSW (Marchant & Higgins 1993). Also, several of those occurrences have involved gatherings of multiple birds, males and females, which is a known pre-breeding behaviour (Marchant & Higgins 1993). Therefore, it seems likely that birds have bred in the Hunter Region on other occasions. The painted-snipe's small population and cryptic nature possibly have led to an under-recording of local breeding episodes.

CONCLUSIONS

The occurrence of Australian Painted-snipe in the Hunter Region reflects the pronounced seasonal pattern exhibited in other areas of the state, with the species recorded dominantly in spring-summer and rare winter occurrences. The rate of occurrence in the Hunter Region has increased since the mid-1990s but this may in part, be the result of increased survey effort in key areas of habitat. There have been very few occurrences in winter, the last such record being from 1984.

This present study has shown that significant weather-related events such as long-term drought and drought-breaking rains provide drivers for most occurrences of Australian Painted-snipe in the Hunter Region. It also highlights the importance of permanent wetlands in the Lower Hunter as refuges for the species during drought and for breeding when conditions are suitable. Short-term flood events that recharge the wetlands may also be a factor contributing to favourable conditions.

The Australian Painted-snipe is probably under-recorded in the Hunter Region, particularly in the Upper and Northern Hunter sub-regions where visits by observers are irregular. In contrast, regular surveying of more permanent, readily accessed wetlands in the Lower Hunter sub-region may have produced a bias in records. The presence of flocks containing male and female birds between October and January on several occasions and records of nests associated with one such flock suggests that breeding in the Hunter Region may occur more frequently than recognised to date. There are no indications that local wetlands are unfavourable for breeding under the appropriate weather conditions. For better understandings about local breeding activity, it is recommended that whenever flocks are found in suitable habitat in the period from October to February, they be closely monitored. Watercourses in the Upper Hunter should also be surveyed more closely when conditions are favourable.

The small population, nomadic behaviour, cryptic nature, mainly nocturnal foraging and rare vocalisation are factors which make study of the Australian Painted-snipe difficult. However, the availability of online sites, such as Birdata, and blogs such as Hunterbirding to report local sightings, provide tools that could be used to disseminate sightings details in real time and facilitate more regular, longer-term observation of future occurrences.

ACKNOWLEDGEMENTS

I wish to thank the following people who suppled data for this study: Alan Stuart provided historical records for the Hunter Region, Fred van Gessel and Tom Kendall provided details of early records from Kooragang Island, Graeme Stevens and Dennis Gosper provided details of early records from Lenaghans Swamp including a nesting event, Alan Morris provided details of records from Windeyer Swamp, Laurie Conole provided details of sightings at Castle Rock and Dan Williams provided information on flood records for the Hunter River. Constructive feedback from the referee, Dick Cooper, improved the manuscript.

REFERENCES

Australian Museum Ornithology Collection, Registration number O.15474 http://collections.australianmuseum.net.au/amweb/pages/am/Display.php?irn=3016986&QueryPage=%2Famweb%2Fpages%2Fam%2FQuery.php&highlight_term=painted+snipe. Accessed 12/02/2020.

Baker, A.J., Pereira, S.L., Rogers, D.I., Elbourne, R. and Hassell, C.J. (2007). Mitochondrial-DNA evidence shows the Australian Painted-snipe is a full species, *Rostratula australis*. *Emu* **107**:185-189.

Barrett, G.W., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). 'The New Atlas of Australian Birds'. (Birds Australia: Melbourne.)

BirdLife Australia (2020). https://birdata.birdlife.org.au/. Accessed 12/02/2020.

Black, R., Houston, W. and Jaensch, R. (2010). Evidence of regular seasonal migration by Australia Painted-snipe *Rostratula australis* to the Queensland tropics in autumn and winter. *Stilt* **58**: 1-9.

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). 'The Atlas of Australian Birds'. (Royal Australasian Ornithological Union: Melbourne University Press.)

Breton, (Lieutenant) W.H. (1833). 'Excursions in New South Wales, Western Australia, and Van Diemen's Land, during the years 1830, 1831, 1832 and 1833'. (Richard Bentley: London.)

Bureau of Meteorology (2020a). Climate Data Online. http://www.bom.gov.au/climate/data/. Accessed 12/02/2020.

Bureau of Meteorology (2020b). Recent rainfall, drought and southern Australia's long-term rainfall decline. http://www.bom.gov.au/climate/updates/articles/a010-southern-rainfall-decline.shtml. Accessed 29/04/2020.

Christidis, L. and Boles, W. (2008). 'Systematics and taxonomy of Australian Birds'. (CSIRO Publishing: Collingwood, Victoria.)

Cooper, R.M., McAllan, I., Brandis, C. and Curtis, B. (2016). 'An Atlas of the Birds of NSW & the ACT, Volume 2. Comb-crested Jacana to Striated Pardalote'. (New South Wales Bird Atlassers Inc.: Woolgoolga, NSW)

D'Ombrain, A.F. (1944). Behaviour of the Painted Snipe in Captivity. *Emu* **43**: 248-249.

Eremaea Birdlines (2020). http://www.eremaea.com/BirdlineRecentSightings.aspx?Birdline=2. Accessed 12/02/2020.

Gould, J. (1848). 'The Birds of Australia, Volume 6'. (Gould: London.)

Herring, M. and Silcocks, A. (2014). Use of rice fields by the endangered Australian Painted-snipe (*Rostratula australis*): A rare opportunity to combine food production and conservation? *Stilt* **66**: 20-29.

Lane, B.A. and Rogers, D.I. (2000). The Australian Painted-snipe *Rostratula (benghalensis) australis*: an endangered species? *Stilt* **36**: 26-34.

Lowe, V.T. (1963). Observations on the Painted Snipe. *Emu* **62**: 221-237.

Marchant, S. and Higgins, P.J. (Eds) (1993) 'Handbook of Australian, New Zealand and Antarctic Birds. Volume 2: Raptors to Lapwings'. (Oxford University Press: Melbourne.)

Menkhorst, P., Rogers, D., Clarke, R., Davies, J., Marsack, P. and Franklin, K. (2017). 'The Australian Bird Guide'. (CSIRO Publishing: Clayton South, Victoria.)

McGilp, J.N. (1934). The nesting of the Painted Snipe (*Rostratula australis*). *South Australian Ornithologist* **12**:167-169.

Office of Environment & Heritage (2004). Australian Painted-snipe profile. https://www.environment.nsw.gov.au/threatenedspeciesapp/profile.aspx?id=10734. Accessed 12/02/2020.

Oring, L.W., Rogers, D., Oring K.E. and Tzaros, C. (2004). Snipes in peril. *Wingspan* **14**:10-15.

Purnell, C., Thomas, J. and O'Connor, J. (2014). Painting the picture: identifying key habitat for the Australian Painted Snipe. In: 'Birds of the Murray–Darling Basin' (Eds. R. Kingsford,, J. Lau and J. O'Connor) Pp. 27-29.

Rogers, D., Hance, I., Paton, S., Tzaros, C., Griffioen, P., Herring, M., Jaensch, R., Oring, L., Silcocks, A. and Weston, M. (2005). The breeding bottleneck: breeding habitat and population decline in the Australian Painted-snipe. In: 'Status and Conservation of Seabirds in the East Asian-Australasian Flyway'. (Ed. P. Straw). (Australasian Wader Study Group, December 2003, Canberra, Australia) Pp. 15-23.

Schodde, R. and Tidemann, S.C. (1988). 'Complete Book of Australian Birds'. Second edition. (Reader's Digest: Sydney.)

Smith, S. (2002). Drought. NSW Parliamentary Library Research Service. Briefing Paper 14/02. file:///C:/Users/neil8/Documents/A_Neil_Documents/Birds/Whistler/Whistler_14/Painted_Snipe_Review/Drought_Briefing_2002.pdf. Accessed 20/04/2020

Stuart, A. (Ed.) (1993-2018). Hunter Region New South Wales Annual Bird Report Numbers **1- 25** (1992-2017). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

Stuart, A. (Ed.) (2018). Hunter Region New South Wales Annual Bird Report Number **25** (2017). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

The Cornell Lab of Ornithology (2020). https://ebird.org/home. Accessed 12/02/2020

Williams, D. (Ed.) (2019). Hunter Region New South Wales Annual Bird Report Number **26** (2018). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

Book Review

An Atlas of the Birds of NSW and the ACT, Volume 3. Eastern Spinebill to Common Greenfinch

By Richard M. Cooper, Ian A.W. McAllen, Christopher C.P. Brandis and Brian R. Curtis, 2020.
New South Wales Bird Atlassers Inc, Woolgoolga, 762 pp., numerous tables, graphs and maps.
Hardback, A4 format, $170, ISBN 9780957704756

The third and final volume of the Atlas of the Birds of NSW and the ACT (Atlas) is now available. The accolades for this monumental work by NSW Bird Atlassers are many. Volume 2 was awarded the Royal Zoological Society of NSW Whitley Award for the Best Zoological Resource published on any Australian fauna or flora in 2016.

The methodology of documentation and analysis of data from the two previous volumes is unchanged in volume 3. For each species, there are maps, graphs and tables summarising 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. The analysis is based on an audited database of over six million records and although the data has a 2006 cut-off, the accompanying text references sources as recent as 2019. The strength of the Atlas lies in its 20+ year record of change which provides a multi-generational time frame for assessing population trends using IUCN listing criteria. Some excellent photographs accompany the text.

The final volume includes 10 supplementary species that were not included in volumes 1 and 2. These include two new records for NSW, Aleutian Tern and Eyrean Grasswren. The accompanying text indicates that the Manning Estuary appears to be a unique wintering habitat for Aleutian Tern. The South Island Pied Oystercatcher, which has been present on Stockton Beach in recent years, is also included. Many Hunter Region bird observers will have recently twitched these two species. The 13 endemic species of Lord Howe Island are included in this volume as are 79 authenticated NSW vagrant species. There are no statistics for the latter two groups. The list of supplementary and vagrant species includes information that will be of particular interest to pelagic birders. A list of literature and manuscript sources for historical data is included along with over 1,600 reference sources.

Sadly, the overarching message of the Atlas is the decline of avian species in NSW and ACT. The three volumes include 573 species that are known to have existed in NSW and ACT and the western Tasman Sea. The completion of the third volume has allowed analysis of the status of all included species. After excluding species that no longer exist in mainland NSW, vagrants, occasional visiting seabirds, non-breeding trans-equatorial migrants and human-introduced species, 393 species remain that are either resident or regional migrants. Of these 203 species (52%) exhibit a decline in reporting rate between 1986 and 2006. Statistically, this decline is highly significant for 162 species and significant for 37 species. Only 33 of the declining species are listed as threatened in NSW. While many of the declining species are classified as least concern under IUCN criteria (i.e. large range and population), the decline represents an irrefutable record of the continuing loss of habitat for these species.

The overwhelming majority of species in Volume 3 that exhibit declines in reporting rate are woodland birds, some of which we tend to take for granted, e.g. Golden Whistler, Grey Shrike-thrush, Australian Magpie, Grey Fantail, Willie Wagtail, Australian Raven, Magpie Lark and Eastern Yellow Robin.

Those species exhibiting an increase in reporting rate tend to be large, noisy, aggressive birds that have adapted successfully to the changed Australian landscape, e.g. Blue-faced Honeyeater, Australasian Figbird, Grey Butcherbird and Pied Butcherbird. Two uncommon cryptic species with increased reporting rates are Bassian Thrush and Russet-tailed Thrush.

There is some good news in the Atlas. Ten threatened species, some of which have healthy populations in the Hunter Region appear to have increased in number over the Atlas period: i.e. Wompoo Fruit-Dove, Black-necked Stork, Eastern Osprey, Square-tailed Kite, White-bellied Sea-Eagle, Australian Pied Oystercatcher, Sooty Oystercatcher, Superb Parrot, Powerful Owl and Eastern Grass Owl.

The Atlas tells us our record of environmental management is poor. We are experiencing increasing urbanization, agricultural development, altered water flows and poor water management as we attempt to meet the insatiable demands of our increasing population. As a result, the habitat of our birds is subject to ongoing destruction, degradation and fragmentation. Now climate change has been added as an additional threat.

Although the Atlas contains information that is not included in field guides, it may not appeal as a reference work to the average bird enthusiast. It will mainly appeal to more technically minded ornithologists, conservation organisations, wildlife managers, environmental consultants, scientists and government agencies. The quantitative data will undoubtedly be used to facilitate more cost-effective, targeted research and conservation management.

Unfortunately, the Atlas is unlikely to end up on the desk of those elected individuals who are charged with the responsibility of protecting our environment. Instead it is up to us to bring the results of the Atlas to their attention and demand effective action to protect our native species and their habitat.

I encourage all readers to carefully consider the section on declining annual trends on pages 4 and 5 of the Atlas, volume 3. In the words of the authors: "Overall this Atlas demonstrates that the habitat of many birds is now seriously affected by influences that will mean many species cannot survive the next century. The long-term outlook for many is bleak."

Neil Fraser
8 Flannel Flower Fairway
Shoal Bay NSW 2315
neil8fff@gmail.com

Expansion in the range of the Spiny-cheeked Honeyeater in the Hunter Valley – an example of the use of time-variant distribution maps to study Hunter Region species

Dan Williams

86 Blanch Street, Shortland NSW 2307, Australia scythrops@yahoo.com.au

Received 29 September 2020; accepted 14 October 2020; published on-line 19 November 2020.

There has been a relatively recent eastward movement in the distribution of the Spiny-cheeked Honeyeater *Acanthagenys rufogularis* into the Hunter River Valley of central New South Wales (McAllan & Lindsay 2016). In recent years, the Hunter Bird Observers Club has been producing maps of species distribution in the Hunter Region within the Annual Bird Reports (ABR). This thematic mapping analyses survey effort and species records within defined areas of the Hunter Region to produce a 'weighted reporting rate' (WRR), as documented in the 2018 ABR (Williams 2019). The mapping produces an overall approximation of a species range, using a three-tiered colour gradation to indicate the frequency of reporting.

The Spiny-cheeked Honeyeater has been selected to demonstrate the potential of the mapping methodology to assist in the studies of individual species. The distribution map for the Spiny-cheeked Honeyeater in the Hunter Region using the full period of surveys (1998-2019) is presented in **Figure 1**. An analogous mapping exercise has been undertaken for four subsets of the records database, each representing a period of five years: 2000-2004, 2005-2009, 2010-2014 and 2015-2019. The results of this analysis are presented in **Figure 2**. This time period was selected as the first regular observations of Spiny-cheeked Honeyeater in the Hunter Region began in 2000. There are no records of the species in the 1993-1999 ABRs.

Figure 1 Spiny-cheeked Honeyeater distribution in the Hunter Region (all surveys for 1998-2019).

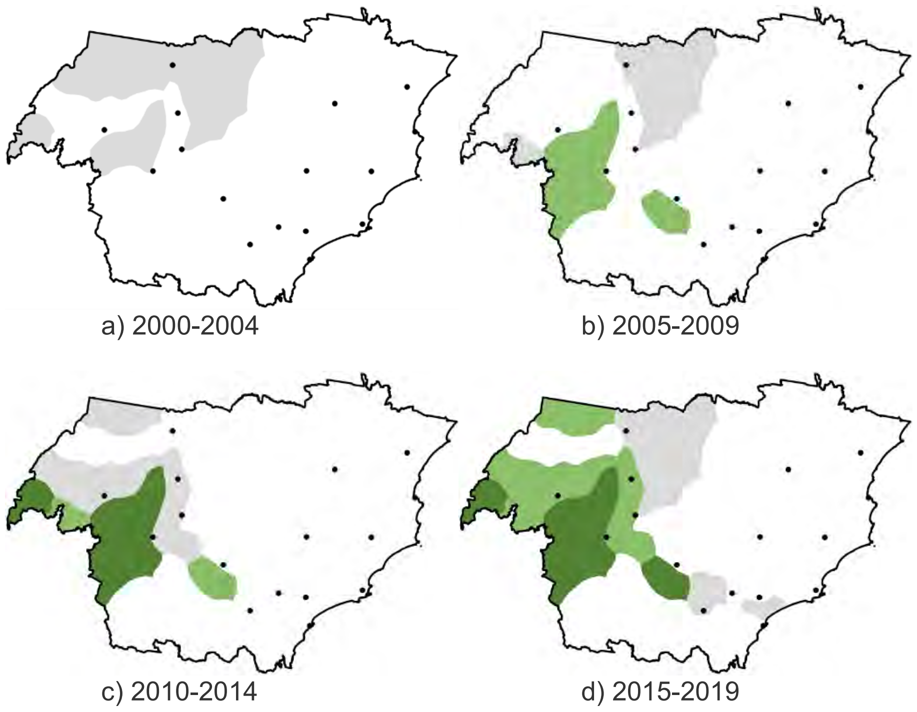


Figure 2 Change in the Spiny-cheeked Honeyeater distribution in the Hunter Region for four 5-year time periods between 2000 and 2019.

The mapping presented in **Figure 2** is strong supportive evidence of the eastward expansion in the range of the Spiny-cheeked Honeyeater in the Hunter Region. In the period 2000-2004 the mapping analysis shows the range of the Spiny-cheeked Honeyeater was largely restricted to the western parts of the Hunter Valley. In 2005-2009 there was an eastern movement into central parts of the Hunter Valley and an overall increase in the WRR, as is evident in the mapping. In 2010-2014 there was a further increase in WRR, with the species taking a firm hold in the western parts of the Hunter Valley. In 2015-2019 the WRR further increased within the western and central parts of the Hunter Valley and the overall range extended to the Hunter Estuary.

The time-varied distribution mapping of the Spiny-cheeked Honeyeater within the Hunter Region provides a strong visual aid in support of the relatively recent eastward movement in the distribution of the Spiny-cheeked Honeyeater documented by McAllan & Lindsay (2016). It also demonstrates the potential use of the Hunter Region records database and ABR mapping methodology to assist in the study of individual bird species. This method of potential analysis is not only limited to changes in distribution over time but can be used to help understand seasonal movements or sporadic irruption events. It is hoped that such analyses can be used to support future studies published in *The Whistler*.

REFERENCES

McAllan, I. and Lindsay, K. (2016). Stranger in the valley: Expansion in the range of the Spiny-cheeked Honeyeater in central eastern New South Wales. *Australian Field Ornithology* **33**: 125-132.

Williams, D. (Ed.) (2019). Hunter Region of New South Wales 2018 Bird Report Number **26**. (Hunter Bird Observers Club Inc., New Lambton, NSW).

Nocturnal detection of Australian Little Bittern and Australian Painted-snipe – Prospects for nocturnal survey methods for rare wetland birds

Chad T. Beranek

School of Environmental and Life Sciences, Biology Building, University of Newcastle, University Drive, Callaghan NSW 2308, Australia.
FAUNA Research Alliance, PO Box 5092, Kahibah, NSW 2290, Australia
Correspondence - E: chad.beranek@uon.edu.au

Received 11 July 2020; accepted 14 October 2020; published on-line 19 November 2020.

Some of the most difficult to detect Australian wetland birds include bitterns and snipes. Here I present novel nocturnal observations of the Australian Painted-snipe *Rostratula australis* and the Australian Little Bittern *Ixobrychus dubius* on Kooragang Island, NSW and discuss possible alternative survey methods based on these observations, in hopes of stimulating ideas for methods that increase the detection probability for these birds. The site contained 2.6 ha of wetlands which were surveyed for birds almost weekly (once during the day and once at night) from September to March during 2016 – 2019. During this time, a female Australian Painted-snipe was observed on three separate nights in September 2017, and a female Australian Little Bittern was observed once at night with certainty in November 2018. A male Australian Little Bittern was flushed during the day on 22/10/2019. There were several similarities for these observations: they all occurred within the same wetland, they occurred in spring when the wetlands had been charged with water for ~7 months and were in the process of drying, and most of the birds (with one exception) were observed at night. The snipe was detected from its eye-shine while the bittern was detected during a nocturnal reed search. Both species did not flush immediately when found in close-quarters at night time. I hypothesise that nocturnal visual encounter surveys in drying ephemeral wetlands during spring will lead to a higher detection probability of these species compared to traditional survey methods.

INTRODUCTION

Some of the most difficult to detect and secretive Australian wetland birds include the bitterns, Australasian Bittern *Botaurus poiciloptilus*, Black Bittern *Ixobrychus flavicollis* and the Australian Little Bittern *Ixobrychus dubius*, as well as the snipes which include the Australian Painted-snipe *Rostratula australis* and Latham's Snipe *Gallinago hardwickii* (Weston *et al.* 2012). Currently, survey techniques for these birds usually involve area searches with binoculars during the day in attempts to flush the birds, or in the case of bitterns, using call playback at dusk to elicit a response (Gibbs & Melvin 1993; Pickering 2010, 2012). To my knowledge there have been no documented spotlight observations of these species. All these birds have the following traits in common: they are highly dispersive; their long-distance movements are somewhat unpredictable; they are low in abundance; and they have cryptic behaviours (Kingsford & Norman 2002). Any insight into increasing the detection probability of these rare wetland birds is of high importance so that their ecology can be further understood for more effective conservation management. This article focuses on the Australian Painted-snipe and the Australian Little Bittern.

The Australian Painted-snipe and the Australian Little Bittern are more commonly encountered in the Riverina region of New South Wales (NSW) and are comparatively rarely encountered within the Hunter Region of NSW (Birds Australia & Australasian Wader Studies Group 2002; BirdLife Australia 2015). The Murray-Darling River in western NSW has the most Australian Painted-snipe observations, however they are known to be highly nomadic and disperse to distant locations during periods of heavy rainfall and wetland inundation in other regions of Australia (Knuckey *et al.* 2013). The Australian Painted-snipe and the Australian Little Bittern can often go several years without detection in the Hunter Region (Stuart 1994-2018; Roderick 2014; Fraser 2020). Although the region does not fall within what is considered the core distribution of these species, there is circumstantial evidence of breeding for both species (Stuart 2005;

Roderick 2017; Fraser 2020). The overall pattern of records suggests that both species may be usually present in this region during favourable conditions in most years, but that they are often undetected.

The aim of this article is to present the first nocturnal detections of the Australian Little Bittern and the Australian Painted-snipe, found at the same wetland on Kooragang Island, NSW, and discuss trends and insights from these observation in order to stimulate ideas for more effective survey methods of these rare species.

METHODS

The observations occurred in a 2.6 hectare wetland complex which was created in 2015 and 2016 as habitat for the Green and Golden Bell Frog *Litoria aurea* (Beranek *et al.* 2020a). The wetlands consist of 11 water bodies that have varying hydrology, some being ephemeral and others being permanent. Each wetland was surrounded by an earthern bunding wall that was designed to prevent overland flow of water to limit Plague Minnow *Gambusia holbrooki* dispersal. There are several wetland plant species that occur in dense stands through this area, including Marsh Club Rush *Bolboschoenus caldwelli*, River Bulrush *B. fluviatalis*, Common Reed *Phragmites australis* and Broad-leaved Cumbungi *Typha orientalis.* Despite the large coverage of wetland vegetation, there are also large portions of the wetlands that are open and do not contain stands of dense emergent vegetation. These areas are usually characterised by water that is >1 m deep which is apparently too deep for growth of emergent vegetation.

Routine visual encounter surveys of the wetlands were conducted about once a week over three years from September – March over 2016-17, 2017-18 & 2018-19, as well as September – October 2019. Each water body was searched once a day and once at night per week with 2 – 8 observers. Nocturnal surveys were conducted using head torches (LED Lensor 7.2R and 14.2R). During day-time surveys, the paths used in nocturnal surveys were re-searched, and an additional 20-minute perimeter walk was conducted with binoculars. Before a visual encounter survey commenced, a five-minute auditory survey was used to detect vocalisations. Birds were recorded as using the wetlands if they were located within the boundary of the bunded walls. The visual encounter survey periods ranged from 20 – 60 minutes.

Maximum water depth was measured weekly during the survey period. This was achieved by comparing water levels to measurement increments scribed onto polyvinyl-carbon piping that was inserted in the middle of each wetland in the study site.

Fyke netting and opportunistic capture with a hand-held net was used to collect information on potential prey items of the birds present within the wetlands. Fyke nets are designed with wing nets that direct aquatic fauna to a central entry hoop that leads to a netting bag with several valves. They were originally designed for the capture of eels but have since been used for the capture of a range of other aquatic fauna (Wassens *et al.* 2017). The Fyke nets used in this study had a 70 cm diameter hoop opening, with 2.5 m wings both sides and a mesh size of 5 mm. The hand-held net had a surface area of 30 x 30 cm with a mesh size of 5 mm. Both techniques were targeted in microhabitats of the wetlands that were well vegetated to maximise capture of potential prey items. Freshwater macroinvertebrates were either identified in the field or if this was not able to be done, they were placed in 70% ethanol and identified under a microscope using the water bug guide provided by the Murray–Darling Basin Authority (2009). Amphibian larvae were identified in the field using Anstis (2013).

RESULTS

A list of all birds encountered during nocturnal visual encounter surveys within the wetlands is presented in the **Appendix** available on-line. The Australian Little Bittern and the Australian Painted-snipe were found at the same wetland (GPS: -32.8520 S, 151.7116 E), which was ephemeral and dominated by Common Reed. For both species, this wetland was in the process of drying up after having been inundated for 7 – 8 months.

All the records of Australian Painted-snipe and Australian Little Bittern from the current study are presented in **Table 1**.

There were several potential food items observed in the wetland close to the times when the birds were observed. These included a freshwater macroinvertebrate assemblage consisting of the dragonfly larvae of the Australian Emperor *Anax papuensis*, and dragonfly larvae in the Libullidae family, damselfly larvae of the *Austrolestes* genus, backswimmers (Notonectidae), water boatmen *Agraptocorixa* sp., and the Hunter endemic yabby *Cherax setotus*. Amphibian species commonly observed in this wetland at the time of the observations were juvenile and adult Green and Golden Bell Frogs *Litoria aurea* and tadpoles of the Striped Marsh Frog *Limnodynastes peronii*.

DISCUSSION

Here I discuss the spotlight observations of the Australian Painted-snipe and the Australian Little

Table 1. List of observations. ALB = Australian Little Bittern. APS = Australian Painted-snipe.

Time & Date	GPS	Species observed	Detection	Water depth (cm)	Observation description
2228 h 13/09/2017	-32.851968 S, 151.711431 E	APS (Female)	Eye-shine	16	Observed ~1.5 m from the nearest Common Reed stand. Did not flush and was able to get within ~50 cm to it. If approached too close it would walk quickly away, but remained in open water.
2021 h 20/09/2017	-32.851968 S, 151.711431 E	APS (Female)	Eye-shine	14	Observed in similar circumstances as the previous observation, and likely to have been the same bird.
2131 h 27/09/2017	-32.851970 S, 151.711787 E	APS (Female)	Eye-shine	4	Observed in the puddles of the same wetland in a different location. The original locations where the bird was found in previous weeks were dry. Found in open water within the puddle within ~80 cm of a stand of River Club Rush *Schoenoplectus validus*.
2125 h 1/11/2018	-32.852019 S, 151.711613 E	ALB (Female)	Visual encounter	28	Observed perched ~130 cm above the ground on Common Reed. It displayed a typical bittern camouflage posture and remained for ~2 minutes before taking flight. I was able to get within 50 cm of the bird.
2145 h 7/11/2018	-32.851912 S, 151.711949 E	ALB (sex unknown)	Flushed	24	Observed flushed at the edge of a wetland in thick River Bulrush. It flushed during the approach, at ~7 m distance. It cannot be confirmed as an ALB, but is highly likely an ALB since no other heron-type birds have been observed in any of the wetlands at night.
10:04 h 22/10/2019	-32.852019 S, 151.711613 E	ALB (Male)	Flushed	~30	Observed flushed at the edge of a wetland in thick River Bulrush. It flushed during the approach, at ~5 m distance. Clear view of the bird and confident of identification.

Bittern in the Hunter Region which may also be the first such detections throughout Australia (Stuart 1994, 1995, 2004, 2005; Roderick 2014, 2017). While no definitive conclusions can be made from just three observations of each species, there are two interesting commonalities which can be used to formulate hypotheses that relate to improving detection probability of rare wetland birds.

It has been demonstrated that wetland bird species prefer wetlands that are drying and relatively shallow as they have more concentrated food items, and therefore this ecological trait can confer a way of optimising targeted surveys of rare wetland birds (Kushlan 1981). I detected both the Australian Painted-snipe and the Australian Little Bittern during a period of wetland drying after being inundated for ~7-8 months. Similar observations have been made; for example, a study which used camera footage to quantify foraging behaviours of an Australian Little Bittern in Canberra found that the bittern would most often forage in water that was knee-deep but would occasionally forage in water which was as deep as the bittern's belly (Wallace 2013). The Australian Painted-snipe is also reported to mainly use shallow ephemeral wetlands for breeding and foraging (Birds Australia & Australasian Wader Studies Group 2006).

Diet may also determine wetland choice. It has been found that the Australian Painted-snipe predates on freshwater macroinvertebrates in the Corixidae and Notonectidae families and there is a published photo of an Australian Painted-snipe consuming a dragonfly larvae (Odonota order) (Birds Australia & Australasian Wader Studies Group 2009). The Australian Little Bittern is a known predator of tadpoles (Barker & Vestjens 1989). All of these prey items were present within the wetland during the times of observation, presumably at high concentrations due to wetland drying. Using this information, I hypothesise that the Australian

Painted-snipe and the Australian Little Bittern are most likely to be detected in wetlands that are drying up after a long period of retaining water, as such situations may result in high concentrations of prey in the water column.

Nocturnal visual encounter surveys may result in higher detection rates of Australian Little Bittern and Australian Painted-snipe compared to diurnal surveys due to less sensitivity to flushing (conferring an advantage in identification), and higher detectability with head torches via eye shine. While the Australian Little Bittern was not detected by eye shine, the Australian Painted-snipe was detected on all occasions by its eye shine. This difference in means of nocturnal detection may be explained by habitat use. The Australian Painted-snipe inhabits wetlands that contain thick vegetation bordering shallow open water (Birds Australia & Australasian Wader Studies Group 2006; Herring & Silcocks 2014). In contrast, the Australian Little Bittern is known to primarily inhabit dense stands of reeds (Wallace 2013). Both species are known to forage in shallow open water. I observed the Australian Painted-snipe primarily occupying an open-water section of the wetland, although I could not confirm any foraging behaviours. However, this use of habitat at night enabled efficient detection of the snipe with eye-shine reflection as there was no impairment of the view of the bird due to reeds.

The Australian Little Bittern was not observed by its eye-shine on any occasion, and it was either visually encountered during intensive searches through Common Reed or it was flushed. However, neither of the two birds that I encountered flushed easily and they could be approached to within a distance of ~1 m, which is against most other observations (Jaensch 1989; Knuckey *et al.* 2013). For example, the mean flight-initiation distance of the Australian Little Bittern in day time is 12.9 m (Weston *et al.* 2012), which is much larger than the flight-initiation distance of *circa* 0.5 m for the two birds I encountered. Australian Painted-snipe are also reported to take flight readily when approached (Birds Australia & Australasian Wader Studies Group 2009). Indeed, close proximity mobile-phone photographs were taken of both birds (see **Figure 1**), which to my knowledge have not been possible for these birds during diurnal observations. It appears these species are less prone to flushing when being viewed with a head torch at night time, which enables easier confirmation of species identity and therefore it is likely these species are more detectable at night time.

Figure 1. Mobile-phone photographs. Above: Australian Painted-snipe (female), date: 13/09/2017. Below: Australian Little Bittern (female), date: 1/11/2018.

CONCLUSION

In the future, studies should conduct replicated surveys in wetlands of known sites of the Australian Little Bittern and Australian Painted-snipe, both in night and day time to determine which method has higher detection probability. Surveys should target wetlands which are drying after prolonged inundation, which typically occurs from September to February in the Hunter Region. Evaporation rates decrease in the colder months of autumn and winter, which results in most wetlands that are filled in late summer remaining inundated throughout this period (Beranek & Mahony 2018). These ideas are likely most efficiently testable under an occupancy modelling experimental design which accounts for imperfect detection.

Given that the Australian Little Bittern appears to flush less easily at night time and occupies dense vegetation in wetland solitarily, this species and similar rare wetland bird species might be detected effectively using drones with thermal imagery. Drones with thermal imaging mounts have been increasingly used to improve detection rates of rare and cryptic animals such as the koala (Beranek *et al.* 2020b), and this technology appears useful for wetland birds (e.g. Afán *et al.* 2018). The feasibility of using drones to detect bitterns and other rare wetland birds depends on the emissivity of their thermal signature while obscured by wetland vegetation. This should also be trialled in future studies.

The combination of rarity, dispersive nature and shyness of wetlands birds such as the Australian Little Bittern and the Australian Painted-snipe make them difficult to survey, however the observations presented in this article coupled with knowledge gleaned from the available literature (Jaensch 1989; Birds Australia & Australasian Wader Studies Group 2006; Fraser 2020) provides insight for novel survey strategies. This includes: surveying wetlands that are drying after long periods of inundation or that are recharged after dry conditions; surveying wetlands during September – December; and conducting nocturnal surveys with a head torch, while wading through the wetland. These ideas should be combined with the methods used by Jaensch (1989) to improve detection probability. However, these ideas should be assessed statistically in future studies to determine if they present superior alternative methods.

ACKNOWLEDGEMENTS

I thank Robert Scanlon for impressively revealing the first Australian Little Bittern of the site (Aka "wetland chicken") on his first night out at the wetlands. I also thank Kathleen Bushell, Max Manion, Lachlan McCrae, Jessica McGregor, Dayna Mitchell and Samantha Sanders for aiding with field work to collect these observations and for garnering a broader enthusiasm for ecology that extends beyond (but includes) frogs to encompass all fauna, including rare wetland birds. I also thank Ian Benson, Alex Berryman, Jeff Jones, Mick Roderick and Bruce Watts for aiding in bird surveys and for providing information to foster my interest in birds. Additionally, I thank Neil Fraser and an anonymous reviewer for comments which led to improvement of the manuscript.

REFERENCES

Afán, I., Máñez, M. and Díaz-Delgado, R. (2018). Drone monitoring of breeding waterbird populations: the case of the glossy ibis. *Drones* **2:** 42.

Anstis, M. (2013). 'Tadpoles and frogs of Australia'. (New Holland Publishers: Chatswood, Australia.)

Barker, R. D. and Vestjens, W. J. M. (1989). 'The food of Australian birds. I. Non-passerines'. (CSIRO Division of Wildlife and Ecology: Lyneham, ACT.)

Beranek, C. T. and Mahony, M. J. (2018). BHP Compensatory Habitat Green and Golden Bell Frog Population Monitoring - Spring Memo 2017-2018. (University of Newcastle, Callaghan, NSW.)

Beranek, C. T., Clulow, J. and Mahony, M. (2020a). Wetland restoration for the threatened green and golden bell frog (*Litoria aurea*): development of a breeding habitat designed to passively manage chytrid-induced amphibian disease and exotic fish. *Natural Areas Journal* **40**: *in press*.

Beranek, C. T., Roff, A., Denholm, B., Howell, L. G. and Witt, R. R. (2020b). Trialing a real-time drone detection and validation protocol for the koala (*Phascolarctos cinereus*). *Australian Mammalogy* **42**: *Online early*.

BirdLife Australia (2015). Little Bittern - Where were they and how many were there? *Bittern Chronicle* **7**: 2.

Birds Australia and Australasian Wader Studies Group. (2002). Painted Snippets - Newsletter of the Australian Painted Snipe Project Volume 1.

Birds Australia and Australasian Wader Studies Group. (2006). Painted Snippets - Newsletter of the Australian Painted Snipe Project Volume 2.

Birds Australia and Australasian Wader Studies Group. (2009). Painted Snippets - Newsletter of the Australian Painted Snipe Project Volume 3.

Fraser, N. (2020). A review of Australian Painted-snipe records from the Hunter Region, 1966-2020. *The Whistler* **14**: 35-43.

Gibbs, J. P. and Melvin, S. M. (1993). Call-response surveys for monitoring breeding waterbirds. *The Journal of Wildlife Management* **57**: 27-34.

Herring, M. and Silcocks, A. (2014). The use of rice fields by the endangered Australian Painted Snipe (*Rostratula australis*): a rare opportunity to combine food production and conservation? *The Stilt* **66**: 20-29.

Jaensch, R. P. (1989). Little Bittern *Ixobrychus minutus* breeding at Bool Lagoon, 1984-1986. *South Australian Ornithologis* **30**: 205-209.

Kingsford, R. and Norman, F. (2002). Australian waterbirds—products of the continent's ecology. *Emu* **102**: 47-69.

Knuckey, C. G., Trainor, C. R., Firth, R., Sansom, J. L. and Trainer, J. E. (2013). A record of the Endangered Australian Painted Snipe *Rostratula australis* (Gould, 1838) in the Fortescue valley, Pilbara region. *Wader Study Group Bulletin* **120**: 11-14.

Kushlan, J. A. (1981). Resource use strategies of wading birds. *The Wilson Bulletin* **93**: 145-163.

Murray–Darling Basin Authority (2009). Environmental watering for food webs in the living Murray icon sites. (Murray-Darling Basin Authority: Canberra, ACT.)

Pickering, R. (2010). Summary of the Australasian Bittern and Australian Little Bittern Surveys 2009/10. *Western Australian Bird Notes* **134**: 13-14.

Pickering, R. (2012). Summary of the Bittern project, 2011/12. *Western Australian Bird Notes* **142**.

Roderick, M. (2014). Records Appraisal Committee - 2013 Report. (Hunter Bird Observers Club: New Lambton, New South Wales.)

Roderick, M. (2017). Records Appraisal Committee - 2016 Report. (Hunter Bird Observers Club: New Lambton, New South Wales.)

Stuart, A. (Ed.) (1994-2018). Hunter Region of New South Wales - Annual Bird Report Nos 1-25. (Hunter Bird Observers Club: New Lanbton, New South Wales.)

Wallace, S. (2013). Australian Little Bittern behaviour. *Canberra Bird Notes* **38**: 119-133.

Wassens, S., Hall, A., and Spencer, J. (2017). The effect of survey method on the detection probabilities of frogs and tadpoles in large wetland complexes. *Marine and Freshwater Research* **68**: 686-696.

Weston, M., McLeod, E. M., Blumstein, D. and Guay, P.-J. (2012). A review of flight-initiation distances and their application to managing disturbance to Australian birds. *Emu* **112**: 269-286.

Port Stephens shorebird and waterbird surveys 2004-2020

Alan Stuart

81 Queens Road, New Lambton NSW 2305, Australia. almarosa@bigpond.com

Received 25 October 2020; accepted 9 November 2020; published on-line 19 November 2020.

Shorebird and waterbird populations in the Port Stephens estuary in New South Wales have been monitored regularly since 2004, using teams in boats to survey sub-sections of the estuary simultaneously. Overall, 23 shorebird species and 31 waterbird species have been recorded in the surveys, which were carried out twice-yearly in most years, as one summer survey and one winter survey.

Sixteen migratory shorebirds were recorded, including 13 species which had regular records. The most abundant shorebird species in Port Stephens was Bar-tailed Godwit *Limosa lapponica*, followed by Far Eastern Curlew *Numenius madagascariensis* and Whimbrel *N. phaeopus*. The numbers of visiting shorebirds have decreased, with average declines of around 2.5% per year having occurred for the above three species since 2004.

There were several records in summer of more than 1% of the total world population of Far Eastern Curlew; Port Stephens is an internationally significant site for that species. In winter, many immature (non-breeding) curlews stay in Port Stephens, with an average winter count of 66 birds and a peak count of 223 birds in 2009.

More than 1% of the total population of the Australian Pied Oystercatcher *Haematopus longirostris* was regularly recorded in Port Stephens, in both the summer and winter surveys and with a peak count of 192 birds. The numbers of Sooty Oystercatcher *H. fuliginosus* increased, such that since 2013 more than 1% of the total population of subspecies *H. f. fuliginosus* has often been present, particularly in summer.

The most abundant waterbirds were Australian Pelican *Pelecanus conspicillatus*, Little Pied Cormorant *Microcarbo melanoleucos*, Little Black Cormorant *Phalacrocorax sulcirostris*, Great Pied Cormorant *P. varius*, Silver Gull *Chroicocephalus novaehollandiae* and Greater Crested Tern *Thalasseus bergii*, all of them having average counts of more than 100 birds in both the summer and winter surveys. The Little Tern *Sternula albifrons* was only recorded in low numbers each summer until 2016. From then, their numbers increased, to a peak count of 304 birds in 2018 and breeding colonies have re-established.

Several waterbird species were present in larger numbers in the winter surveys than in summer. Examples included Little Pied Cormorant, Great Cormorant *P. carbo*, Great Pied Cormorant and Caspian Tern *Hydroprogne caspia*. Conversely, species such as Black Swan *Cygnus atratus*, Silver Gull, and Greater Crested Tern were more abundant in summer than in winter. There was some evidence to suggest that rainfall patterns (El Niño and La Niña events)) affected waterbird numbers.

INTRODUCTION

The Port Stephens estuary (**Figure 1**), situated approximately 200 km north of Sydney, is a popular tourist and recreational area. The area around the south-eastern section of the estuary has experienced substantial development as has the north-eastern section to some extent. However, many parts of Port Stephens are relatively undisturbed. All the Port Stephens waters, to the high-tide shoreline, are part of the Port Stephens-Great Lakes Marine Park.

A substantial portion of the less-disturbed parts of Port Stephens provides suitable foraging or roosting habitat for shorebirds and various waterbirds. This includes two nature reserves – Gir-um-bit National Park (the southern part of the reserve is centred at 32º 42'S, 151º 58'E) and Corrie Island Nature Reserve (32º 40'S, '152º 08'E). Also, there are several islands (see **Figure 1**) that offer foraging or roosting habitat. At low tides, many mudflats and sand banks around the Port, and oyster racks, become exposed; these all offer opportunities for shorebirds and some waterbirds to forage. Many other waterbird species can utilise the extensive areas of open water found in Port Stephens.

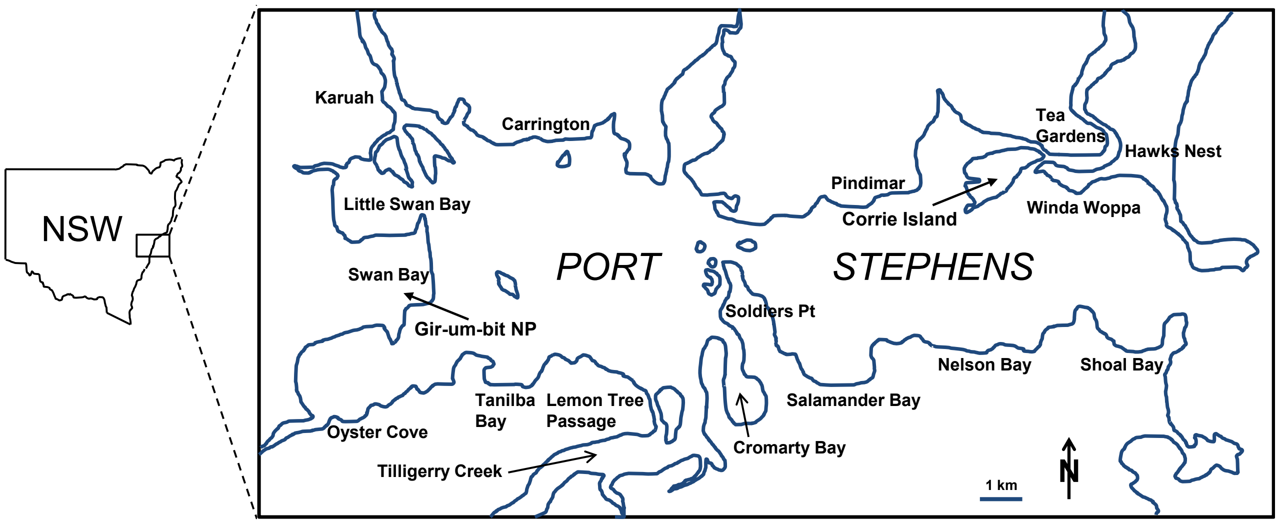


Figure 1. Port Stephens in New South Wales, showing the main towns and topographic features.

Prior to 2004, Port Stephens was sometimes surveyed for shorebirds, particularly in the 1980s, and its importance for certain species was recognised (Lane 1987; Smith 1991; Bamford *et al*. 2008). However, the surveys in general were infrequent, and they were land-based. Being limited to land-accessible locations meant that not all of the now-known roost sites for shorebirds were able to be surveyed, because some of them are only accessible by boat (Stuart 2011). In 2004 I began organising regular boat-based surveys of Port Stephens, with all shorebirds, waterbirds and birds of prey utilising the marine and estuarine habitats of the Port being recorded. For 2004-2007, a survey was carried out every summer, and there have been both summer and winter surveys in most years since 2008.

Some of the results from the post-2004 surveys have been presented elsewhere, namely: the interim findings from the first three years of summer surveys (Stuart 2005, 2007); information about the Australian Pied Oystercatcher in Port Stephens (Stuart 2010; Fraser 2019); data for shorebirds from the 2004-2011 surveys and comparison with pre-2004 shorebird records (Stuart 2011); data for some shorebirds from the 2004-2015 surveys (Roderick & Stuart 2016); and information about the birds of prey in Port Stephens (Stuart 2016). In this report I present and discuss the findings for all shorebird species and the main waterbird species from the 2004-2020 surveys.

METHODS

The general methodology for the surveys has been described previously (Stuart 2011). Four to six teams (for most of the surveys, six teams) in boats simultaneously surveyed sub-areas (sectors) of Port Stephens, following pre-defined standard routes every time. Due to human activity, shorebirds only occasionally use the south-eastern section of the Port Stephens coastline and only in small numbers (AS pers. obs.). Hence that area was not included in the surveys. The teams collectively covered the remainder of the Port Stephens shoreline including all of the contained islands.

Each survey commenced approximately 90 minutes before the predicted time for high tide at Soldiers Point in Port Stephens. The surveys of each sector took *c*. 3 hours to complete, meaning that all the surveys were carried out in high-water conditions when shorebirds usually are congregated at their roost sites (Finn 2007). Port Stephens is often subjected to strong afternoon sea breezes, hence days with early high tides were chosen for the surveys.

Every vessel had a dedicated skipper and 1-2 observers, at least one of whom was an experienced birdwatcher. After the initial set of surveys in 2004, teams were assigned such that at least one of the observers and/or the skipper had surveyed the sector previously and was familiar with the route and its subtleties. Each team recorded the numbers of all shorebird species observed and of all other waterbirds, as well as birds of prey.

A de-briefing session for participants was held after every survey. That session provided the opportunity to eliminate any possible instances of double-counting because of movements of birds out of a sector mid-survey. Such instances were found to be rare.

Data management

The records for each sector were entered into Birdata as individual Shorebirds 2020 surveys. For each summer and winter overall survey, the aggregated counts for each species from all six sectors were collated in a Microsoft Excel file, from which graphs (annual results and trends, summer/winter comparisons) were generated using standard Excel software tools. Regression analyses were carried out using Excel's Data Analysis Add-in software.

RESULTS

Surveys

The summer surveys, spanning 2004-2020, were carried out in February, except in 2005 when the originally scheduled date had to be postponed to early March. There were some operational issues during the 2005 survey and only 80-90% of the targeted area was able to be surveyed. The winter surveys have spanned 2008-2020 and all of them were done on a July date, if done at all. In 2016, owing to deteriorating weather conditions during the scheduled survey, not all areas were able to be visited by boat on the chosen date. All the main roost sites that were missed that day were able to be surveyed from land-based visits over the following two days. Extended periods of poor weather conditions prevented the winter surveys in 2015 and 2017 from occurring.

With the above limitations, 17 summer and 11 winter surveys were completed over 2004-2020, overall recording 23 shorebird species and 31 waterbird species. The results are summarised in **Table 1**. It should be noted that, although observers also counted the numbers of Australian White Ibis *Threskiornis moluccus*, Straw-necked Ibis *T. spinicollis* and Cattle Egret *Bubulcus ibis* that they encountered during the survey, those species were excluded from analysis for this report, for reasons discussed later.

Table 1. Summary of Port Stephens surveys 2004-2020

	Summer surveys	Winter surveys	Overall
No. of surveys	17	11	28
Total shorebird species	23	14	23
Total waterbird species	28	28	31

Details of the summer surveys are presented in **Table 2**. Overall, the summer surveys recorded 23 shorebird species and 27 waterbird species; however, for any individual survey there were 8-15 shorebird species and 13-25 waterbird species recorded. In general, there were fewer birds and fewer species recorded in the winter surveys, as summarised in **Table 3**. The winter surveys recorded 14 shorebird species overall (with 8-12 species recorded each survey) and 25 waterbird species (ranging from 13-25 species per survey).

The Coefficients of Variation (CV), (which is the ratio of the Standard Deviation (SD) to the Mean) for the results from all surveys have ranged between 7% and 35% (**Tables 2** and **3**).

Table 2. Results from summer surveys in Port Stephens (number of species of shorebirds and waterbirds, total counts of shorebirds and waterbirds, and the overall results).

	Shorebirds		Waterbirds		Overall	
Year	Spp	Birds	Spp	Birds	Spp	Birds
2004	13	2053	23	2387	36	4440
2005	11	689	13	688	24	1377
2006	18	1527	18	1473	36	3000
2007	14	1750	25	1796	39	3546
2008	13	1695	21	982	34	2677
2009	14	1554	16	2235	30	3789
2010	15	1812	22	2280	37	4092
2011	11	1431	19	1072	30	2503
2012	13	1479	19	967	32	2446
2013	10	1147	18	1580	28	2727
2014	11	1230	21	1740	32	2970
2015	13	1327	18	1406	31	2733
2016	13	1419	18	1216	31	2635
2017	8	937	16	1510	24	2447
2018	13	960	18	1970	31	2928
2019	10	1142	19	2584	29	3716
2020	11	1209	19	1539	30	2748
Max.	18	2053	25	2602	39	4440
Mean	12	1374	19	1615	32	2989
SD	2	350	3	547	4	736
CV	17%	25%	16%	34%	13%	25%

Table 3. Results from winter surveys in Port Stephens (number of species of shorebirds and waterbirds, total counts of shorebirds and waterbirds, and the overall results).

	Shorebirds		Waterbirds		Overall	
Year	Spp	Birds	Spp	Birds	Spp	Birds
2008	8	608	22	1219	30	1827
2009	8	738	21	1262	29	2000
2010	8	699	21	674	29	1373
2011	11	544	16	1141	27	1685
2012	10	429	18	885	28	1314
2013	11	630	20	2223	31	2853
2014	12	384	17	1590	29	1974
2016	8	512	18	1570	26	2082
2018	10	368	21	2104	31	2472
2019	9	374	20	2208	29	2582
2020	9	641	16	1381	25	2018
Max.	12	738	22	2223	31	2853
Mean	9	540	19	1478	29	2018
SD	1	136	2	523	2	478
CV	11%	25%	11%	35%	7%	24%

Overview of results for all species

Table 4 summarises the summer and winter results for individual shorebird species, and **Table 5** the analogous results for waterbirds. Six shorebird species were recorded in every summer and winter survey, as were nine waterbird species. The six shorebirds were Australian Pied Oystercatcher *Haematopus longirostris*, Sooty Oystercatcher *H. fuliginosus*, Masked Lapwing *Vanellus miles*, Whimbrel *Numenius phaeopus*, Far Eastern Curlew *N. madagascariensis* and Bar-tailed Godwit *Limosa lapponica*. The nine waterbirds were White-faced Heron *Egretta novaehollandiae*, Australian Pelican *Pelecanus conspicillatus*, Little Pied Cormorant *Microcarbo melanoleucos*, Great Cormorant *Phalacrocorax carbo*, Little Black Cormorant *P. sulcirostris*, Great Pied Cormorant *P. varius*, Australasian Darter *Anhinga novaehollandiae*, Silver Gull *Chroicocephalus novaehollandiae* and Greater Crested Tern *Thalasseus bergii*.

Sixteen migratory shorebird species were recorded in the surveys, although for three of those species there were only single records. Whimbrel, Far Eastern Curlew and Bar-tailed Godwit were by far the most abundant of the migratory species, but there were regular records of Pacific Golden Plover *Pluvialis fulva*, Ruddy Turnstone *Arenaria interpres*, Red-necked Stint *Calidris ruficollis*, Terek Sandpiper *Xenus cinereus*, Grey-tailed Tattler *Tringa brevipes* and Common Greenshank *T. nebularia* in summer, and of Double-banded Plover *Charadrius bicinctus* in winter.

The threshold for a site to be rated as internationally significant for a migratory species is that it hosts 1% of the total population, which for Far Eastern Curlew is 350 birds based on the current estimated population of 35,000 (Hansen *et al*. 2016). The mean summer count for Far Eastern Curlew in Port Stephens was 310 birds. However, four of the 17 summer surveys recorded more than 350 birds, with the peak count being 649 birds in 2004.

The estimated population of Australian Pied Oystercatcher is 11,000 birds (Delany & Scott 2006). Twenty of the 28 Port Stephens surveys have recorded more than 110 birds (i.e. more than 1% of the total population), with 100-110 birds having been recorded in four other surveys. In only three summer surveys and one winter survey were fewer than 100 birds present.

There were breeding records for Little Tern *Sternula albifrons* in 2018 and 2019; several pulli were observed on both occasions. Prior to 2016, when 80 birds were present, Little Tern were only recorded in low numbers (less than 20 birds and usually, less than ten birds). They were not recorded in any of the winter surveys.

The mean counts for Black Swan *Cygnus atratus* were of 379 birds (in summer) and 131 birds (in winter). However, those results were affected by five surveys in which birds were present in large numbers: 1,056 birds in February 2004; 1,120 birds in February 2010; 651 birds in February 2019; 444 birds in February 2020 (i.e. summer surveys); and 829 birds in July 2019.

Table 4. Summarised data for Port Stephens shorebird species.

	Summer surveys *(n = 17)*				**Winter surveys** *(n = 11)*			
Species	**No. times recorded**	**Max.**	**Mean**	**SD**	**No. times recorded**	**Max.**	**Mean**	**SD**
Bush Stone-curlew *Burhinus grallarius*	1	2	-	-	0	-	-	-
Beach Stone-curlew *Esacus magnirostris*	2	2	-	-	3	4	1	1
Australian Pied Oystercatcher *Haematopus longirostris*	17	192	123	38	11	162	137	21
Sooty Oystercatcher *Haematopus fuliginosus*	17	52	26	15	11	46	25	12
Red-necked Avocet *Recurvirostra novaehollandiae*	2	2	-	-	1	20	-	-
Grey Plover *Pluvialis squatarola*	1	1	-	-	0	-	-	-
Pacific Golden Plover *Pluvialis fulva*	9	38	9	13	3	5	-	-
Red-capped Plover *Charadrius ruficapillus*	12	41	15	13	10	21	8	6
Double-banded Plover *Charadrius bicinctus*	4	3	-	-	8	37	21	14
Lesser Sand Plover *Charadrius mongolus*	7	15	2	4	0	-	-	-

Table 4. Summarised data for Port Stephens shorebird species continued.

	Summer surveys *(n = 17)*				**Winter surveys** *(n = 11)*			
Species	**No. times recorded**	**Max.**	**Mean**	**SD**	**No. times recorded**	**Max.**	**Mean**	**SD**
Masked Lapwing *Vanellus miles*	17	75	41	17	11	54	26	13
Whimbrel *Numenius phaeopus*	17	424	207	86	11	67	22	20
Far Eastern Curlew *Numenius madagascariensis*	17	649	310	134	11	223	66	62
Bar-tailed Godwit *Limosa lapponica*	17	888	574	196	11	424	222	124
Black-tailed Godwit *Limosa limosa*	4	51	4	12	0	-	-	-
Ruddy Turnstone *Arenaria interpres*	12	20	4	5	0	-	-	-
Red Knot *Calidris canutus*	1	1	-	-	0	-	-	-
Sharp-tailed Sandpiper *Calidris acuminata*	1	40	-	-	0	-	-	-
Red-necked Stint *Calidris ruficollis*	14	59	15	17	1	1	-	-
Terek Sandpiper *Xenus cinereus*	10	6	2	2	1	1	-	-
Common Sandpiper *Actitis hypoleucos*	4	1	-	-	0	-	-	-
Grey-tailed Tattler *Tringa brevipes*	16	100	35	25	10	23	9	8
Common Greenshank *Tringa nebularia*	9	15	4	5	0	-	-	-

Table 5. Summarised data for Port Stephens waterbird species.

	Summer surveys *(n = 17)*				**Winter surveys** *(n = 11)*			
Species	**No. times recorded**	**Max.**	**Mean**	**SD**	**No. times recorded**	**Max.**	**Mean**	**SD**
Pink-eared Duck *Malacorhynchus membranaceus*	0	-	-		1	2	-	-
Black Swan *Cygnus atratus*	17	1120	379	313	10	829	131	241
Australian Wood Duck *Chenonetta jubata*	14	41	14	9	10	23	9	7
Pacific Black Duck *Anas superciliosa*	14	35	7	9	4	8	1	3
Grey Teal *Anas gracilis*	4	10	1	3	3	4	-	-
Chestnut Teal *Anas castanea*	17	30	13	11	10	21	11	7
Hoary-headed Grebe *Poliocephalus poliocephalus*	0	-	-	-	1	20	-	-
Little Penguin *Eudyptula minor*	4	4	-	-	0	-	-	-
Royal Spoonbill *Platalea regia*	7	5	1	2	5	13	2	4
Nankeen Night Heron *Nycticorax caledonicus*	4	12	1	2	0	-	-	-
Striated Heron *Butorides striata*	12	11	3	3	8	7	2	2
White-necked Heron *Ardea pacifica*	2	1	-	-	0	-	-	-
Great Egret *Ardea alba*	15	14	7	5	11	23	13	6

Table 5. Summarised data for Port Stephens waterbird species continued.

	Summer surveys *(n = 17)*				**Winter surveys** *(n = 11)*			
Species	**No. times recorded**	**Max.**	**Mean**	**SD**	**No. times recorded**	**Max.**	**Mean**	**SD**
Intermediate Egret *Ardea intermedia*	4	2	-	-	9	8	2	2
White-faced Heron *Egretta novaehollandiae*	17	58	31	14	11	250	86	72
Little Egret *Egretta garzetta*	8	15	1	4	11	18	10	5
Australian Pelican *Pelecanus conspicillatus*	17	213	126	49	11	198	127	36
Australasian Gannet *Morus serrator*	0	-	-	-	6	6	2	2
Little Pied Cormorant *Microcarbo melanoleucos*	17	473	114	101	11	298	190	52
Great Cormorant *Phalacrocorax carbo*	17	55	25	13	11	154	66	58
Little Black Cormorant *Phalacrocorax sulcirostris*	17	475	146	145	11	910	226	253
Great Pied Cormorant *Phalacrocorax varius*	17	458	252	104	11	681	362	232
Australasian Darter *Anhinga novaehollandiae*	14	25	5	7	11	39	16	10
Silver Gull *Chroicocephalus novaehollandiae*	17	449	259	96	11	250	135	76
Little Tern *Sternula albifrons*	14	304	53	87	0	-	-	-
Australian Gull-billed Tern *Gelochelidon macrotarsa*	6	19	2	5	8	21	7	7
Caspian Tern *Hydroprogne caspia*	13	12	4	4	11	51	38	10
White-fronted Tern *Sterna striata*	0	-	-	-	3	3	-	-
Common Tern *Sterna hirundo*	13	122	20	30	0	-	-	-
Greater Crested Tern *Thalasseus bergii*	17	318	148	68	11	76	40	22
Arctic Jaeger *Stercorarius parasiticus*	5	5	-	-	0	-	-	-

Summer and winter variations in abundance

Many species were only recorded in summer. Excluding four species which only had single records, the summer specialists were Lesser Sand Plover *Charadrius mongolus*, Black-tailed Godwit *Limosa limosa*, Ruddy Turnstone *Arenaria interpres*, Common Sandpiper *Actitis hypoleucos*, Common Greenshank *Tringa nebularia*, Little Penguin *Eudyptula minor*, Nankeen Night Heron *Nycticorax caledonicus*, White-necked Heron *Ardea pacifica*, Little Tern *Sternula albifrons*, Common Tern *Sterna hirundo* and Arctic Jaeger *Stercorarius parasiticus*.

A small number of species were only recorded in winter. The winter specialists, excluding two species with one-off records, were Australasian Gannet *Morus serrator* and White-fronted Tern *Sterna striata*.

Summer and winter abundance data were compared for a selection of species which were regularly recorded in medium to high numbers in summer and winter (all of the selected species had mean counts of ten or more birds in summer or winter, or both). Within **Figures 2-13** are presented comparisons of summer and winter numbers for the selected species, using box and whisker plots in which the median counts for each species are represented as horizontal lines between the 25% and 75% interquartile ranges (boxes), and the 1.5 x interquartile ranges are shown as whiskers. Outlier values are presented individually. **Figures 2-9** also show the summer and winter trends for some species, as described later.

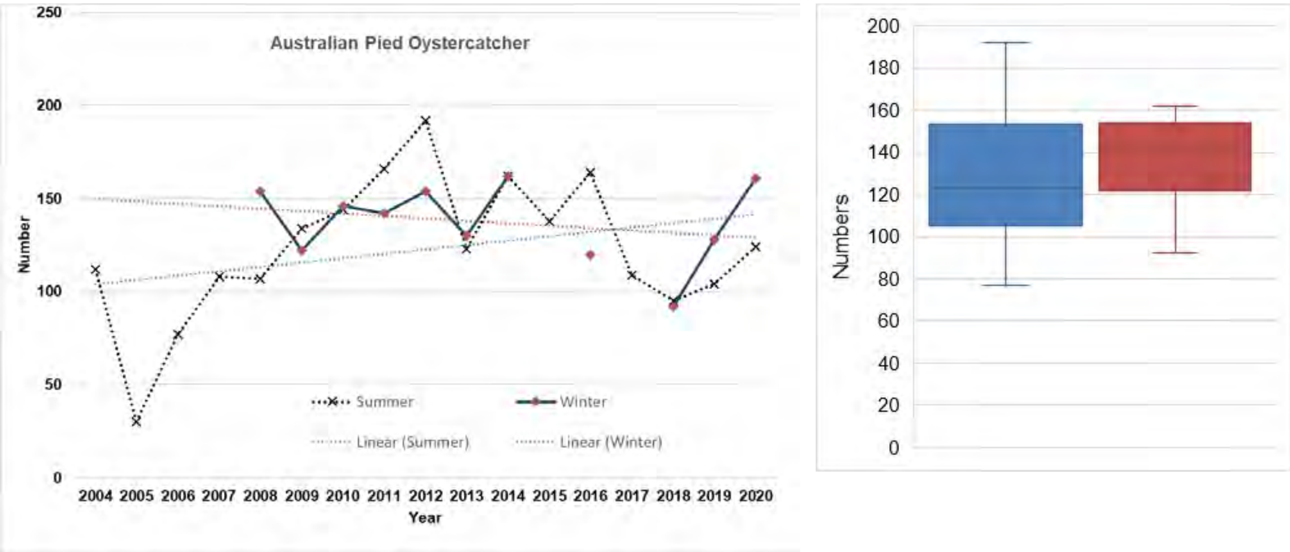


Figure 2. Summer and winter comparisons for Australian Pied Oystercatcher. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers).

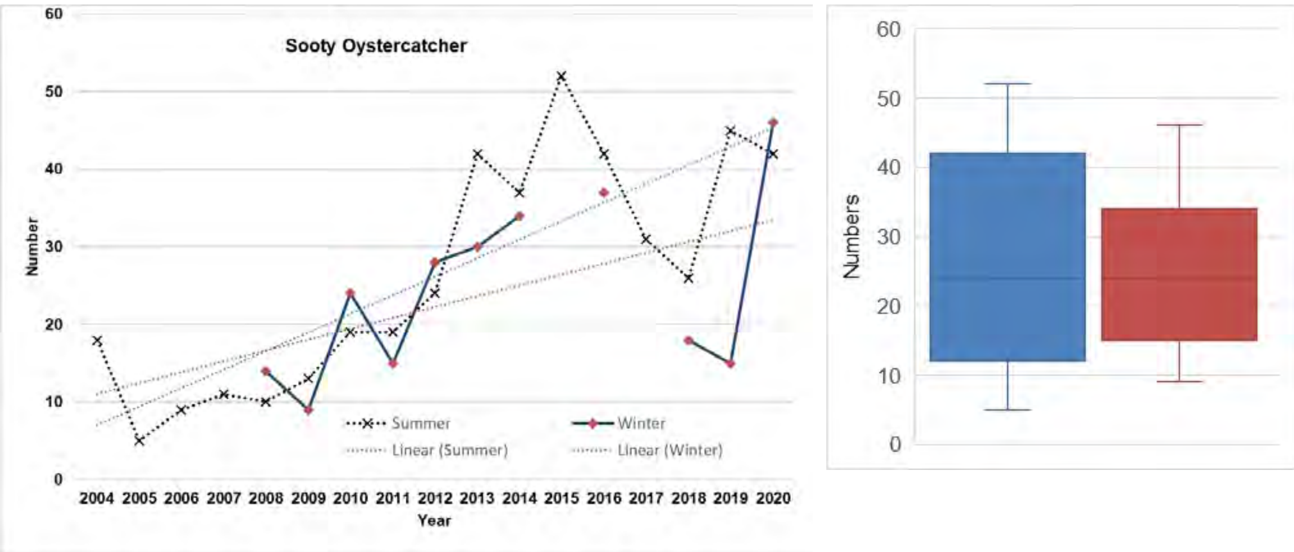


Figure 3. Summer and winter comparisons for Sooty Oystercatcher. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers).

Australian Pied Oystercatcher and Sooty Oystercatcher numbers exhibited no substantial summer/winter differences **(Figures 2-3)**. However, for the three main migratory shorebirds of Port Stephens (Whimbrel, Far Eastern Curlew and Bar-tailed Godwit), the winter numbers were substantially lower than the summer ones **(Figures 4-6)**. The resident shorebird Masked Lapwing also was present in lower numbers in the winter surveys compared with the summer ones (**Figure 10**).

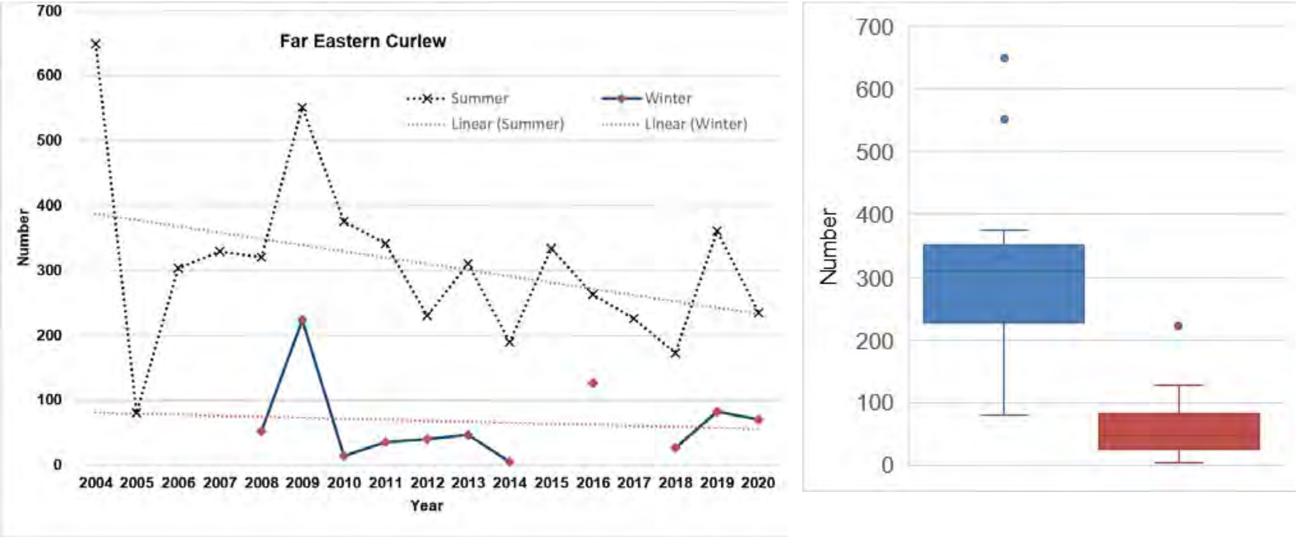


Figure 4. Summer and winter comparisons for Far Eastern Curlew. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).

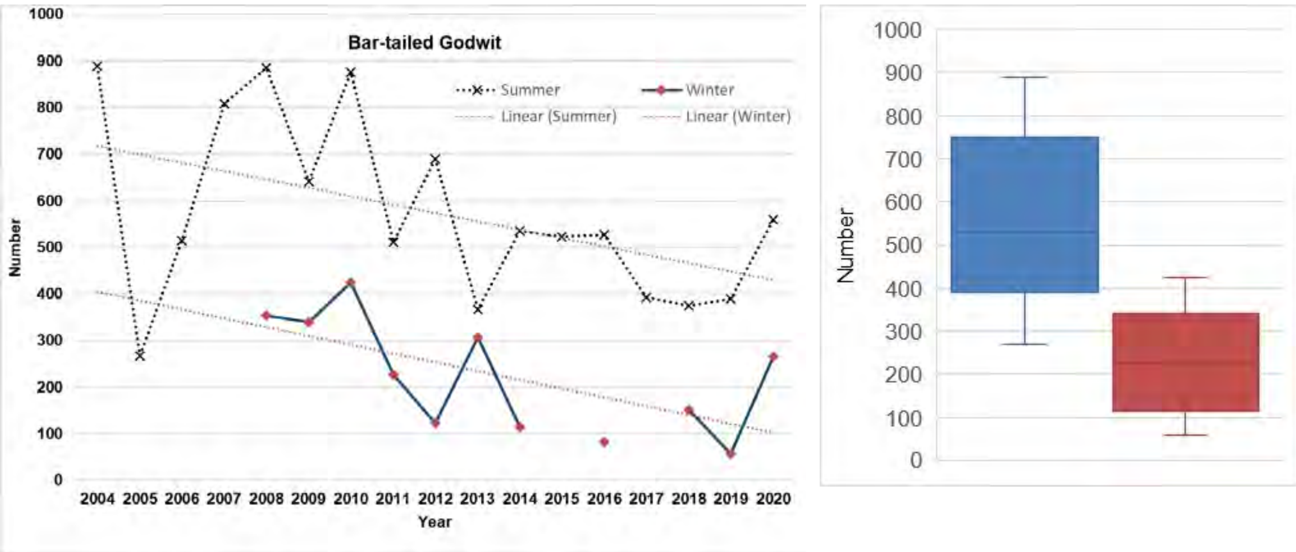


Figure 5. Summer and winter comparisons for Bar-tailed Godwit. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers).

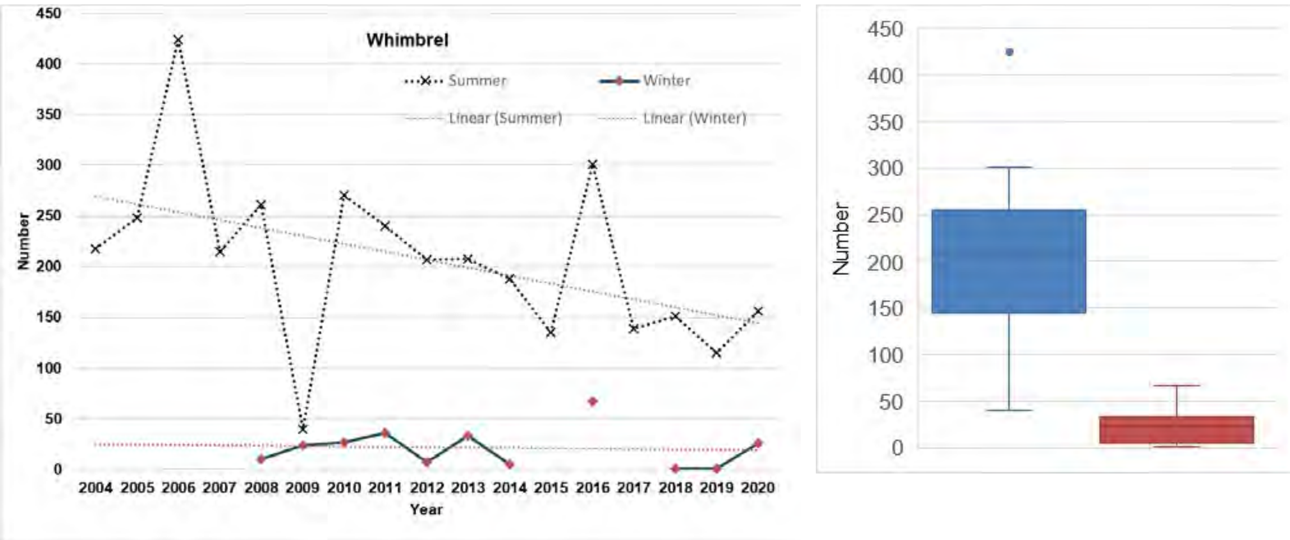


Figure 6. Summer and winter comparisons for Whimbrel. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).

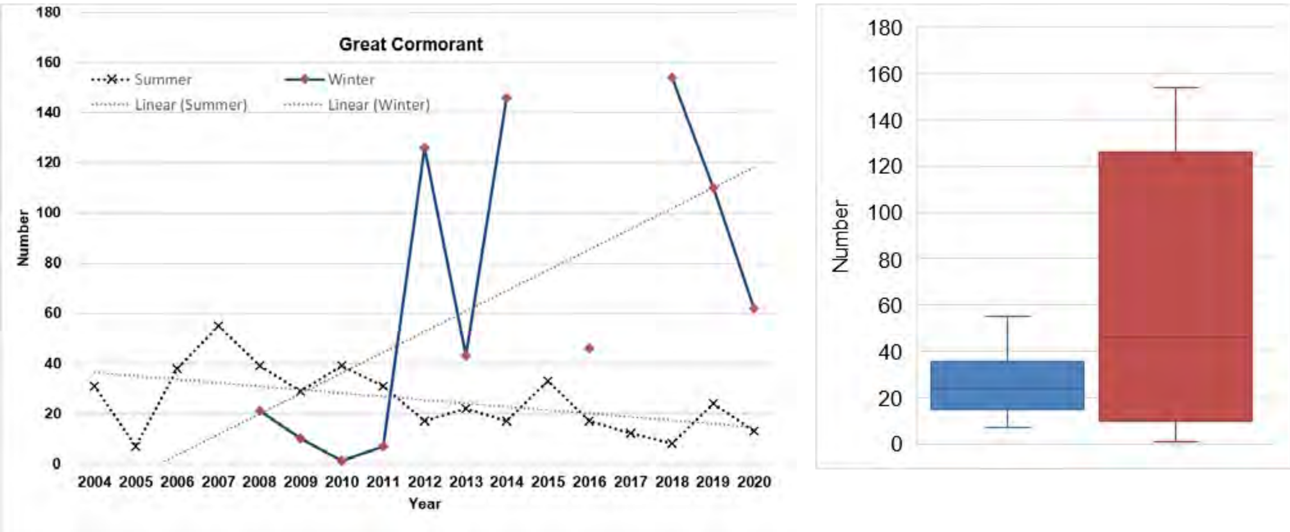


Figure 7. Summer and winter comparisons for Great Cormorant. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers).

Australian Gull-billed Tern *Gelochelidon macrotarsa* and Caspian Tern *Hydroprogne caspia* were more abundant in winter than in summer as were three cormorant species (Little Pied Cormorant, Great Cormorant, Great Pied Cormorant), Double-banded Plover and White-faced Heron (**Figures 7-12**). Conversely, the counts of Silver Gull, Greater Crested Tern and Black Swan were greater in summer surveys (**Figures 11-12**).

The differences in the summer and winter counts of Far Eastern Curlew, Bar-tailed Godwit, Whimbrel, Double-banded Plover, Great Cormorant, White-faced Heron, Silver Gull, Caspian Tern and Greater Crested Tern were statistically significant (all had $p < 0.05$).

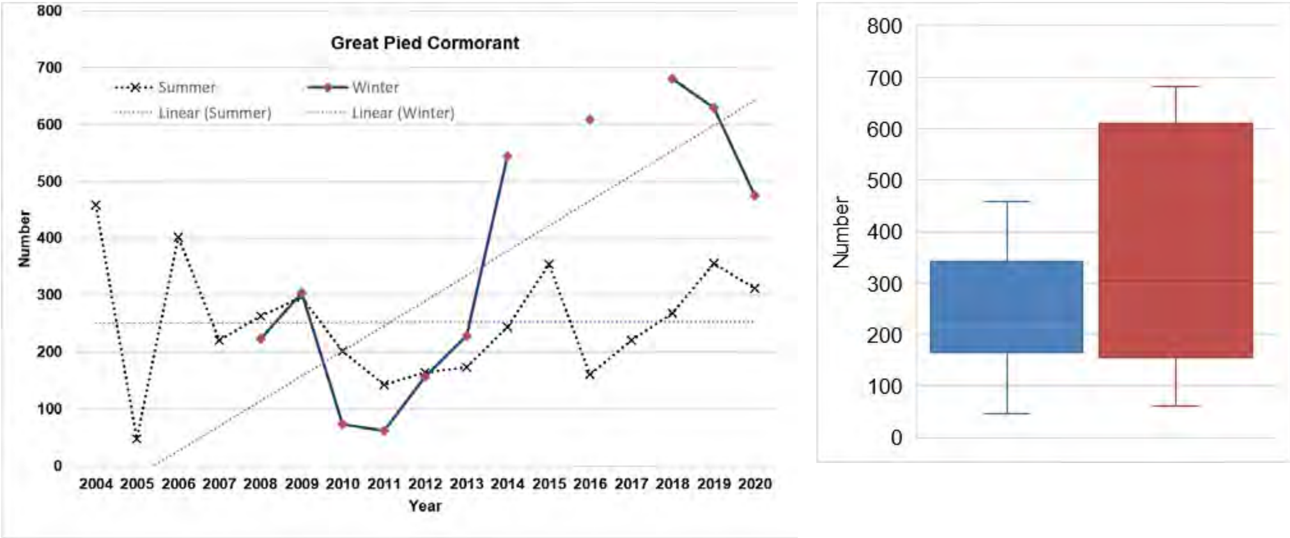


Figure 8. Summer and winter comparisons for Great Pied Cormorant. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers).

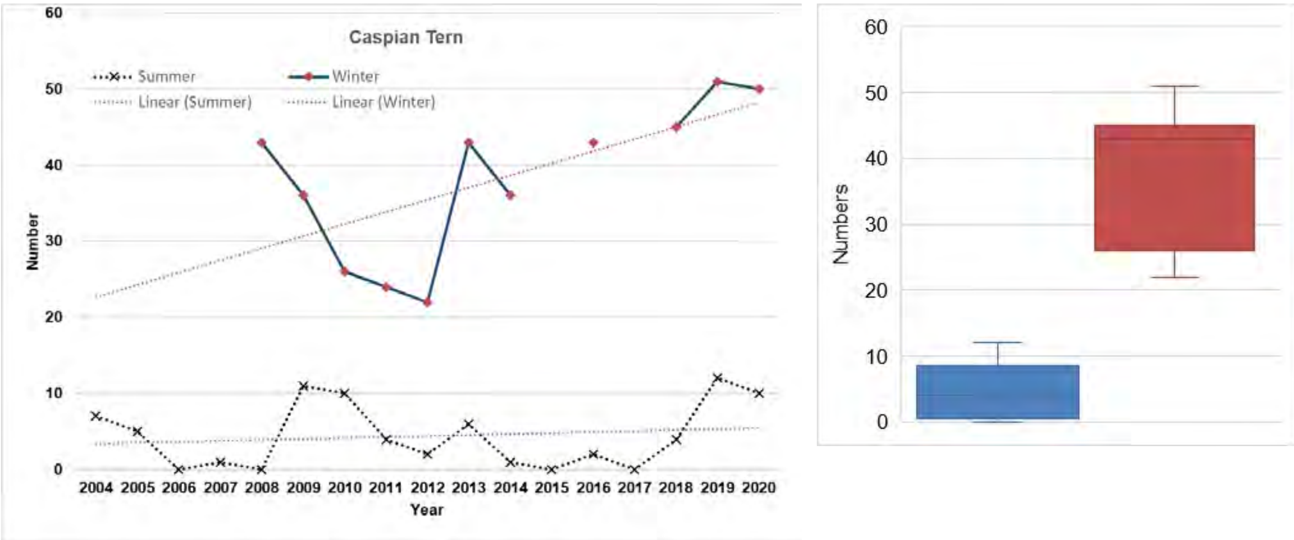
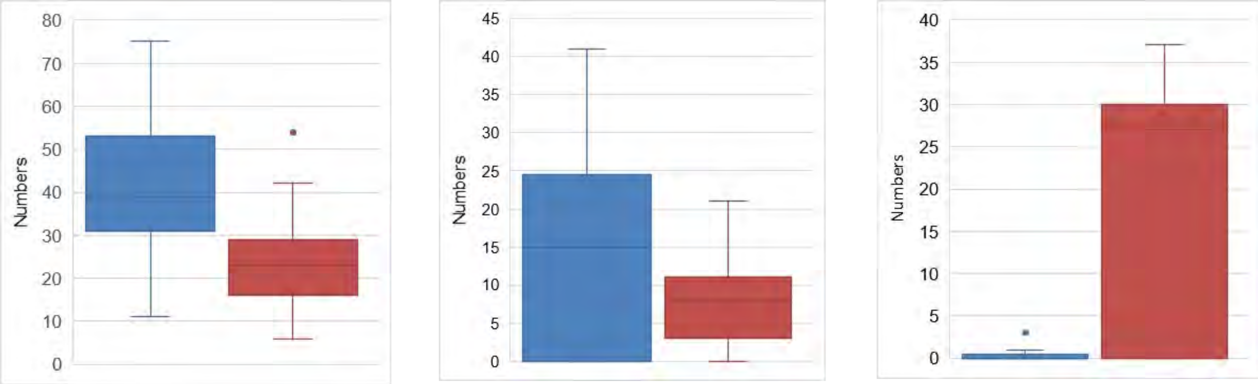
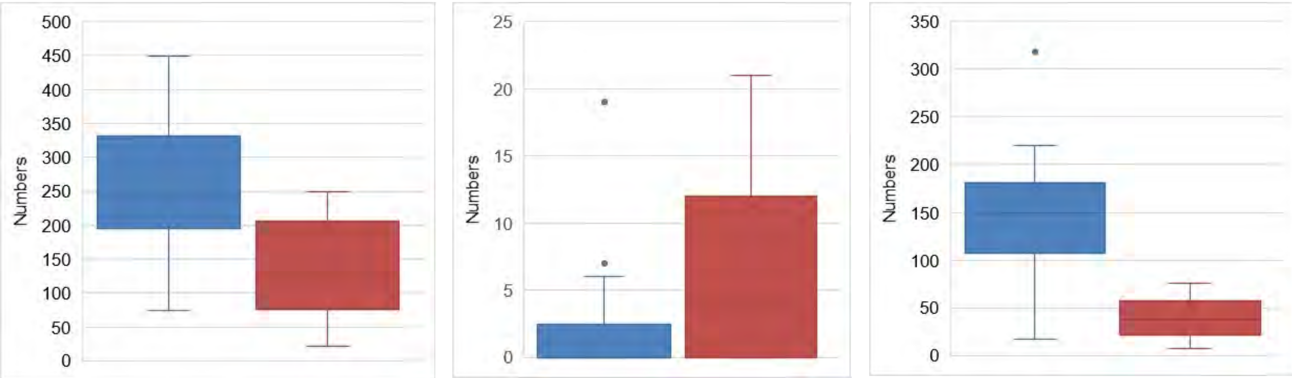


Figure 9. Summer and winter comparisons for Caspian Tern. Left-hand side: Results from individual summer and winter surveys, and trend lines. Right-hand side: Box plots summarising the overall results (summer data in blue, winter data in red), with medians represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers).



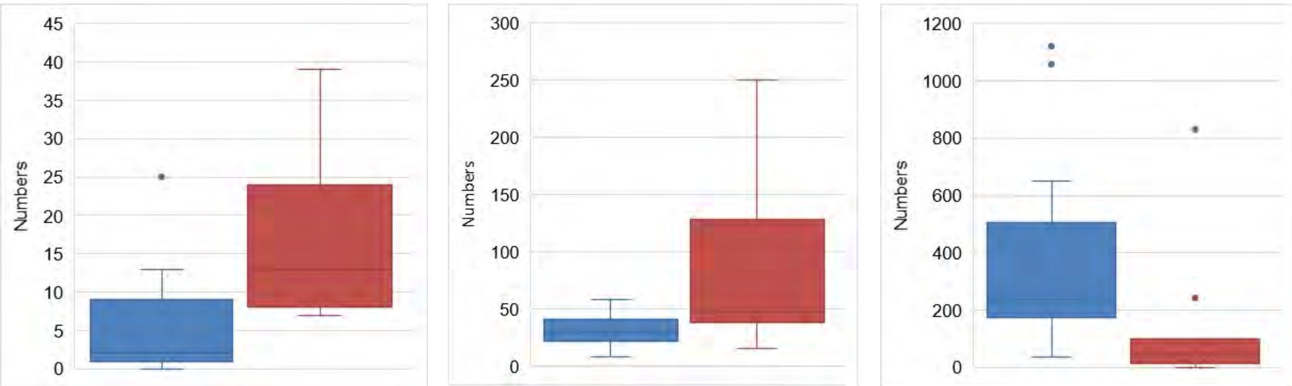
Masked Lapwing Red-capped Plover Double-banded Plover

Figure 10. Shorebird summer and winter abundance comparisons for Masked Lapwing, Red-capped Plover and Double-banded Plover (summer data in blue, winter data in red). Medians are represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).



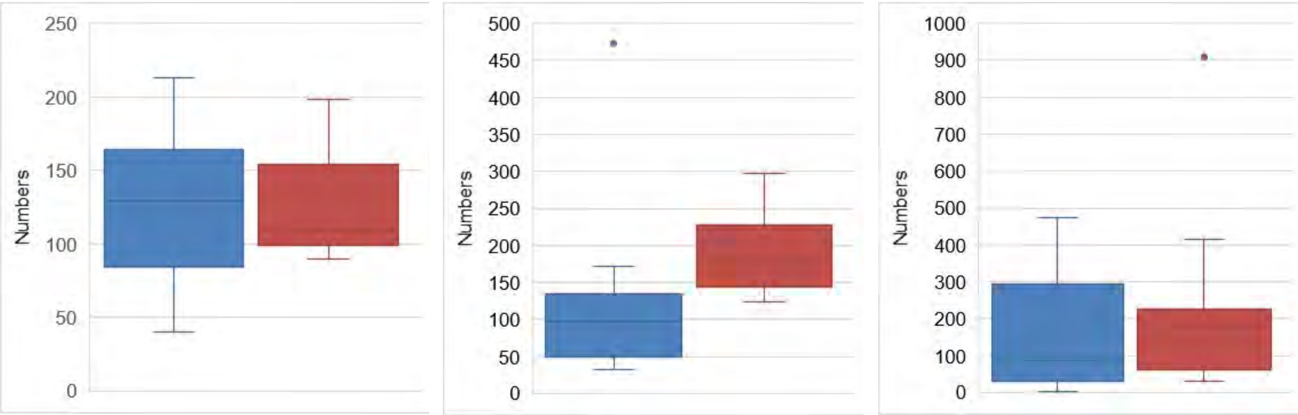
Silver Gull Australian Gull-billed Tern Greater Crested Tern

Figure 11. Shorebird summer and winter abundance comparisons for Silver Gull, Australian Gull-billed Tern and Greater Crested Tern (summer data in blue, winter data in red). Medians are represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).



Australasian Darter White-faced Heron Black Swan

Figure 12. Shorebird summer and winter abundance comparisons for Australasian Darter, White-faced Heron and Black Swan (summer data in blue, winter data in red). Medians are represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).



Australian Pelican Little Pied Cormorant Little Black Cormorant

Figure 13. Shorebird summer and winter abundance comparisons for Australian Pelican, Little Pied Cormorant and Little Black Cormorant (summer data in blue, winter data in red). Medians are represented as horizontal lines between the interquartile ranges (boxes), and 1.5*interquartile ranges (whiskers). Outlier values are presented individually (•).

Trends

Although numbers fluctuated for all species from survey to survey, for most species the fluctuations appeared to be random and there was no obvious trend for change occurring (except for when there were differences between the summer and winter numbers, as described above). However, the numbers for three species have been declining, and for three other species they appear to have been increasing.

Summer counts of Far Eastern Curlew *Numenius madagascariensis* have been decreasing (see **Figure 4**), from peak counts of 649 birds in 2004 and 551 birds in 2009 down to counts of 200-250 birds in recent years. The decline trend was statistically significant (*p* 0.015) if the result for 2005 was excluded from regression analysis. The low count for 2005 was because their main roost site at Gir-um-bit NP was not able to be surveyed. The winter counts (which were of immature birds that had not returned to the breeding grounds) did not show any clear trend, particularly if the anomalously high counts for 2009 (223 birds) and 2016 (127 birds) were excluded from analysis.

The Bar-tailed Godwit *Limosa lapponica* is a common bird in Port Stephens but the numbers have been decreasing in both the summer and the winter surveys, at similar rates (**Figure 5**). There were several summer records of 800-900 birds during 2004-2010, whereas fewer than 400 birds were recorded in the 2017-2019 summer surveys. There were 559 birds in the 2020 summer survey, the first positive result for some time. The declining trend in summer was statistically highly significant (*p* 0.002) if the result for 2005 was excluded from the regression analysis. The low count for 2005 was because Gir-um-bit NP was not able to be surveyed. The declining trend in winter was statistically significant (*p* 0.029).

The numbers of Whimbrel *Numenius phaeopus* in summer also have decreased (**Figure 6**), although the extent of the decline perhaps is exaggerated by an anomalously high count in 2006 (424 birds) and an anomalously low count in 2009 (40 birds). Nevertheless, 220-280 birds usually were recorded in 2004-2010 whereas recent counts have mostly been of *c*. 150 birds. The declining trend was statistically significant (*p* 0.012) if the anomalous results for 2006 and 2009 were excluded from the regression analysis (*p* 0.009 when only the 2009 result was excluded from analysis). The winter counts for Whimbrel were more consistent (**Figure 6**).

The linear trends for Far Eastern Curlew, Bar-tailed Godwit and Whimbrel in the summer surveys all correspond to declines of *c*. 2.5% each year for each species.

The numbers of Sooty Oystercatcher *Haematopus fuliginosus* in Port Stephens have been increasing, from ten or so birds recorded in the early years to recent summer counts of more than 40 birds and a peak count of 52 birds in February 2015 (**Figure 3**). The increase in summer was statistically highly significant (*p* 0.002). The winter trend was similar, although there were fewer birds present in the 2018 and 2019 winter surveys and the trend in winter was not statistically significant. All of the birds recorded in all the surveys were the subspecies *H. f. fuliginosus*.

The winter counts of Great Cormorant *Phalacrocorax carbo* and Great Pied Cormorant *P. varius* have been increasing (**Figures 7-8**). Fewer than 25 Great Cormorant were recorded in the 2008-2011 winter surveys, but since then, more than 100 birds have been present in four of the seven winter surveys. The trend for Great Cormorant was statistically significant (*p* 0.048). The counts for Great Pied Cormorant between 2008 and 2013 were of fewer than *c.* 300 birds (and usually, of less than 150 birds); all five winter surveys since 2014 recorded more than 500 birds with a peak count of 681 birds in July 2018. The trend for Great Pied Cormorant was statistically highly significant (*p* 0.006).

The winter counts of Caspian Tern have also been increasing (**Figure 9**). The trend was statistically significant (*p* 0.049).

DISCUSSION

Although Australian White Ibis, Straw-necked Ibis and Cattle Egret were sometimes encountered during a survey, all three species are land-based foragers (albeit that Australian White Ibis does also forage in the inter-tidal zone) and records of them during a boat-based survey were considered likely to be opportunistic and unpredictable. Hence those three species were excluded from the analyses in this report, which is focused on birds that are dependent on the marine or estuarine habitat of Port Stephens. Records for Australian Wood Duck *Chenonetta jubata* were included, although arguably they fall into the same category as the other three species.

Shorebirds

Port Stephens has long been known for its importance to the Australian Pied Oystercatcher (Stuart 2010). That continues to be the situation, with many records of 120-150 birds and a peak count of 192 birds in February 2012. In recent years, their numbers have been increasing at the nearby Worimi Conservation Lands, with many counts since 2018 of 80 or more birds and occasionally of more than 100 birds (Fraser & Lindsey 2018; N. Fraser & A. Lindsey pers. comm.). However, high numbers continue to be recorded within Port Stephens (for example, 161 birds in July 2020). The combined total numbers at both sites (Port Stephens and Worimi Conservation Lands) is now typically in the range of 220-250 birds (i.e. more than 2% of the total population). As well, there are increasing numbers of breeding records at the two sites (Fraser & Lindsey 2018; Fraser 2019). The Australian Pied Oystercatcher is flourishing in those parts of the Hunter Region.

Wooding (2019) recognised Port Stephens as an important local site for the Sooty Oystercatcher. The twice-yearly boat-based surveys confirm that to be the case and show that numbers have been increasing. Since 2013, five summer surveys and one winter survey have recorded more than 40 birds, which is 1% of the estimated total population of subspecies *fuliginosus* (Wooding 2019). The peak count, of 52 birds in February 2015, corresponds to 1.3% of the total population of the subspecies.

In a review of the Far Eastern Curlew in Port Stephens, using results from the boat-based surveys as well as from land-based surveys at the Gir-um-bit National Park high-tide roost site, the decrease in numbers was found to be statistically significant, and with very significant decreases occurring at the high-tide roost site and in areas around Corrie Island (Griffin & Williams 2019). The current estimated total population of Far Eastern Curlew is 35,000 birds (Hansen *et al.* 2016). Based on that estimate, Port Stephens still can be considered internationally significant for the species – for example, 361 birds were recorded in February 2019. However, it should be noted that the population estimate is likely to be revised downwards, by some 4,000 birds, because of continuing decline mainly arising from threats at coastal stopover locations in the East Asian – Australasian Flyway (Lilleyman *et al.* in preparation). Thus, Port Stephens continues to be an important site internationally for Far Eastern Curlew.

Bar-tailed Godwit numbers have decreased in Port Stephens since the surveys commenced, and probably the Whimbrel numbers as well. The trend is less certain for Whimbrel because of two anomalous counts, in 2006 and 2009. The main decline for Bar-tailed Godwit occurred between 2004 and 2013, when the summer counts dropped from 888 birds to just 366 birds. Similarly, between 2008 and 2012 the winter numbers decreased from 350-400 birds to *c.* 100 birds. However, the situation may now have stabilised. For the period 2014-2020, the average summer count was 471 birds, with SD of 81 birds. The relatively low CV (17%) suggests moderate stability. The winter pattern since 2013 is less clear, especially as there were two years without a winter survey. There have been two winter counts of *c.* 300 birds, in 2013 and 2020, and with 100±20 birds in the other four years.

Most other shorebirds were recorded in low numbers; Port Stephens does not host large numbers of small and medium-sized waders, as has previously been noted (Stuart 2011). The Grey-tailed Tattler can be present in moderate numbers (up to 100 or so birds at times) but it has been shown that boat-based surveys are less effective at finding them than are land-based surveys, owing to the often-cryptic nature of their roosting behaviour (Wooding & Stuart 2013). Red-capped Plover *Charadrius ruficapillus* was recorded in many surveys, more often in the winter surveys although in lower numbers than for summer. Pacific Golden Plover *Pluvialis fulva* was recorded in nine summer surveys and three winter surveys. The winter migrant Double-banded Plover *Charadrius bicinctus* was recorded in all bar one of the winter surveys, with a mean count of 21 birds; occasionally in the February surveys some early-returning birds were present. Red-capped Plover and Double-banded Plover usually were found close together, with their preferred locations being around Corrie Island and Winda Woppa.

There were no breeding records from the surveys for any shorebirds. However, the focus during the surveys is on finding and counting birds and it is possible that some instances of breeding activity may have been overlooked. For example, it seems plausible that Red-capped Plover would breed in Port Stephens. There are breeding records for Beach Stone-curlew *Esacus magnirostris* and Australian Pied Oystercatcher at other times of the year (Fraser & Lindsey 2018; Fraser 2019; Murray 2019).

Waterbirds

Usually, there were many waterbirds in Port Stephens. The average summer and winter counts were of 1,615 birds and 1,478 birds, respectively; however, there were several surveys in which more than 2,000 waterbirds were present. The main species, comprising 1,000 or more birds in total on most surveys, were Black Swan, Australian Pelican, the four cormorants, Silver Gull and Greater Crested Tern. The counts for all of those species and for other waterbirds varied considerably from survey to survey. The most stable numbers were for Australian Pelican, with CV 39% in the summer surveys and 29% in the winter ones. The relatively high CVs for most waterbird species (in general, the CVs were in the range 50-100%, if not higher) is an indicator of the variability in their abundance across the surveys.

Little Tern in Port Stephens usually start to breed in the November/December period (Fraser 2019). The few breeding records for them from the boat-based summer surveys possibly reflects that the breeding season was over or nearly over by the time of the survey, which sometimes was carried out in the latter half of February. It seems unlikely that Little Tern bred in Port Stephens in the period 2005-2015, because the numbers present in those years were quite low, mostly less than ten birds. There are records of Little Tern breeding on Corrie Island and Winda Woppa during the period 1958-1990 (Fraser (2017).

There were no breeding records from the surveys for any waterbirds other than Little Tern. However, as commented above for shorebirds, some instances of breeding activity may have been overlooked.

Threatened species

Eleven threatened species were recorded in the surveys, the majority of those being shorebirds. They are listed in **Table 6**, which also shows the species' classification under the Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and the NSW *Biodiversity Conservation Act* 2016 (BC Act). Also, Great Knot *Calidris tenuirostris* (EPBC Critically Endangered, NSW Vulnerable) was recorded occasionally on Corrie Island outside of the scheduled surveys (AS pers. obs.).

Table 6. Threatened shorebird and waterbird species recorded in the Port Stephens surveys and their Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) and NSW *Biodiversity Conservation Act* 2016 (BC Act) classifications.

Species	EPBC Act	BC Act
Bush Stone-curlew	-	Endangered
Beach Stone-curlew	-	Critically Endangered
Aust. Pied Oystercatcher	-	Endangered
Sooty Oystercatcher	-	Vulnerable
Lesser Sand Plover	Endangered	Vulnerable
Far Eastern Curlew	Critically Endangered	-
Bar-tailed Godwit	Vulnerable	-
Black-tailed Godwit	-	Vulnerable
Red Knot	Endangered	-
Terek Sandpiper	-	Vulnerable
Little Tern	-	Endangered

Drought

Eastern Australia was in drought in 2001-2009 and 2016-2019, with a high rainfall La Niña event occurring in 2010-2011 (Wikipedia 2020). The changing conditions could be expected to have affected waterbird numbers. For the cormorants, the link with rainfall pattern was not strong. Cormorant numbers were at their lowest in 2010-2011 which might reflect dispersal of birds to inland wetlands during the La Niña event. Numbers then began to rise, but for Great and Great Pied Cormorant that increase in numbers began in 2013 i.e. before drought conditions had re-established. Then, over 2019-2020 when the drought was dominant, their numbers in Port Stephens decreased. The pattern for cormorant species 2004-2009 was less clear, particularly as the 2005 survey may have under-estimated the numbers present. However, above-average numbers of Great Pied Cormorant were present in 2004 and 2006.

Three of the peak counts for Black Swan occurred in the three consecutive surveys between February 2019 and February 2020. By July 2020, most of those birds had departed. The pattern fits with birds having moved to Port Stephens from drying areas elsewhere, during the final stages of the 2016-2019 drought. However, the peak counts in February 2004 and February 2010, both involving more than 1,000 birds, occurred when most of NSW had experienced average or above-average rainfall in the preceding three months (Bureau of Meteorology 2020).

Summer and winter differences

There were many differences in the results from the summer and winter surveys. Partly, those differences were associated with known migratory species such as the shorebirds which breed in the northern hemisphere in the austral winter. Those migratory shorebirds were absent in the winter surveys, or else recorded in much lower numbers than in the summer surveys. For the winter-visiting Double-banded Plover, that situation was reversed. The Masked Lapwing *Vanellus miles* was present in every summer and winter survey; however, it too was recorded in lower numbers in the winter surveys.

The migratory Arctic Jaeger *Stercorarius parasiticus* also was absent in winter, and Little Penguin *Eudyptula minor* was not recorded in winter (i.e. in their non-breeding season).

The numbers of Silver Gull, Greater Crested Tern and Black Swan were substantially lower in the winter surveys. Conversely, more White-faced Heron, Little Pied Cormorant, Great Cormorant, Great Pied Cormorant and Caspian Tern were present in winter than in summer. For several other species, such as Australian Gull-billed Tern, there were insufficient data to draw firm conclusions.

CONCLUSIONS

Port Stephens is an important area for many shorebird and waterbird species. Twenty-three shorebird species and 31 waterbird species were recorded in systematic surveys of Port Stephens since 2004. Although some of those species may be considered to be vagrants, at least 12 shorebirds and at least 19 waterbirds frequently were present in the estuary. For three species, Far Eastern Curlew, Australian Pied Oystercatcher and Sooty Oystercatcher, many of the records have been of more than 1% of the total population of the relevant species or subspecies. High numbers of Bar-tailed Godwit continue to be present, despite a population decline having occurred for that species as well as for other migratory shorebirds. The Port Stephens estuary also hosts several hundred non-breeding migratory shorebirds each winter.

The Australian Pied Oystercatcher population seems stable, while Sooty Oystercatcher numbers have risen in recent years. Large numbers of waterbirds were recorded in every survey of Port Stephens, although for individual surveys there was considerable variability in the numbers of each species. Some waterbird species were present in greater numbers in summer than in winter, while for other species the reverse situation occurred.

This study has identified several changes in species' abundance. Understandings about the causes of those changes are speculative and require closer analysis, done on an individual species basis and comparing the changes with patterns occurring in other parts of the Hunter Region and more widely. For example, there was some evidence of rainfall patterns (El Niño and La Niña events) affecting waterbird numbers. However, the evidence requires further examination.

ACKNOWLEDGEMENTS

Each survey involved 12-14 volunteers from the Hunter Bird Observers Club, with a total of 61 people having participated in at least one survey. Ten of the volunteers assisted in at least half of the surveys, and 35 people assisted in three or more of them. The surveys were organised jointly with the Hunter Coast Area of the NSW National Parks and Wildlife Service (NPWS); their Rangers arranged most of the boats and skippers. Over the years, the prime organisers on behalf of NPWS have variously been Laurence Penman, Susanne Callaghan, Duncan Scott-Lawson and Richard Ghamraoui. Other organisations which have provided boats and/or skippers are Hunter Local Land Services (per the Kooragang Wetlands Rehabilitation Project), Marine Rescue Port Stephens, Marine Rescue Lemon Tree Passage, the Port Stephens-Great Lakes Marine Park Authority and the owners of MV Koala. Robyn Stuart provided guidance in statistical analysis.

REFERENCES

Bamford, M., Watkins, D., Bancroft, W., Tischler, G. and Wahl, J. (2008). Migratory Shorebirds of the East Asian – Australasian Flyway: Population Estimates and Internationally Important Sites. (Wetlands International – Oceania: Canberra, Australia.)

Bureau of Meteorology (2020). http://www.bom.gov.au/climate/maps/rainfall. Accessed 28 October 2020.

Delany, S. and Scott, D. (2006). Waterbird population estimates, fourth edition. (Wetlands International: Devon, United Kingdom.)

Finn, P. G. (2007). Feeding ecology and habitat selection. In 'Shorebirds of Australia'. (Eds Geering, A., Agnew, L. and Harding, S.) Chapter 4, Pp 51-59. (CSIRO Publishing: Collingwood, Victoria.)

Fraser, N. (2017). Observations of Little Tern nesting at Winda Woppa, Port Stephens, 2016-2017. *The Whistler* **11**: 15-25.

Fraser, N. (2019). Update on breeding activity by threatened shorebird species on Corrie Island, Port Stephens. *The Whistler* **13**: 22-24.

Fraser, N. and Lindsey, A. (2018). Some observations of Australian Pied Oystercatcher on Worimi Conservation Lands. *The Whistler* **12**: 35-42.

Griffin, A. and Williams, T. (2019). Eastern Curlew (*Numenius madagascariensis*) in the Port Stephens estuary: two 2019 counts against an historical analysis. Intermediate report to Hunter Local Land Services, May 2019. (Faculty of Science, University of Newcastle.)

Hansen, B.D., Fuller, R.A., Watkins, D., Rogers, D.I., Clemens, R.S., Newman, M., Woehler, E. and Weller, D.R. (2016). Revision of the East Asian – Australasian Flyway population estimates for 37 listed migratory shorebird species. Unpublished report for the Department of the Environment. (BirdLife Australia: Melbourne, Victoria.)

Lane, B.A. (1987). 'Shorebirds in Australia'. (Royal Australasian Ornithologists Union: Melbourne, Victoria.)

Lilleyman, A., Woodworth, B.K., Clemens, R., Rogers, D.I. and Garnett, S.T. (in preparation). Far Eastern Curlew *Numenius madagascariensis*. In 'Action Plan for Australian Birds 2020'. (Eds S.T. Garnett and G.B. Baker). (CSIRO Publishing: Melbourne, Victoria.)

Murray, T. (2019). Beach Stone-curlew at Soldiers Point Port Stephens: breeding records and behavioural observations. *The Whistler* **13**: 17-21.

Roderick, M. and Stuart, A. (2016). Threatened bird species in the Hunter Region: 2016 status review. *The Whistler* **10**: 33-49.

Smith, P. (1991). The biology and management of Waders (Suborder Charadrii) in NSW. Species management report number 9. (NSW National Parks & Wildlife Service.)

Stuart, A. (2005). Survey of the Shorebirds of Port Stephens, February 2004. *Stilt* **47**: 20-25.

Stuart, A. (2007). Surveys of the waterbirds of Port Stephens, 2004-2006. *The Whistler* **1**: 16-20.

Stuart, A. (2010). Australian Pied Oystercatchers *Haematopus longirostris* in the Hunter Region of New South Wales, Australia. *Stilt* **57**: 18-20.

Stuart, A. (2011). Shorebird Surveys at Port Stephens, New South Wales 2004-2011 and comparisons with results from previous surveys. *Stilt* **60**: 14-21.

Stuart, A. (2016). Raptors of estuarine Port Stephens. *The Whistler* **10**: 57-58.

Wikipedia (2020). Drought in Australia. https://en.wikipedia.org/wiki/Drought_in_Australia. Accessed 25 October 2020.

Wooding, L. (2019). A review of the Sooty Oystercatcher on the Hunter Region coastline of New South Wales, Australia. *The Whistler* **13**: 83-93.

Wooding, L. and Stuart, A. (2013). Initial findings from a study of Grey-Tailed Tattlers in Port Stephens. *The Whistler* **7**: 38-43.

A second successful nesting attempt by the Black Kite in the Hunter Region, New South Wales

Kimberley Jane Pryor

PO Box 3168, Thornton, NSW 2322, Australia

Received 20 September 2020, accepted 1 December 2020, published on-line 15 December 2020.

Black Kites *Milvus migrans* are uncommon residents in the Hunter Region, New South Wales. They have been recorded annually since an irruption occurred in 2013. However, a successful nesting attempt has only been confirmed once, near Martindale in 2015. To investigate nesting attempts at other sites, observations of Black Kites were made between 2016 and 2020. Two unsuccessful nests and one successful nest (2019) were found at Fletcher and two unsuccessful nests were found at Beresfield. Frequent sightings of Black Kites in conjunction with observations of consecutive nesting attempts at two sites suggest that Black Kites are beginning to establish territories in the Hunter Region.

INTRODUCTION

Black Kites *Milvus migrans* are found in Asia, Europe and Africa (BirdLife Australia 2019), where they may undergo annual migrations (Agostini & Logozzo 1997). They are also found over most of mainland Australia (BirdLife Australia 2019). They inhabit northern and inland areas but sometimes irrupt in areas outside their normal range (Debus 2012).

Black Kites irrupted in the Hunter Region between March and June 2013. The greatest numbers were recorded at the Mt. Vincent and Summerhill Waste Management Centres. After the irruption, small groups, pairs and single birds were observed at several Hunter locations, including Hexham Swamp and Lenaghans Flat (Stuart 2014-2018).

Black Kites breed from July to November in southern Australia (BirdLife Australia 2019; Debus 2012). They occasionally breed successfully outside their known breeding range, for example near Melbourne (McDonald 2003).

Black Kites are now considered to be resident in the Hunter Region and are thought to be breeding. On 13 October 2015, a Black Kite nest containing two nestlings was discovered near Martindale. A fledgling accompanied by an adult was later observed (Alexander 2016). To date, this is the only successful breeding record of Black Kites in the Hunter Region. To confirm breeding in the small resident Black Kite population, observations were made of two pairs of Black Kites between 2016 and 2020. This paper describes their nesting behaviour and nesting success.

MATERIALS AND METHODS

Between 2016 and 2020, searches for pairs of Black Kites were carried out in areas surrounding Hunter Wetlands National Park (HWNP). Occupied territories were identified in the suburbs of Beresfield and Fletcher (City of Newcastle 2019a, 2019b). Searches for guard-roosts and nest trees (**Table 1**) were carried out by car and by foot. Nests that appeared to be active were observed throughout the breeding season to determine whether they were successful or unsuccessful (**Table 1**).

Table 1. Terminology used to describe territories and nests of Black Kites *Milvus migrans* (adapted from Dennis *et al*. 2012)

Occupied territory	Territory in which an adult pair was regularly seen near the nest and was repairing the nest or defending the territory
Guard-roost	A vantage point in the occupied territory which was used as a day-roost by the non-incubating bird
Nest tree	A tree containing a nest
Active nest	A nest in which an adult bird showed incubation behaviour, suggesting that eggs were present
Successful nest	A nest from which at least one fledgling was observed away from the nest
Unsuccessful nest	An active nest from which no young fledged

Field observations were made opportunistically for a maximum of two hours twice per week. To minimise disturbance, camouflage clothing was worn and a tree or car was used for concealment. Nests were observed using binoculars (Barska 10-30x50 mm Gladiator Zoom) and photographs were taken using a digital SLR camera (Canon 7D with an EF 100-400 mm F/4.5-5.6L IS lens).

RESULTS

A pair of Black Kites made nesting attempts at Fletcher between 2016 and 2019 and another pair of Black Kites made nesting attempts at Beresfield in 2018 and 2019.

Fletcher

On 30 September 2016, a Black Kite was observed in a nest (nest 1) in a eucalypt *Eucalyptus* sp. (nest tree 1, **Figure 1**) in an area of high disturbance (**Table 2**). A Black Kite was observed in nest 1 during each of four visits between 5 and 18 October but none were observed during three visits between 2 November and 6 December 2016.

Table 2. Disturbance categories for nest sites (adapted from Dennis 2004)

Disturbance category	Criteria
Low	Remote setting Cannot be reached by terrestrial predators or people No roads or tracks within 1000 m Few people visits on foot within 1000 m during breeding season
Moderate	Semi-remote setting Cannot be reached by terrestrial predators but reached by people with difficulty No roads or tracks within 500-1000 m Few people visits on foot within 500 m during breeding season
High	Disturbed or developed setting Can be reached by terrestrial predators and people Roads or tracks occur within 200-500 m Frequent people visits on foot within 200-500 m and above during breeding season

In 2017, two Black Kites were observed in or near nest tree 1, but not in nest 1, during three visits between 16 August and 19 September.

On 29 August 2018, a Black Kite was observed in a second nest (nest 2) in a eucalypt (nest tree 2) located approximately 20 m from nest tree 1 (**Figure 1**). A Black Kite was observed in nest tree 2 on 5 September but none were observed during three visits between 9 September and 10 October 2018.

On 30 April 2019, two Black Kites were observed copulating in nest tree 2. Black Kites were seen in or near nest tree 2, but not in nest 2, during twenty-five of thirty visits between 30 April and 18 October. On 18 October, a third active nest (nest 3) was found in a eucalypt (nest tree 3) approximately 250 m from nest tree 2 (**Figure 1**). On 21 October, a juvenile attended by adults was observed nearby (**Figure 2**). On two visits on 28 and 31 October, Black Kites were observed perching on a fourth nest (nest 4) approximately 10 m from nest tree 3 (**Figure 1**) and it was not clear whether the pair had nested in nest 3 or nest 4. On 4 November, a second fledged juvenile was observed (**Figure 3**) and on 6 November 2019 one fledged juvenile was observed on a street light (**Figure 4**).

In 2020, no Black Kites were seen in the former nests. However, on 15 September, two Black Kites were seen flying over the site.

Beresfield

On 1 September 2018, an adult was observed calling from a nest (nest 5) in a eucalypt (nest tree 5, **Figure 5**) in an area of high disturbance (**Table 2**). A Black Kite was observed perched with food 2 m from nest 5 on 6 October and in nest 5 on 23 December 2018 (**Figure 6**). No nestlings or fledglings were observed.

On 21 July 2019, no trace of nest 5 was seen but a sixth active nest (nest 6) was found in a eucalypt (nest tree 6) approximately 100 m from nest tree 5 (**Figure 5**). The female was observed in nest 6 during nine of ten visits between 8 September and 16 October. No Black Kites were seen during eight visits between 20 October and 27 November 2019.

In 2020, no Black Kites were seen in the former nests or flying over the site during eight visits up to 22 September 2020.

Each Black Kite nest was approximately 3-7 m from the top of a *Eucalyptus* sp. approximately 20-35 m in height.

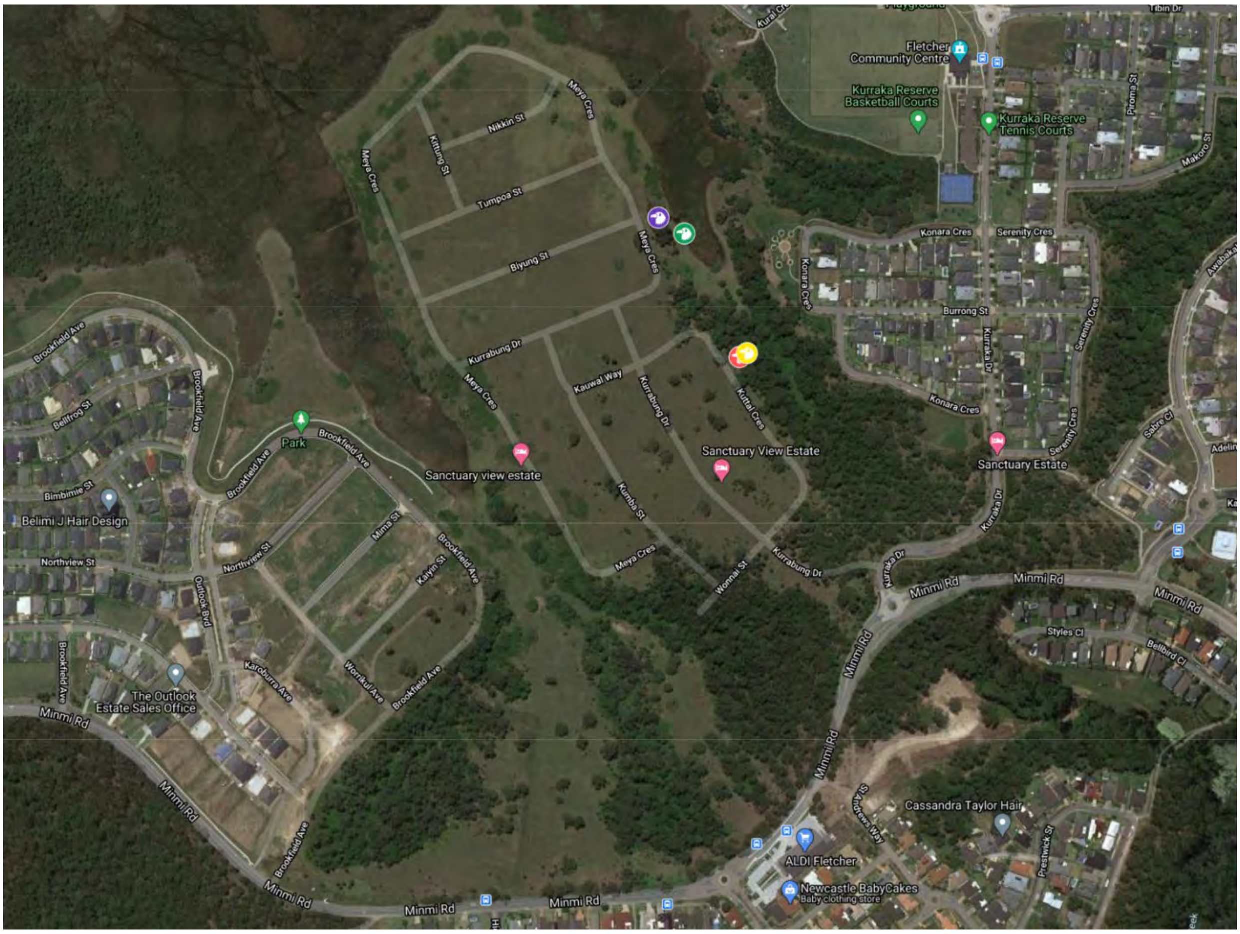
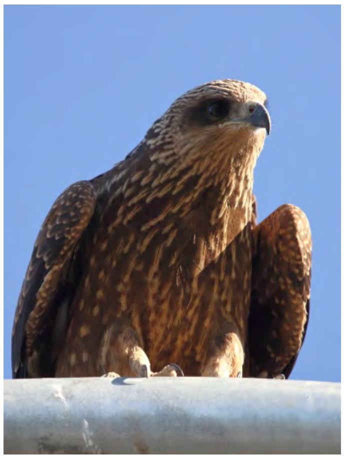


Figure 1. Active nests at Fletcher: nest 1 green 2016 and 2017; nest 2 purple 2018; nest 3 red and nest 4 yellow 2019.





L – R: **Figure 2**. A newly-fledged juvenile (right) with an adult at Fletcher on 31/10/2019
Figure 3. Two newly-fledged juveniles at Fletcher on 4/11/2019
Figure 4. A newly-fledged juvenile at Fletcher on 6/11/2019

Figure 5. Active nests at Beresfield: nest 5 blue 2018; nest 6 orange 2019

Figure 6. An adult in nest 5 at Beresfield on 23/12/2018

DISCUSSION

This study provides evidence of a second successful nesting attempt by Black Kites in the Hunter Region. It confirms that the region can provide suitable territories, nest trees and food for resident Black Kites.

Both territories in this study were located where open land with water bodies met residential, light industrial or recreational land. As expected, each territory was less than 12 km from one of the waste management centres at which hundreds of Black Kites congregated in 2013. These findings agree with previous findings that Black Kites select open habitats (Tanferna *et al*. 2013) and often breed near large water bodies and rubbish dumps (Bordjan 2018).

The nest trees were all tall (20-35 m) eucalypts. The choice of nest tree is influenced by several factors, the most important of which are the height and type of tree (Bakhtin 2015). The height range reported in this study is similar to the range of 7-32 m reported by Bakhtin (2015). Interestingly, the type of tree reported in this study is the same as the type of tree most commonly used in Delhi, India (Kumar *et al*. 2014). Usually, different trees are used in different countries according to the local flora. For example, the most commonly used nest tree in Italy is the oak *Quercus* spp. (Zocchi *et al*. 2004) and in western Siberia is the poplar *Populus* spp. (Bakhtin 2015).

All nests were located 3-7 m from the tops of the nest trees. This is in good agreement with Debus (2012), who reported that nests are placed within the tree canopy, and with Zocchi *et al.* (2004), who reported that nests are placed at approximately 70% of relative tree height.

All nests were large stick nests, as previously reported (Debus 2012). It is not known whether they were built by the Black Kites or by other birds such as ravens or crows *Corvus* spp. (Sergio & Boto 1999). The linings of the nests could not be seen, so the presence of human-made materials, such as paper, cloth and plastics (Mazumdar *et al*. 2016), could not be ascertained.

For the successful nesting attempt, the first fledged juvenile was seen on 21 October 2019, suggesting that egg-laying occurred in early to mid-August (BirdLife Australia 2019; Debus 2012). The fledging of two young is consistent with a reported mean clutch size of 2.5 +/- 0.7 (Olsen & Marples 1993). The sightings of at least one of the two fledglings with the adults until 20 November 2019 are consistent with a reported post-fledging dependence period of 15-36 days (Bustamante & Hiraldo 1989).

The reasons for the unsuccessful nesting attempts are unclear. Others have suggested that failed nesting attempts may be due to low food availability, water pollution or prey contamination (Sergio & Boto 1999). Both Fletcher and Beresfield contain open land in which prey can live and predators can hunt. In addition, Black Kites eat a variety of foods including rabbits (Viñuela *et al*. 1994), rodents (Boumaaza, *et al*. 2016), birds (Kumar *et al*. 2014), fishes (Sergio & Boto 1999), meat (Kumar *et al*. 2014) and carrion (Debus 2012). Whether water is polluted or prey is contaminated at the sites is unknown.

In this study, human disturbance was likely to have contributed to, but not necessarily caused, the unsuccessful nesting attempts. In 2016, road and house construction had not commenced in the Sanctuary Cove Estate in Fletcher, yet the nesting attempt appeared to be unsuccessful. Conversely, in 2019, when house construction was underway along a new road 25 m from nest tree 3, the nesting attempt was successful. Black Kites have bred in areas of high human disturbance in other countries (Kumar *et al*. 2014; Mazumdar *et al*. 2016). However, their absence from the former nests at Fletcher and Beresfield in the 2020 breeding season suggests that they have not successfully adapted to breeding in areas of high human disturbance in the Hunter Region.

CONCLUSION

The observations presented here confirm that Black Kites are making nesting attempts over consecutive breeding seasons in the Hunter Region. They provide evidence of a successful nesting attempt resulting in two fledged young.

Nesting attempts may also be continuing elsewhere in the Hunter Region. Further research is needed to explore this possibility.

REFERENCES

Agostini, N. and Logozzo, D. (1997). Autumn migration of Accipitriformes through Italy en route to Africa. *Avocetta* **21**: 174-179.

Alexander, P. (2016). Black Kite breeding - a first for the Hunter Region. *The Whistler* **10**: 58-59.

Bakhtin, R. (2015). On the problem of nesting trees preferred by *Milvus migrans* in the forest belts of the south of western Siberia. *Biosciences, Biotechnology Research Asia* **12**: 2427-2431.

BirdLife Australia. (2019). Black Kite. http://birdlife.org.au/bird-profile/Black-Kite. (accessed 11 January 2019)

Bordjan, D. (2018). Black Kite *Milvus migrans* in Slovenia - its distribution, phenology, breeding and habitat. *Acrocephalus* **39**: 71-83.

Boumaaza, O., Bara, M., Khemis, M., Boucherit, K., Elafri, A., Bouslama, Z. and Houhamdi, M. (2016). Breeding biology of the Black Kite *Milvus migrans* (Accipitridae) at Ras El Ma ravine (Guelma, northeast Algeria). *Journal of Entomology and Zoology Studies* **4**: 480-483.

Bustamante, J. and Hiraldo, F. (1989). Post-fledging dependence period and maturation of flight skills in the Black Kite *Milvus migrans*. *Bird Study* **36**: 199-204.

City of Newcastle (2019a). Beresfield and Tarro. http://www.newcastle.nsw.gov.au/Living/Our-City/Suburbs/Beresfield-and-Tarro.aspx. (accessed 21 February 2019)

City of Newcastle (2019b). Fletcher. http://www.newcastle.nsw.gov.au/Living/Our-City/Suburbs/Fletcher.aspx. (accessed 21 February 2019)

Debus, S. (2012). 'Birds of prey of Australia: a field guide'. (2nd Edition) (CSIRO Publishing: Collingwood, Victoria.)

Dennis, T. (2004). Conservation status of the White-bellied Sea-Eagle, osprey and peregrine falcon on western Eyre Peninsula and adjacent offshore islands in South Australia. *South Australian Ornithologist* **34**: 222-228.

Dennis, T., Fitzpatrick, G. and Brittain, R. (2012). Phases and duration of the White-bellied Sea-Eagle *Haliaeetus leucogaster* breeding season in South Australia and the implications for habitat management. *Corella* **36**: 63-68.

Kumar, N., Mohan, D., Jhala, Y., Qureshi, Q. and Sergio, F. (2014). Density, laying date, breeding success and diet of Black Kites *Milvus migrans govinda* in the city of Delhi (India). *Bird Study* **61**: 1-8.

Mazumdar, S., Ghose, D. and Saha, G. (2016). Nests of Black Kite (*Milvus migrans govinda*) in Urban Landscape of Kolkata, India. *Proceedings of the Zoological Society* **70**: 201-205.

McDonald, P. (2003). A successful extra-limital breeding record of the Black Kite '*Milvus migrans*' south-west of Melbourne, Victoria [online]. *Australian Field Ornithology* **20**: 17-20.

Olsen, P. and Marples, T. (1993). Geographic variation in egg size, clutch size and date of laying of Australian raptors (Falconiformes and Strigiformes). *Emu - Austral Ornithology* **93**: 167-179.

Sergio, F. and Boto, A. (1999). Nest dispersion, diet, and breeding success of Black Kites (*Milvus migrans*) in the Italian pre-alps. *Journal of Raptor Research* **33**: 207-217.

Stuart, A. (Ed.) (2014-2018). Hunter Region of New South Wales Annual Bird Report Numbers **21**-**25** (2013-2017). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

Tanferna, A., López-Jiménez, L., Blas, J., Hiraldo, F. and Sergio, F. (2013). Habitat selection by Black Kite breeders and floaters: implications for conservation management of raptor floaters. *Biological Conservation* **160**: 1-9.

Viñuela, J., Villafuerte, R. and Court, C. (1994). Nesting dispersion of a Black Kite population in relation to location of rabbit warrens. *Canadian Journal of Zoology* **72**: 1680-1683.

Zocchi, A., Lacroix, L., Bianchi, M. and Battisti, C. (2004). Characteristics of Black Kite *Milvus migrans* nest-trees in two Italian colonies. *Avocetta* **28**: 9-14.

Comparing changes in the abundance of woodland birds in the Hunter Region of New South Wales

Mike Newman

72 Axiom Way, Acton Park, Tasmania 7170, Australia omgnewman@bigpond.com

Received 14 September 2020; accepted 7 December 2020; published on-line 15 December 2020.

Birdata records suggest that many woodland and other birds have experienced serious decreases in the Hunter Region during the last two decades. These include species such as the Superb Fairy-wren *Malurus cyaneus*, which, however, remains widespread and abundant. Others, like the Jacky Winter *Microeca fascinans,* are becoming increasingly uncommon. Reliable estimation of the population trajectories of uncommon species is compromised by a lack of sufficient records in short-duration surveys. This difficulty is addressed in this paper by combining the results of surveys of different duration in order to increase the number of records. A screening process involving comparison of the rates of decrease with a benchmark species, the Superb Fairy-wren, has highlighted species of concern which require more detailed analysis.

Of 17 Hunter Region woodland birds, ten species decreased monotonically at rates that were statistically significantly more rapid than the rate for the Superb Fairy-wren: up to 2.7 times greater in the case of the Pallid Cuckoo *Heteroscenes pallidus*. The rates of decrease in the Superb Fairy-wren and six other species were statistically significantly different from the rates for the ten species showing greater decline. In general, uncommon species were decreasing more rapidly than common species. Not all species fitted the pattern of monotonic decline; examples being the Dusky Woodswallow *Artamus cyanopterus* and the Spiny-cheeked Honeyeater *Acanthagenys rufogularis*. The latter has recently established a presence in the Hunter Region.

Potential causes of population decrease include land clearing, excessive fragmentation of remnant woodland and drier conditions resulting from climate change. It is speculated that uncommon species may decrease more rapidly because they are less adaptable, having specialized ecological requirements, and diminished ability to disperse.

INTRODUCTION

A key purpose of Birdata is to identify changes in bird populations. For this purpose, Reporting Rates (RR), are used as a measure of the abundance of a species (Clarke *et al*. 1999). Inspection of Birdata RRs suggests that many species are rapidly disappearing from the Hunter Region's landscape. However, the extent to which the apparent trends are affected by changes in data collection procedures is unclear. For instance, during the past two decades technological and social changes have influenced where, and how, people watch birds, complicating interpretation. This paper provides insights into the changes in Hunter Region bird populations by comparing the rates at which different species have altered.

Contributors to Birdata are encouraged to use standard survey methods, ideally 2-ha surveys, where an area of 2 ha is surveyed for 20 minutes and short bird lists are generated. However, many Birdata participants prefer to survey larger areas for extended periods of time, generating longer bird lists than from 2-ha surveys. While 2-ha survey data have advantages for determining changes in common species such as the Superb Fairy-wren *Malurus cyaneus* (Hunter Region RR 42.4% from 2-ha surveys), there are seldom sufficient records for meaningful analysis of uncommon species, such as Pallid Cuckoo *Heteroscenes pallidus* (Hunter Region RR 2.1% from 2-ha surveys), necessitating the use of records from other survey types. Unfortunately, combining the results of different types of surveys introduces bias, complicating the analysis of trends. The approach adopted in this paper is based on the proposition that if all species experience the same annual bias, differences in their relative rates of change will provide an indication of how the status of individual species are changing. This will provide insights into the ability of species to adapt to environmental changes in the Hunter Region. The Superb Fairy-wren is used as a benchmark for comparing the status of other woodland species.

METHODS

The analysis in this paper is based on the results of three types of Birdata survey:

- 2-ha surveys – an area of 2 ha is searched for a period of 20 min. The 2-ha survey is BLA's preferred method because both the area searched and the survey duration are standardised.
- 500-m surveys – birds are recorded within an area not exceeding 500 m radius. Duration is not constrained, although participants are encouraged to complete surveys during one day.
- 5-km surveys – birds are recorded within an area not exceeding 5 km radius with completion encouraged within one day.

During August 2020 I extracted the annual RRs for Hunter Region from the Birdata portal (General Birdata program) for a combination of the three survey types for 22 species for the period 1999 to 2019 (1999 was the first full year of the New Atlas of Australian Birds; Barrett *et al*. 2003).

The Superb Fairy-wren was selected as the basis for comparison because it is frequently recorded and well distributed across the Hunter Region. Woodland birds with ranges similar to the Superb Fairy-wren (unless otherwise stated) and representing a range of life-style traits (e.g. resident and migratory) and foraging guilds (e.g. ground, bark and foliage gleaning) were chosen otherwise randomly for comparison. The mean RRs for the 21-year period 1999 to 2019 varied widely among the selected species.

Decadal changes in the annual RR (i.e. the extent to which a species decreased during a ten-year period were calculated from the slope and intercept of the linear regression equation of the annual RR trend (See **Figure 1** in the Results section). The 95% confidence intervals (not shown) indicated errors of 4 and 9% for the 2010 estimates of the Superb Fairy-wren and the Jacky Winter *Microeca fascinans*, respectively. In instances where linear regression models were deemed unsuitable, temporal trends were evaluated as three-year moving average values.

The rates of decline of individual species were compared with the Superb Fairy-wren, the benchmark species, by testing whether the slope of the variation in the occurrence of that species was statistically different from that of the Superb Fairy-wren. The probability *p* of this difference was calculated using StatPlus:mac, AnalystSoft Inc. - statistical analysis program for macOS. Version v7.3.

To evaluate the possibility that annual RR trends were affected by variations in the number of surveys and types (see **Figure 7** in Results section) the 500-m and 5-km survey records for each species were adjusted to an equivalent number of 2-ha records using the ratios of their mean annual RR with the 2-ha RR. This allowed a 2-ha equivalent annual RR to be calculated for each species and the trend of the adjusted values to be compared with the uncorrected trend. No correction was made for variations in survey duration, which is not standardized in 500-m and 5-km Birdata surveys.

RESULTS

The RRs of the Superb Fairy-wren and many other species of the Hunter Region have decreased over the past 20 years. In most cases these decreases are explained by a linear model as shown for the Superb Fairy-wren and three other species in **Figure 1**.

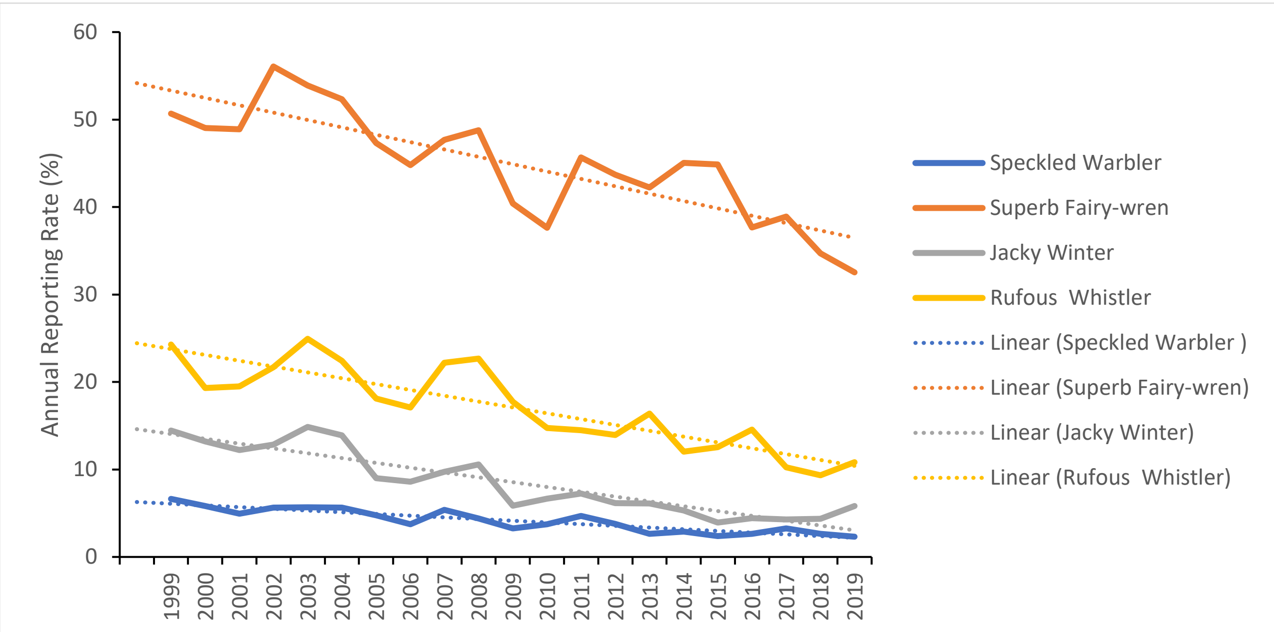


Figure 1. Variation in annual reporting rate of Superb Fairy-wren, Rufous Whistler, Jacky Winter and Speckled Warbler for the period 1999 to 2019 based on the combined results of Birdata 2-ha, 500-m and 5-km surveys.

The temporal trends of 17 of the 22 species evaluated were described by linear regression models with high values of the correlation coefficient r and statistically significant negative slopes $p<0.05$ (**Table 1**).

Table 1. Summary of population change statistics for 22 species of woodland birds with extensive distributions in the Hunter Region of NSW. Analysis based on the annual reporting rates for combined 2-ha, 500-m and 5-km Birdata surveys for the 21-year period 1999 to 2019.

Common Name	**Scientific Name**	**Mean Annual RR (%)**	**Decadal Decrease RR (%)**	**Correlation Coefficient r**
Superb Fairy-wren	*Malurus cyaneus*	42.4	15.3	0.84
Willie Wagtail	*Rhipidura leucophrys*	35.8	15.2	0.64
Grey Fantail	*Rhipidura rufifrons*	35.8	17.1	0.88
Magpie-lark	*Grallina cyanoleuca*	34.7	AM[1]	
Eastern Yellow Robin	*Eopsaltria australis*	23.2	13.8	0.68
Golden Whistler	*Pachycephala pectoralis*	22.7	13.2	0.60
Grey Shrike-thrush	*Colluricincla harmonica*	20.9	22.8	0.91
Eastern Spinebill	*Acanthorhynchus tenuirostris*	20.5	16.1	0.70
Red-browed Finch	*Neochmia temporalis*	19.6	25.9	0.89
White-throated Treecreeper	*Cormobates leucophaea*	18.2	15.6	0.84
Double-barred Finch	*Taeniopygia bichenovii*	15.4	30.0	0.72
Rufous Whistler	*Pachycephala rufiventris*	15.3	26.7	0.88
White-naped Honeyeater	*Melithreptus lunatus*	8.1	AM[1]	
Jacky Winter	*Microeca fascinans*	7.5	37.7	0.92
White-throated Gerygone	*Gerygone olivacea*	7.4	37.3	0.91
White-breasted Woodswallow	*Artamus leucorynchus*	5.8	AM[1]	
Speckled Warbler	*Pyrrholaemus sagittatus*	3.8	31.0	0.91
Varied Sittella	*Daphoenositta chrysoptera*	3.3	34.0	0.77
Dusky Woodswallow	*Artamus cyanopterus*	3.1	AM[1]	
Eastern Shrike-tit	*Falcunculus frontatus*	3.0	36.1	0.73
Pallid Cuckoo	*Heteroscenes pallidus*	2.1	43.0	0.81
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	1.4	NA[2]	

AM[1] – Better described by an alternative non-linear model
NA[2] - Not applicable because of the anomalous expansion of the Spiny-cheeked Honeyeater; see **Figure 6**.

Comparison of rates of population decrease

The decadal rates of decrease of 17 species are compared in **Figure 2**. Rates of decrease ranged from 13% for the Golden Whistler *Pachycephala pectoralis* to 43% for the Pallid Cuckoo. The rates of decadal decrease of seven species were in the range 13 to 17%. These rates were not significantly different from the rate of decrease of the Superb Fairy-wren, the most frequently recorded species. Ten other species decreased at decadal rates in the range 23% (Grey Shrike-thrush *Colluricincla harmonica*) to 43% (Pallid Cuckoo).

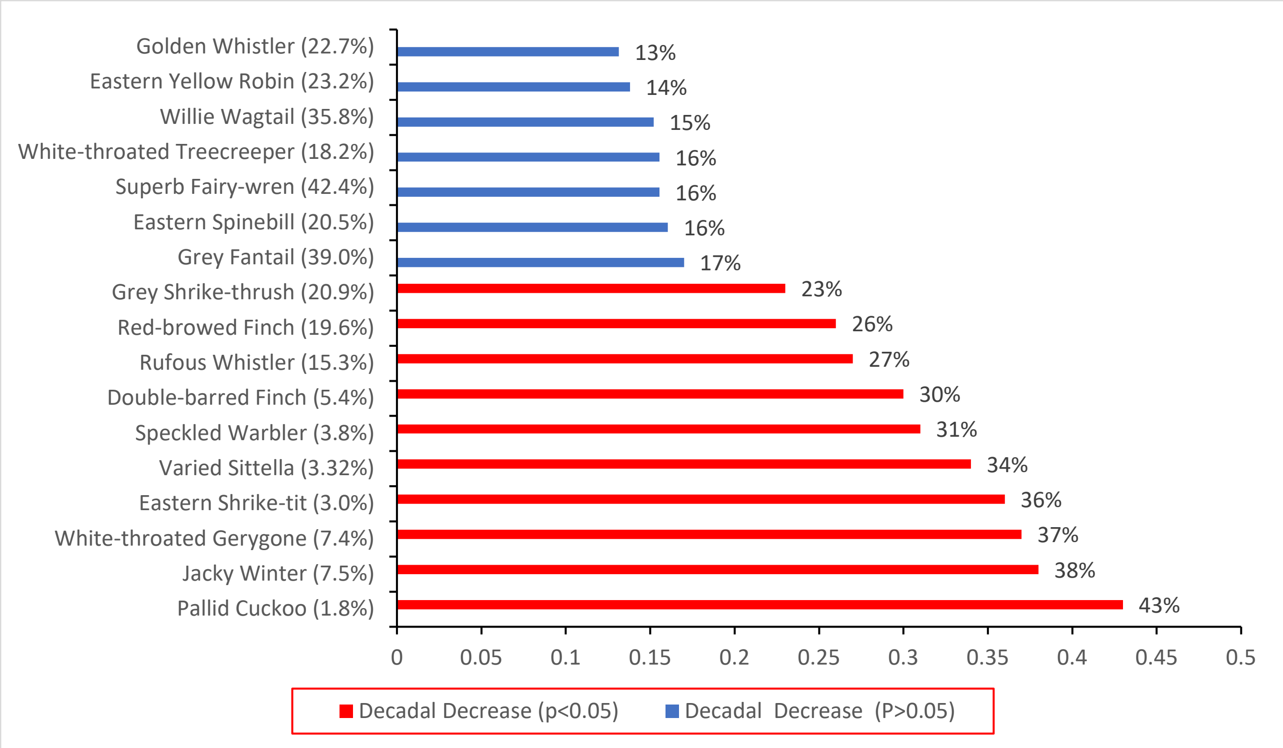


Figure 2. Comparison of the decadal decreases in the annual reporting rates of 17 species (the mean annual reporting rate of each species is shown in parentheses) of woodland birds in the Hunter Region for the period 1999 to 2019 based on the combined results of 2-ha, 500-m and 5-km surveys. The red bars indicate species which decreased at rates significantly different from the Superb Fairy-wren ($p<0.05$).

Species with non-linear Reporting Rate trajectories

The Dusky Woodswallow *Artamus cyanopterus* and White-breasted Woodswallow *A. leucorynchus* were among six species whose temporal trends were better described by non-linear relationships. The annual RR of the Dusky Woodswallow (**Figure 3**) varied in a complex manner, with peak occurrences in the periods 2001-07 and 2016-19. This is in contrast to the monotonic decreases exhibited by the Superb Fairy-wren and many other woodland species (**Figure 1**). The variation in the annual RR of White-breasted Woodswallow, a near-coastal species, was also complex (**Figure 3**). The trends in the RRs of the two Woodswallow species were similar between 2009 and 2019, but not in the previous decade.

The annual RR trends of the Magpie-lark *Grallina cyanoleuca* and White-naped Honeyeater *Melithreptus lunatus* differed from the linear trends of the Superb Fairy-wren and many other woodland species (**Figure 1**). Both species decreased between 1999 and 2010, before partially recovering during the following decade (**Figure 4**).

Figure 3. Variation in annual reporting rate of Dusky and White-breasted Woodswallows in the Hunter Region for the period 1999 to 2019 based on the combined results of Birdata 2-ha, 500-m and 5-km surveys. (Trend lines based on 3-year moving average.)

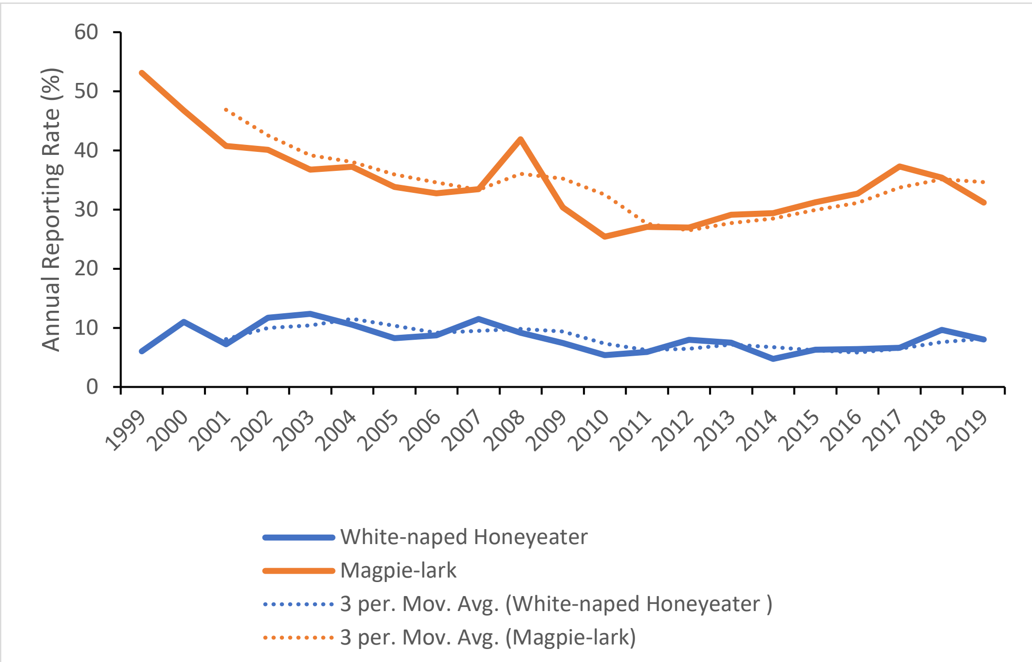


Figure 4. Variation in annual reporting rate of Magpie-lark and White-naped Honeyeater in the Hunter Region for the period 1999 to 2019 based on the combined results of Birdata 2-ha, 500-m and 5-km surveys. (Trend lines based on 3-year moving averages\.)

Although the Pallid Cuckoo was assessed in **Table 1** and **Figure 2** using a linear trend, its decrease occurred between 2000 and 2014. Since then, the annual RR has slightly increased (**Figure 5**).

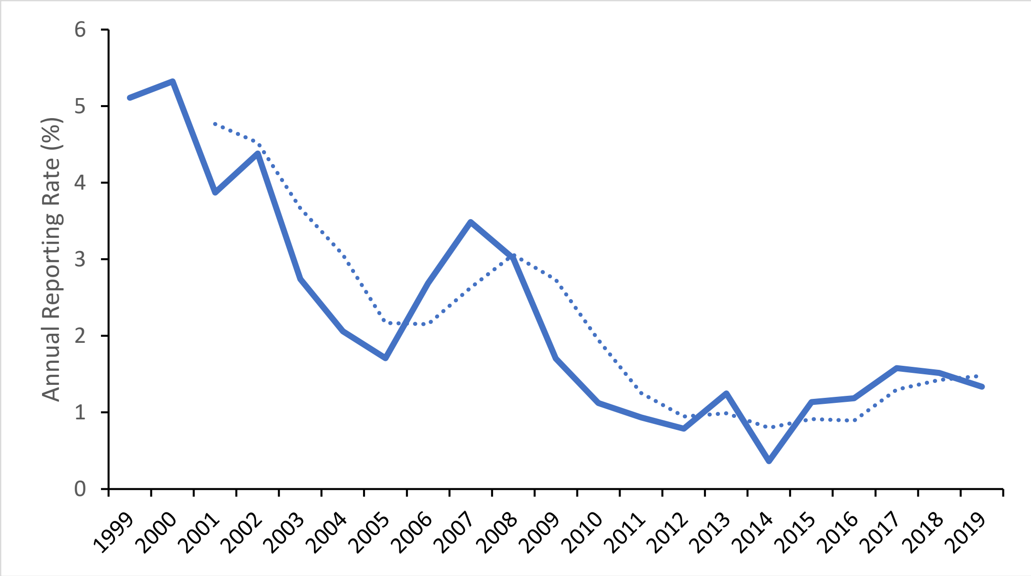


Figure 5. Variation in annual reporting rate of Pallid Cuckoo in the Hunter Region for the period 1999 to 2019 based on the combined results of Birdata 2-ha, 500-m and 5-km surveys. (Trend line based on 3-year moving averages.)

The Spiny-cheeked Honeyeater *Acanthagenys rufogularis* was first recorded regularly in the Hunter Region in 1999. Since then, its population has expanded increasingly rapidly (**Figure 6**) in contrast to all the other species which have decreased.

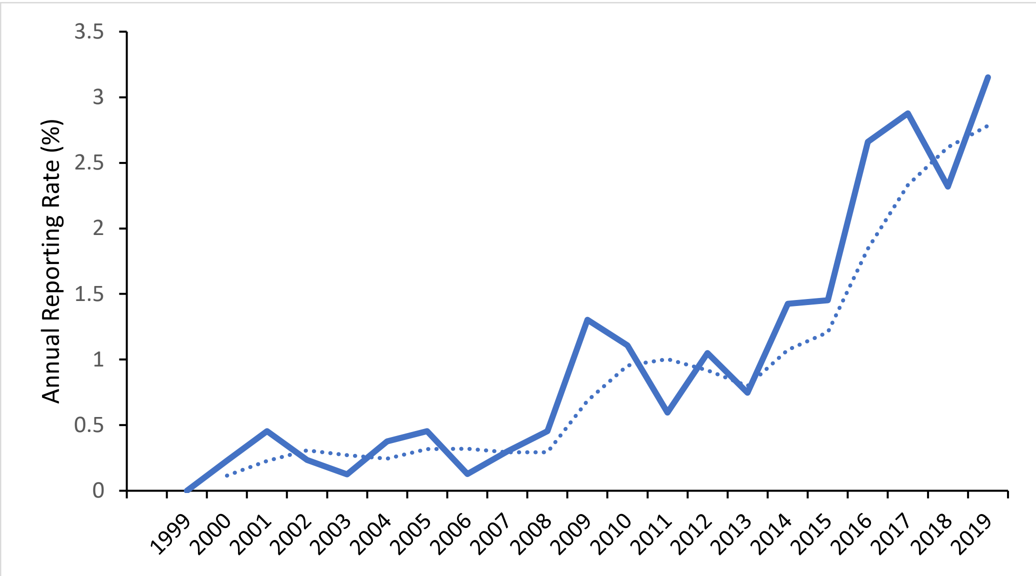


Figure 6. Variation in annual reporting rate of Spiny-cheeked Honeyeater in the Hunter Region for the period 1999 to 2019 based on the combined results of Birdata 2-ha, 500-m and 5-km surveys. (Trend line based on 3-year moving averages).

Correction for variation in survey type

There were large annual differences in the number and type of survey, as shown in **Figure 7**. Three phases of data collection are apparent. During the period of field work for the New Atlas (1999-2001) there was a relatively high proportion of 5-km surveys. When Birdata entered the bird-monitoring phase in 2002, the number of 2-ha and 5-km surveys decreased, but the number of 500-m surveys remained relatively stable. This situation persisted until 2008. During the next decade the number of surveys increased, ultimately by a factor of five, and predominantly involved increased numbers of 2-ha and 500-m surveys.

To assess how these variations in survey numbers and survey types were affecting the annual RR trends, the RR of three species were adjusted to their 2-ha-equivalent RR, as outlined in the Methods section. In each case the adjusted decadal decrease in RR was lower: Superb Fairy-wren 16% to 13%;

Rufous Whistler 27% to 24%; Jacky Winter 36% to 33%. Thus, variation in survey type between years seems to lead to only a small over-estimation of the rates of population decrease (in the relative percentage range 10 to 20%).

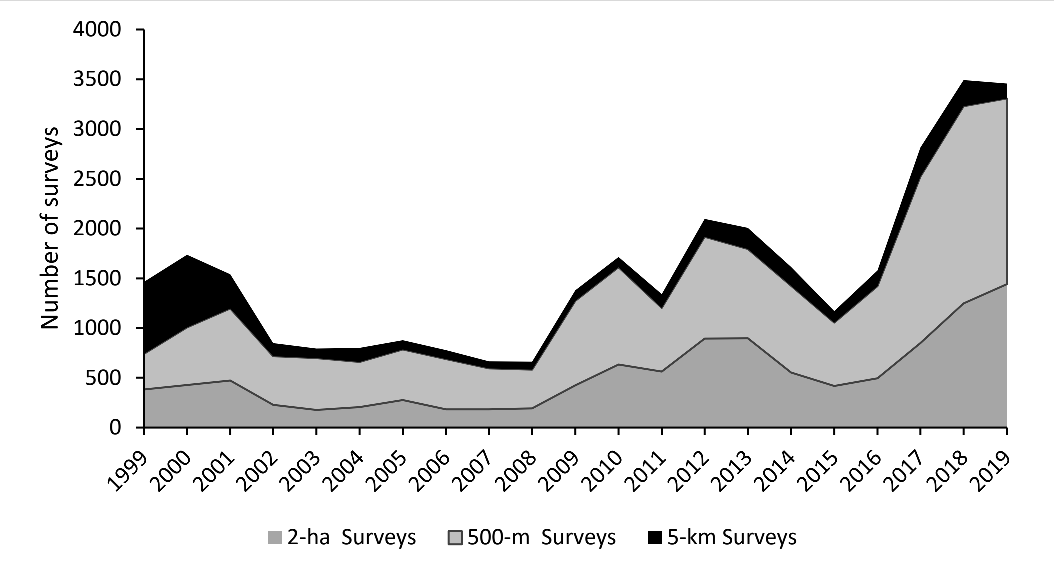


Figure 7. Variation in the number and proportion of 2-ha, 500-m and 5-km surveys conducted annually in the Hunter Region between 1999 and 2019.

DISCUSSION

The 21-year decrease in the annual RR of the Superb-Fairy wren equates to a decadal decrease of 16%. However, this decrease is subject to numerous sources of bias, which if corrected for might adjust the magnitude of that value. In addition to differences in survey type and duration, other factors to consider are annual variations in the representation of different habitat types, and the uneven distribution of survey activity across the Hunter Region. Sources of such bias include species-specific projects (e.g. Rufous Scrub-bird studies in the Gloucester Tops which commenced in 2010 (Newman *et al*. 2014), more intensive monitoring of areas near to where people live, and birdwatchers being attracted to areas of higher avian diversity.

The similarity in the 21-year RR trends of the Superb Fairy-wren and a number of other woodland birds with similar Hunter Region ranges was an expectation of this study, which compares changes in the RR rates of these species to the Superb Fairy-wren. Combining the results of 2-ha, 500-m and 5-km surveys enabled conclusions to be drawn about changes in the status of less common species, such as the Jacky Winter, Speckled Warbler *Pyrrholaemus sagittatus* and Pallid Cuckoo, by increasing the number and hence statistical power of their records (there were insufficient records of these species to draw meaningful conclusions using only 2-ha survey data).

Small woodland birds, including the Superb Fairy-wren, typically have generation times of three to four years (Bird *et al*. 2020). For these species, a sustained decrease in RR lasting two decades (i.e. about six generation times) is an indication that their populations are unstable at the landscape scale. It is normal for bird populations to experience short-term fluctuations in abundance (Newton 2013), but with a periodicity less than three generation times.

Species with sustained linear decreases in Reporting Rate

For seven of the 17 species showing long-term linear decrease in RR, their decadal declines were in the range 13 to 17%. These rates were not statistically different from that of the Superb Fairy-wren, the benchmark species. All seven species were frequently recorded, with mean RRs in the range 18% to 42%. They included species from a range of avian families, which adopt a variety of different foraging styles and have different ecological requirements.

The RRs for the other ten species decreased more rapidly, and at rates that were statistically significantly different from the Superb Fairy-wren. The Pallid Cuckoo, the species with the greatest change in RR, was decreasing in RR 2.7 times more rapidly than the Superb Fairy-wren. It also was the species with the lowest mean RR for the 21-year period. This exemplifies the tendency for the more rapidly decreasing species to be those which were already less common initially.

The shared long-term monotonic decrease in RR suggests that there is an environmental factor (or factors) which adversely affects all 17 species, but that some species are more impacted than others. Land clearing and increasing fragmentation of remnant vegetation are obvious possibilities, as is climate change, involving a tendency to increasingly dry and hotter conditions during the last two decades (Ehmke *et al*. 2015). It is beyond the scope of this paper to provide detailed explanations of the impact of these factors on individual species. The following discussion is limited to some generic possibilities.

Increasing fragmentation of remnant vegetation would be expected to have greater impact on the dispersal of species with specialized habitat preferences, providing a possible explanation of the higher rates of decrease found for species such as the Speckled Warbler. Mobile, opportunistic species, which exploit locally variable food resources (e.g. honeyeaters seeking flowering trees), might be less impacted. This could explain why the less common White-naped Honeyeater shows similar population resilience (i.e. has a similar decadal decrease) to more common species, such as the Superb Fairy-wren, but with different population dynamics.

Ecological specialization is another factor which may cause species to decrease their environmental resilience and be uncommon. For example, ground-feeding specialists such as the Red-browed Finch *Neochmia temporalis* and Double-barred Finch *Taeniopygia bichenovii*, as well as the Speckled Warbler, are all uncommon and decreasing more rapidly than the more common species.

For migratory species (e.g. Rufous Whistler *Pachycephala rufiventris* and Pallid Cuckoo), factors outside the Hunter Region may contribute to, or determine, regional population changes, thus explaining why some migrant species have population trajectories that are distinct from resident species.

Species with non-linear decrease in Reporting Rate

The non-linear variation of the annual RR of the Dusky Woodswallow suggests that the factors causing variations in its population size are different from those affecting the Superb Fairy-wren and the other woodland birds with decreasing linear RR trends. This proposition is supported by evidence of a strong northern seasonal movement along the east of Australia involving a shift between summer and winter population centres (Griffieon & Clarke 2002). Hence, although Dusky Woodswallow breed and occur throughout the year in the Hunter Region (Stuart 1993 – 2018), a large proportion of the Region's records may involve non-resident birds. Interestingly, the RR trend of the White-breasted Woodswallow, a summer visitor with a near-coastal distribution (Williams 2019), has also increased strongly during the last decade. As the RRs of both species, which forage insects on the wing, have increased during the last decade it is possible that recent conditions in the Hunter Region have favoured them.

In the case of the Pallid Cuckoo, it appears that the steep decrease in annual RR experienced in the first decade of this study has been arrested and that the species' status in the Hunter Region is now relatively stable, although less common than formerly. This is another example of a species with a complex migratory pattern (Griffieon & Clarke 2002) for which the Hunter Region is not core habitat (Newman 2019). Hence, external factors may have caused its status in the Hunter Region to change.

The Magpie-lark and White-naped Honeyeater are examples of species with populations that appear relatively stable, although subject to medium-term fluctuations. The resilience of these species may be associated with their life-style traits. For instance, the White-naped Honeyeater may be differentiated from other woodland species by its mobility as it seeks out and opportunistically exploits flowering gum and other food resources. Cursory inspection of Hunter Region Birdata records suggests that other honeyeater species may have similar RR profiles. Thus, the possible benefits from mobility warrant future investigation. Although requiring trees for nest sites, the Magpie-lark predominantly inhabits open areas, which may explain the difference between its population dynamics and species more heavily dependent on woodland habitat.

The Spiny-cheeked Honeyeater provides a rare example of a woodland bird which is increasing in the Hunter Region. It was first recorded in 2000 and the annual RRs have increased rapidly since that time. Two decades later, the annual RR continues to increase, probably associated with an ongoing extension of its range within the Hunter Region (Williams 2020).

Combining survey types

Interpretation of Hunter Region Birdata is complicated by many forms of bias, as outlined previously. Fortunately, annual variations in the numbers of surveys and the proportion of different survey types has small impact on the relative rates of change in annual RR between species when survey types are combined. The superior correlations for uncorrected RR trends (i.e. higher r values) suggest that the loss of statistical power (fewer records) outweighs the advantage of correction. This is an important conclusion, providing confidence in the approach used in this study in which the results of combined survey types were used to screen regional Birdata and identify species seriously impacted by environmental change.

Future directions

The approach used in this analysis only provides an indication of which species are most at risk. It is a screening process to identify priorities for future investigations. It is probable that the rates of decrease reported are somewhat over-estimated as shown when the 2-ha-equivalent survey correction was applied for three of the species. It is therefore important that the data are reassessed to eliminate biases in the raw results used for this analysis. The approach used by Ehmke *et al*. (2015) applying methods developed by Cunningham & Olsen (2009) should provide more accurate estimates for data-rich species, including the Superb Fairy-wren, the benchmark species in this study. The relative rates of decrease established in the present study can then be used to revise the estimates for less common species although it is possible that some species will prove to be too data deficient for detailed modelling. It is expected that the re-assessment will confirm the present conclusion, namely that many of the Hunter's woodland birds have decreased. A previous State of Australia's Birds assessment (Ehmke *et al.* 2015) indicated widespread decreases in the status of Australia's woodland birds.

The question is whether the more sophisticated analysis will substantially alter the present findings. The rates of decrease in RR from this study are cause for serious concern. The IUCN Red List process used in the Action Plan for Australian Birds (Garnett *et al*. 2011) considers species with decreases exceeding 30% in three generation times (e.g. c. 10 years for small woodland birds) to be vulnerable when the decreases are ongoing and their causes are uncertain. On the above basis, seven of the 17 species assessed in this study, i.e. those species which have decadal RR decreases of 30% relative or greater, might be considered regionally vulnerable. This concern is exacerbated by the fact that the linear declines in many of these species in NSW potentially extend back to at least 1986 (e.g. see trends for Jacky Winter, Varied Sittella *Daphoenositta chrysoptera* and Eastern Shrike-tit *Falcunculus frontatus* in Cooper *et al*. 2020).

This analysis evaluated a diverse range of species that are widely distributed in the Hunter Region and which are representative of a number of foraging guilds. The analysis should be expanded to include habitat specialists (e.g. rainforest species) and species with limited distribution ranges. For habitat specialists there may be advantages in restricting the analysis to the core range of the species and in using a reference species which is abundant within that particular habitat.

Woodland birds appear to be particularly vulnerable in the Hunter Region. Improved understanding of the life-style traits of species with relatively stable populations (e.g. White-naped Honeyeater) may provide insights into how woodland habitats can be better managed to halt, and ideally reverse, the decline of the less resilient species.

CONCLUSIONS

Comparing the relative rates of change in RRs has been demonstrated to be a valuable method of screening regional Birdata to identify changes in the status of individual species and highlight those most at risk. The approach is a powerful tool to assist local communities to understand and advocate for the conservation of local bird communities, a need recently highlighted in a recent forum article (Garnett 2020). The approach used here successfully combined 2-ha, 500-m and 5-km survey data to increase the number of records of uncommon species (e.g. Jacky Winter, Speckled Warbler and Pallid Cuckoo).

This analysis suggests that the RRs of the Superb Fairy-wren and many other woodland species have decreased alarmingly throughout the last two decades. Land clearing, excessive fragmentation of remnant woodland habitat and climate change are potential causes of the observed decreases. In general, the species which decreased most rapidly were already uncommon. It is tentatively suggested that such species are less versatile, have specialised ecological requirements and limited dispersal capability (Newman 2018). Inevitably, there will be species for which there are insufficient data to draw statistically confident conclusions concerning their status. In such instance species-specific studies will be required, as exemplified by the Rufous Scrub-bird monitoring project (Newman *et al*. 2014).

It is ironic that the species potentially at greatest environmental risk are less common and hence data deficient. A future challenge is to calibrate the relative rates of RR change identified in this paper in order to generate absolute estimates. This will require detailed modelling to correct the biases in the raw RRs of abundant species such as the Superb Fairy-wren, the base-line species used in this analysis. The use of standardised Birdata survey methods (e.g. 2-ha surveys only) is an important feature of such analysis (Cunningham & Olsen 2009; Emke *et al*. 2015). However, as demonstrated in this paper there are advantages in drawing on data from a range of survey types in order to understand the dynamics of diverse bird populations.

ACKNOWLEDGEMENTS

Writing this paper was challenging. During periods of doubt Barry Baker, Eric Woehler and Alan Stuart all encouraged me to persist in seeking explanations for the compelling trends I was generating. Eric Woehler is thanked for his help with the statistical analysis. Robyn Stuart provided invaluable comments on the interpretation of statistical tests. Comments by an anonymous referee helped shape the final form of the paper. Andrew Silcocks and Joris Driessen are thanked for their tireless efforts in the development and custodianship of the Birdata archive and its portal interface.

As indicated by Garnett (2020), local groups must take ownership of the results of their field studies, including understanding the implications of their work; ultimately applying their findings to the conservation of local bird populations. This can only occur if they receive the generous support of professional experts, which I have received in preparing this paper.

REFERENCES

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R.E. (2003). 'The New Atlas of Australian Birds'. (Royal Australasian Ornithologists Union: Melbourne.)

Bird, J.P., Martin, R., Akçakaya, H.R., Gilroy, J., Burfield, I.J., Garnett, S.T., Symes, A., Taylor, J., Şekercioğlu, Ç.H. and Butchart, S.H. (2020). Generation lengths of the world's birds and their implications for extinction risk. *Conservation Biology* DOI: 10.1111/cobi.13486.

Clarke, M.F., Griffieon, P. and Lyon, R.H. (1999). Where do all the bush birds go? Supplement to *Wing Span* 9, Number 4.

Cooper, R.M., McAllan, I.A.W., Brandis, C.C.P. and Curtis, B.R. (2020). 'An Atlas of the Birds of NSW and the ACT, Volume 3'. (New South Wales Bird Atlassers Inc.: Woolgoolga, NSW.)

Cunningham, R. and Olsen, P. (2009). A statistical methodology for tracking long-term change in reporting rates of birds from volunteer-collected presence-absence data. *Biodiversity Conservation* **18**: 1305-27.

Ehmke, G., Cunningham, R., O'Connor, J., Garnett, S.T., Lau, J. and Herman, K. (2015). 'The State of Australia's Birds 2015: Headline Trends for Terrestrial Birds'. (BirdLife Australia: Carlton, Vic.)

Garnett, S.T., Szabo, J.K. and Dutson, G. (2011). The action plan for Australian Birds 2010. (CSIRO Publishing: Collingwood, Australia.)

Garnett, S.T. (2020). Towards protection of locally significant species. *Emu* **120**: 100-101.

Griffieon, P.A. and Clarke, M.F. (2002). Large scale bird-movement patterns evident in eastern Australia atlas data. *Emu* **102**: 99-125.

Newman, M., Stuart, A. and Hill, F. (2014). Rufous Scrub-bird *Atrichornis rufescens* monitoring at the extremities of the species' range in New South Wales (2010-2012). *Australian Field Ornithology* **31**: 77-98.

Newman, M. (2018). Winners and Losers – Changes in bird population on removing cattle from woodland near Paterson, NSW. *The Whistler* **12**: 7-15.

Newman, M. (2019). Why is the Pallid Cuckoo declining in the Hunter Region, but relatively stable in Tasmania? *The Whistler* **13**: 69-80.

Newton, I. (2013). 'Bird Populations.' *The New Naturalist Library* **124**. (William Collins, London, UK.)

Stuart, A. (Ed.) (1993-2018) Hunter Region of New South Wales Annual Bird Report Numbers 1 to 25 (1993-2017). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

Williams, D. (2019). Hunter Region of New South Wales Annual Bird Report Number 26 (2018). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

Williams, D. (2020). Expansion in the range of the Spiny-cheeked Honeyeater in the Hunter Valley – an example of the use of time-variant maps to study Hunter Region species. *The Whistler* **14**: 46-47.

Breeding record of Black-necked Stork in Hexham Swamp near Newcastle, NSW

Ann Lindsey

37 Long Crescent, Shortland NSW 2307, Australia ann.lindsey@bigpond.com

Received 25 November 2020; accepted 15 December 2020; published on-line 17 December 2020.

Up to eight Black-necked Stork *Ephippiorhynchus asiaticus* are known to be in the Hunter Estuary (Stuart 2018). Although these birds are seen at many locations within the estuary, the two most regular sites for them are Tomago Wetland and Hexham Swamp.

A pair of storks bred at Tomago in 2017 and 2018 raising one young on each occasion. These were the first and second confirmed breeding records for the Hunter Estuary (Lindsey 2019). An adult accompanied by two juveniles was also observed at Tomago Wetland in December 2019 (Lindsey in prep.). Although the nest site was not established, it is likely that the same Tomago pair was involved. Breeding in Hexham Swamp had not been confirmed but a pair was nest-building in 2014, while in 2015 – 2016 an adult pair with two juveniles were regularly present and suspected to have bred nearby (Stuart 2017, Lindsey 2019). However, there was no definite evidence of a nest in Hexham Swamp until 12 August 2020 when a local resident saw an adult Black-necked Stork returning repeatedly to the same bush.

This note documents the third confirmed breeding record for Black-necked Stork in the Hunter Estuary.

Nest Site

The nest was situated at 32°51'17" S 151°39'44" E (G. Little pers. comm.) in the top of a four-metre-high shrub *Melaleuca linariifolia* which was surrounded by dense vegetation consisting of mainly Common Reed *Phragmites australis*. The nearest trees *Casuarina glauca* were approximately fifty metres to the south-east. **Figure 1** shows the nest shrub and nearby vegetation. I observed the nest site from Kauma Park, Fletcher and from Tumpoaba Reserve, Maryland. Because of the distance from observation points, I was unable to see the nest itself or details of adult behaviour while at the nest.

Observing the nest

On 13 August 2020 from 0700 h to 1100 h I watched the nest site with the aid of Swarovski 10x40 binoculars and Swarovski Telescope x20. The pair attended the nest either singly or together on multiple occasions. I was unable to discern the sex of the adults. On five occasions during the 4-hour watch both adults were standing on the nest, frequently with necks stretched, looking down into the nest. On two occasions an adult carried in a stick and deposited it in the nest.

Figure 1. Black-necked Stork nest site in Hexham Swamp October 2020 (the nest shrub is mid-image). The picture also shows two shrubs, one to left of the nest site and the other behind the nest site, where the adults landed on 1 November 2020 to attend fledged young. Photographed from Kauma Park, Fletcher. Photo: A. Lindsey.

On 14 August, a drone (launched from a location near the nest) was flown over the nest by R. McDonald at a height of 16 metres, for approximately five minutes. Photographs taken from the drone revealed that at 0906 h a male bird was sitting on the nest. He did not move or show any visible signs of distress at the presence of the drone. I continued to watch the nest until 1130 h. A second bird landed on the nest at 1030 h, presumably the female. At 1032 h the male flew off the nest and landed close to my observation point.

He spent four minutes collecting black, wet vegetation in his bill probably to be used as nest lining. At 1036 h the male flew back and landed on the nest. The female stood up and sat down again, whereupon the male flew to a higher area again close to my observation point, collected a stick and returned to the nest. At 1045 h an adult flew off the nest, but I could not see whether it was the male or female. The bird returned at 1056 h. Both adults stood for a few minutes and attended the bottom of the nest before both sat down. At 1101 h an adult flew off the nest and returned at 1112 h. When I left at 1130 h both birds were hunkered down on the nest and were not visible.

On 19 August, between 0900 h and 0945 h, R. and M. Stewart observed constant activity at the nest site, with two adult birds in attendance. One of them was already present on the nest at 0900 h. At 0915 h a second adult flew in, remaining until 0925 h. That adult left again, returning ten minutes later but staying only five minutes. The first adult remained on the nest during this time.

I watched the nest site on 24 August from 0825 h to 1030 h. When I arrived, one adult was standing on the nest. At 0830 h, a second adult arrived but it flew off two minutes later. The adult on the nest stood up and attended the bottom of the nest for about five minutes before sitting down again. At 0900 h, a second adult could be seen foraging in open water to the east of the nest site but at 0920 it flew off and was not seen again during my watch. The bird on the nest stood occasionally, tending the bottom of the nest or preening.

On 26 August no adults were visible when I arrived at 0830 h. However, at 0835 h, an adult, which must have been sitting low in the nest, stood up and commenced feeding from the bottom of the nest. This continued until 0915 h. I saw it swallow food including a long black item approximately the length of its bill. At 0945 h, the drone was again flown over the nest, and a short segment of video footage was taken. The video showed two tiny chicks with dark heads and white bodies. They were lying at the feet of an adult and bobbing their heads. On 9 September from 0850 h to 0920 h, I observed both adults attending the nest.

On 12 September G. Little and R. Kyte walked out into the swamp to see if they could reach the nest so that they could band the chicks when they were large enough. Whilst they were walking out, R. Klyve and I watched the nest. At 0800 h both adults were standing on the nest. At 0835 h, one of the adults swallowed two fish, which had been cached in the bottom of the nest. The adults remained at the nest, standing and tending the bottom of the nest, until the walkers were approximately 15 metres away. The birds then flew to open water to the south-west of the nest site where they remained standing still. G. Little and R. Kyte spent less than ten minutes at the nest site. During this time G. Little climbed the tree and took photos (see **Figure 2**) and video of two chicks lying in the nest. There were no visible signs of droppings, food or feathers on the ground beneath the nest (R. Kyte pers. comm.). At 1035 h, an adult flew back to the nest and landed. When we left at 1110 h, the same adult was still standing on the nest. A second adult flew in and circled over the nest at 1044 h before flying to the west.

I checked the nest site on 30 September for activity from 1030 h to 1045 h and found one adult standing on the nest.

Figure 2. Two Black-necked Stork chicks 12 September 2020 with view of Hexham Swamp in background. The estimated age is four weeks. Photo: G. Little.

Banding day

On 15 October in clear, hot conditions, licenced banders, Dr G. Clancy, G. Little, R. Kyte and photographer, D. Getaz, walked out to the nest site. At 0950 h G. Little climbed the shrub which was in full flower. He lowered the chicks individually in a bag to R. Kyte and G. Clancy for banding. By 1020 h the chicks had been returned to the nest and the group left the site at 1030 h. **Figures 3** and **4** are photos of the chicks taken at the nest that day.

At 1107 h the adults flew over the nest and landed to the east, close to the residential area. They stood c. 100 metres apart and were still in the same place when we left at 1215 h.

Figure 3. Two Black-necked Stork chicks on 15 October 2020 with a view of Hexham Swamp in background. Photo shows underparts and primary and secondary feather development of the chick which is standing. The estimated age is 9 weeks. Photo: G. Little

Figure 4. Two Black-necked Stork chicks lying down in nest in Hexham Swamp on 15 October 2020. Photo shows plumage of upper parts. The estimated age is 9 weeks. Photo: G. Little.

To assess if adults were still attending the nest, L. Date-Huxtable checked it for activity on 17 October, from 1315 h to 1330 h. One adult was present on the nest.

Fledging

In late October after a long dry spell, weather conditions changed, and heavy rainfall filled Hexham Swamp. On 1 November from 0700 h, a team of eight Hunter Bird Observers Club members viewed the nest from various points around Hexham Swamp in an effort to ascertain whether the nest was still active and/or whether the chicks had fledged. At 0845 h two adults flew to and landed on a shrub north of the nest site (**Figure 1**) and spent *c*. five minutes bobbing their heads down into the shrub and flapping their wings, before flying to a different shrub a little further to the north (**Figure 1**) where they repeated the head-bobbing and wing-flapping. One adult then flew and landed east of Pipeline Track. We lost sight of the other bird.

The estimated nestling period

The nestling period is difficult to ascertain as hatching and fledging events were not observed. However, adult behaviour at the nest such as constant looking at the bottom of the nest, frequent flights to and from the nest and eating of cached items of food suggested that young were present from 13 August even though chicks were not visible on 14 August when the male was photographed on the nest. Similarly, adult behaviour on 1 November suggested that chicks had fledged and were hidden in different shrubs in the vicinity of the nest site. Using these dates, the nestling period would have been 80 days which is within the known range of 78 to 100 days (Clancy & Ford 2013).

CONCLUSION

I believe that the behaviour of the adults on 1 November 2020 is evidence that the chicks had left the nest and that each was in one of the two shrubs. I deduce that they would have been *c*. 12 weeks old. Banding these chicks before they fledged has provided an opportunity to study their movements/dispersal as well as plumage changes from an early age. If one chick is female it may also be possible to establish when the iris changes from dark brown to the bright yellow of the adult female stork.

ACKNOWLEDGEMENTS

I thank the banding team Dr G. Clancy, G. Little and R. Kyte (all are certified Class A banders), photographer D. Getaz and observers R. McDonald, M. and R. Stewart, R. Klyve, S. Getaz, L. Parashou, L. Date-Huxtable and C. Huxtable, D. Stehr and J. Thomas. My thanks go to Alan Stuart for his comments on an early draft and for his encouragement. I thank Hunter Local Land Services, NSW National Parks and Wildlife Service (NPWS) and Awabakal Local Aboriginal Land Council for permission to access the site. NPWS issued a licence to fly the drone.

REFERENCES

Clancy, G. P. and Ford, H. A. (2013). The season, frequency, parental care and success of breeding Black-necked Storks *Ephippiorhynchus asiaticus australis* in northern New South Wales. *Corella* **37:** 63-68.

Lindsey, A. (2019). Observations of Black-necked Stork breeding in the Hunter Estuary at Tomago NSW. *The Whistler* **13**: 38-49.

Lindsey, A. (in prep). Birds of Tomago Wetland. Submitted for *The Whistler*.

Stuart, A. (Ed.) (2018). Hunter Region New South Wales Annual Bird Report Number 25 (2017). (Hunter Bird Observers Club Inc.: New Lambton, NSW.)

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 (abstract) 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 may be included in tabular form at the end of the submitted article. Usually these will be published on-line and not appear in the hard copy print.
- 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. 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

Formatting of an article for publication is the responsibility of the Whistler production team and is done after the submitted manuscript has been finalised and accepted. Authors are requested to note the following requirements when submitting a manuscript:

1. A4 size pages using portrait layout except for large tables or figures. Margins 2cm all sides.
2. Title of article at top of first page
3. Names and the affiliations or addresses of all authors are to be listed next, with at least one email address included. Each author's preferred first name is to be indicated.
4. The author for correspondence is to be clearly indicated.
5. Typescript for manuscripts is Times New Roman 11 pt.
6. Figures and Tables are to be included at the end of the document, in Times New Roman 11 pt. Each Figure and Table is to have a title that clearly describes the content.
7. Nomenclature and classification of bird species shall follow the current version of BirdLife Australia's "Working List of Australian Birds" (download from: http://birdlife.org.au/conservation/science/taxonomy). The scientific names of all bird species shall be shown in italics after the first mention of their English name in both the text and summary (abstract) and not thereafter.
8. References should 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 same order as the original paper.
9. References shall be listed in alphabetical order and secondarily by year of publication; if published in the same year then in alphabetical order with a, b, or c etc after the year to indicate which paper is being cited in the text (see example below). Each reference shall 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.)

Books:

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.)

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

Please submit all manuscripts to:

Joint Editors, whistler@hboc.org.au

CONTENTS