The Whistler

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2012

Tomago Wetlands
Walka Waterworks
Rufous Scrub-bird
Pied Oystercatcher
Pacific Black Duck
White-throated Nightjar
Variegated Fairy-wren
Regent Honeyeater
White-faced Heron
Pink-eared Duck
Pelican colony
Jacky Winter
Olive groves
Cattle Egret

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

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The *Whistler* is produced by:

Mike Newman (Joint Editor)
Harold Tarrant (Joint Editor)
Liz Crawford (Production Manager)
Chris Herbert (Cover Designer)

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Authors wishing to submit manuscripts for consideration for publication should consult **Instructions for Authors** on page 63 and submit to the **Editors**: Mike Newman omgnewman@bigpond.com and/or Harold Tarrant Harold.Tarrant@newcastle.edu.au

Authors wishing to contribute articles of general bird and birdwatching news to the club newsletter, which has six issues per year, should submit to the **Newsletter Editor:** Liz Crawford chrisliz@internode.on.net

PO Box 24
New Lambton NSW 2305
Website: www.hboc.org.au

Front cover: Pink-eared Duck *Malacorhynchus membranaceus* - Photo: Rod Warnock
Back cover: Pacific Black Duck *Anas superciliosa* - Photo: James Smart

The *Whistler* – Editorial

This volume of *The Whistler* features three major papers. The first two document long-term studies of important wetlands. Both these studies provide valuable information to land managers which will help shape the actions needed to sustain these areas as prime waterbird habitat. They also provide baseline data against which the success of those actions can be judged. The Tomago Wetlands is a work in progress involving the restoration of saltmarsh habitat, a declining natural resource which is particularly important to migratory shorebirds. The success of this project is critical to the future of shorebird populations in our region given the loss of other areas of suitable habitat in the Hunter Estuary to industrial development. The other study involves the Walka Water Works in the rapidly expanding city of Maitland. Here the goal is to effect a compromise which affords recreational opportunities, including bird-watching, to the local community while preserving the bird species diversity of its unique deep freshwater lake. The paper suggests that the Great Crested Grebe *Podiceps cristatus* is a suitable indicator species. Manage its numbers and breeding success and the wetland should be suitable for other waterbird species, particularly deep water specialists which have few other options in the Hunter Region.

Hunter Bird Observers Club members are involved in monitoring the status of the Rufous Scrub-bird *Atrichornis rufescens* in the Gloucester Tops. The final major paper deals with the calling patterns of territorial scrub-birds, a topic central to the monitoring program. While the paper provides valuable insights it also poses unanswered questions; but that is the essence of research.

Short papers and notes provide intriguing insights into bird behaviour. One of these papers explains how Australian Pied Oystercatchers *Haematopus longirostris* successfully adapted their breeding tactics in the Worimi Conservation Lands at Stockton Beach to overcome the multiple hurdles of king tides and excessive recreational vehicle activity which usually causes failure. The other paper delves into the interactions between a pair of Pacific Black Ducks *Anas superciliosa* in a suburban garden. Guess who rules the roost! In addition there is exciting news on the Regent Honeyeater *Anthochaera carunculata*; based on 2012 numbers the dry open forest of the lower Hunter Valley is extremely important to this critically endangered species. Another type of vegetation, olive groves, is shown to be surprisingly good habitat for birds, especially for the Speckled Warbler *Chthonicola sagittata*. Other notes concern Australian Pelicans *Pelecanus conspicillatus*, Cattle Egret *Ardea ibis*, Variegated Fairy-wrens *Malurus lamberti*, White-throated Nightjars *Eurostopodus mystacalis*, Jacky Winter *Microeca fascinans* and White-faced Heron *Egretta novaehollandiae*.

For the first time *The Whistler* contains a regional overview of a single species, the Pink-eared Duck *Malacorhynchus membranaceus*, summarising all the available information in the Hunter Region on this fascinating species. The wealth of information available is a tribute to all Hunter Bird Observers Club members who contribute observations to the club's records, to the Hunter Region Annual Bird Report and to the BirdLife ongoing Atlas. We hope that similar single species accounts will be a feature of future volumes of *The Whistler*.

It is particularly rewarding to welcome a number of new authors to *The Whistler*; for many of them it is the first time they have been involved in a demanding adventure of this type. It has been a privilege to work with the authors of the oystercatcher paper who are of aboriginal descent. Developing their paper resulted in a parallel understanding of the importance of the Worimi Lands to their cultural heritage and an intriguing link in which the conservation of their middens contributes to an opportunity for the oystercatchers to breed successfully.

As *The Whistler* **6** goes to press we are in the embarrassing position for the first time of having excess copy, amounting to almost half the next volume. What a fantastic embarrassment. Another unique feature of 2012 has been that following Harold's move to the UK in 2011 your Editors have worked shifts facilitated by overnight email exchanges. How the world has changed.

Mike Newman and Harold Tarrant
Joint Editors

Birds of Tomago Wetlands, Hunter Wetlands National Park 2007 – 2012

Ann Lindsey and Neville McNaughton

37 Long Crescent, Shortland NSW 2307, Australia
ann.lindsey@bigpond.com
58 Wilkinson Avenue, Birmingham Gardens NSW 2287, Australia
fisho5@bigpond.com.au

As a result of a project to reinstate tidal inundation to the Tomago Wetlands in the Hunter Wetlands National Park, the Hunter Bird Observers Club commenced monthly surveys before and after tidal gates were opened to provide baseline data for waterbirds, in particular shorebirds, and to monitor changes in diversity and numbers. Tidal inundation had been cut off in 1976 which resulted in drying of the largely Coastal Saltmarsh habitat. The effectiveness of the project has been difficult to ascertain as, after initial opening of tidal gates, tidal inundation was interrupted on a number of occasions and consistent heavy rain fell during the study period. The gradual increase in diversity and numbers of waterbirds resulted from the constant presence of water whether saline or fresh. Small numbers of three shorebird species visited the two sites chosen for intensive surveying. The restoration of habitat requires a maturation period and ongoing monitoring will be required before its effectiveness can be quantified.

INTRODUCTION

For the purposes of this article, the story of the Tomago Wetlands begins in the 1970s when, according to Clarke & van Gessel (1983: 117-144), migratory shorebirds used the Tomago Wetlands for diurnal and nocturnal roosting and as a secondary feeding area, but abandoned it sometime after 1976 when saline water was prevented from entering the Wetlands by the installation of tidal gates at the mouth of the North/South Drain (**Figure 1**). The tidal gates were part of a flood mitigation scheme which saw a ring drain, levee and floodgates built around Fullerton Cove. This action excluded tides and minor Hunter River floods and resulted in converting wetlands to grazing land and drying out the saltmarsh. (Brereton *et al.* 2010: 98). In 1983 a recommendation was made to restore saltmarsh behind Fullerton Cove at Tomago by permitting full tidal flushing which would potentially reverse this loss of important shorebird habitat (Moss 1983: 55). In 1985, 716.6ha of land at Tomago was donated by BHP to be added to Kooragang Nature Reserve (KNR) gazetted in 1983 and listed as a Ramsar site in 1984. In 2011, KNR (which includes parts of the bed of the Hunter River and Fullerton Cove), Hexham Swamp Nature Reserve and Ash Island were combined to form the Hunter Wetlands National Park (HWNP). In 1993, the Kooragang Wetland Rehabilitation Project (KWRP), a collaborative project of the Hunter-Central Rivers Catchment Management Authority with several organizations, including NSW Fisheries and NSW National Parks and Wildlife Service (NPWS), was formed and the Tomago site was incorporated into the KWRP. From 1984 until 1993 the Tomago Wetlands received little attention. Implementation of the recommendation to open the tidal gates to restore saltmarsh did not occur until 2008 following a long and arduous approval process. In October of that year a SmartGate system (SG system) to automatically control the amount of water within a flood mitigation network based on real-time environmental parameters was commissioned by the University of New South Wales Water Research Laboratory (WRL) and the plan to restore migratory shorebird and fish habitat finally made progress. The SG system allowed tidal flushing of approximately 100 ha of the Wetlands (WRL website accessed May 2012). However, due to a breach in a levee protecting private land, the SG system was closed in February 2009 and not reopened until June 2010. Since then the SG system has been periodically closed by the managers, NPWS, due to various, unavoidable circumstances.

In response to the plan to reinstate tidal flushing to part of the Tomago Wetlands, the Hunter Bird Observers Club Inc. (HBOC) decided in 2007 to undertake ongoing monthly surveys to document

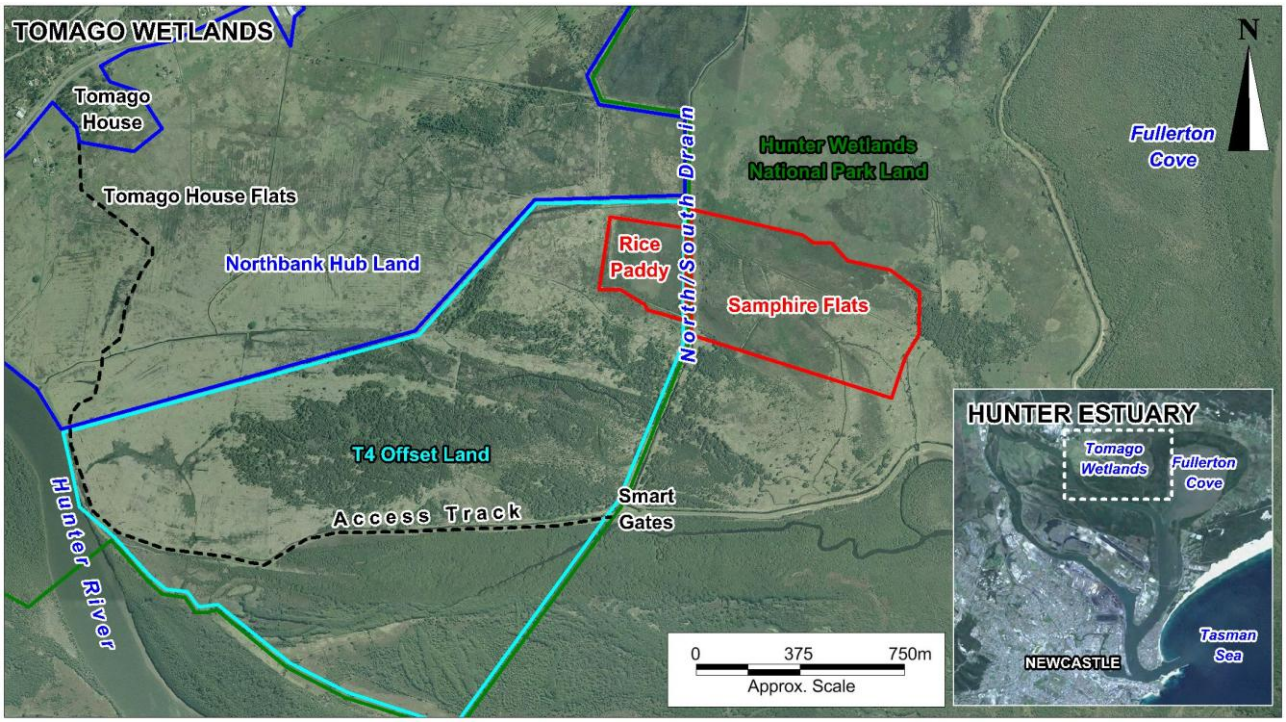

Figure 1. Tomago Wetlands location and sites

Figure 2. Samphire Flats in dry conditions - photo Neville McNaughton

Figure 3. Samphire Flats in flooded conditions - photo Neville McNaughton

changes in avian diversity and abundance, particularly in relation to shorebirds and other waterbirds resulting from the installation of the SG system. It was thought that one measure of success would be to demonstrate the return of waterbirds, and in particular shorebirds, to the Wetlands. The initial HBOC surveys before the SG system was implemented provided baseline data showing that very few waterbirds and no shorebirds, other than the Masked Lapwing *Vanellus miles* were using the Wetlands. It is hoped that the results of these surveys will contribute to overall knowledge about the processes of wetland restoration and aid in ongoing management.

THE SITES

Tomago Wetlands 32° 50' 08" S 151° 42' 32" E (**Figure 1**) lie to the west of Fullerton Cove on the North Arm of the Hunter River approximately 9 km north of Newcastle, NSW. They are encompassed by the North/South Drain on the western side, Fullerton Cove on the eastern side, the Hunter River on the southern side and private land and Tomago Road on the northern side.

A preliminary evaluation in early March 2007 resulted in two sites, Rice Paddy and Samphire Flats, being chosen for concentrated survey effort because of their potential importance as wetland habitat for shorebirds. Although Rice Paddy lies outside HWNP, HBOC chose to monitor this site as a result of discussions with NPWS in 2006 which indicated that Rice Paddy would be added to the national park estate and managed for the restoration of shorebird habitat as a replacement of the mudflats lost at Big Pond on Cormorant Road, Kooragang Island. However, the Rice Paddy was recently purchased by Port Waratah Coal Services as part of an offset for the proposed Terminal 4 coal loader and remains outside HWNP. It must be noted that the two sites constitute a relatively small area of the Tomago Wetlands. Two additional sites, adjacent to Rice Paddy and Samphire Flats, named Smart Gates and Tomago House Flats, were also selected for less rigorous monitoring. All sites contain a degree of residual salinity in the soil as they were historically parts of an estuarine and fully tidal system prior to the construction of levees and tidal gates. A detailed description of these four sites follows.

Tomago House Flats site lies outside HWNP. It is an area of degraded floodplain in private ownership and recently rezoned from agricultural to industrial use. Access to the HWNP is gained through the Tomago House Flats site which is not open to the public.

The Smart Gates site includes the access road and a tidal creek which flows into the Hunter River and the mouth of the North/South Drain where the SG system is installed. Mature mangroves line the creek and a stand of Swamp Oak *Casuarina glauca* borders the northern side. Introduced weeds and grass are abundant along the track.

The Rice Paddy, which is on the western side of the North/South Drain, is about 8.4ha and surrounded by a low levee. Approximately 50% is covered in the Common Reed *Phragmites australis* on its eastern side. The western side is more open and the vegetation is a mixture of shorter sedges, grasses and some remnant Samphire *Sarcocornia quinqueflora*. This site is often dry, but becomes wet after heavy rainfall and, at very high tides, when a culvert allows saline water from the North/South drain to enter the area.

Samphire Flats is bordered on the western side by the North/South Drain. At the eastern and southern edges are stands of Swamp Oak and on the northern side there is a band of Common Reed. The site is approximately 35ha. It is open and flat with remnant saltmarsh vegetation, Samphire and Salt Couch *Sporobolus virginicus*, as well as assorted weeds including small patches of the exotic Spiny Rush *Juncus acutus*. Before the SG system was opened, the site was largely dry becoming wet only through rainfall. Since tidal flushing was reinstated the saltmarsh has rejuvenated and seems to be healthy. The band of Common Reed remains unaffected.

SURVEYS

From March 2007 to March 2012, 59 counts were made at monthly intervals with the exception of June and August 2007 when inclement weather prevented access. The surveys took place on the third Tuesday of the month commencing at 7.30 am at Tomago House Flats. Two to four regular and experienced observers were always present, but as many as ten people have taken part in some surveys. Care was taken to not double count the species through discussion during and after the survey. Sightings of species seen outside the regular survey dates have been included only where they contribute to the overall understanding of the avian population.

The survey of Tomago House Flats had two parts and lasted about 45 minutes; firstly the area around Tomago House was surveyed on foot and secondly both sides of the track leading to Smart Gates were surveyed from vehicles. On reaching the Smart Gates site observers surveyed for approximately 30 to 45 minutes. Observers then drove to the Rice Paddy where they both walked around the levee and through the middle of the site in an attempt to flush birds from the vegetation. This took between 60 and 90 minutes. Samphire Flats was monitored on foot with observers spreading out to cover as much ground as possible. The actual coverage depended on the number of people present and typically took 90 to 120 minutes. Species were located by both call and visual observation.

RESULTS

The baseline period was from March 2007 to October 2008; during this time the wetlands were generally dry due to both low rainfall and lack of tidal flushing. In December 2009 the inland drought broke and there was increased heavy rainfall on the east coast of Australia. From October 2008 to June 2010 the SG system was closed. However, during that period rainfall increased so that water levels in the wetlands were lower due to the tidal gates being closed but remained wet due to the increased rainfall. In summary, Samphire Flats and the Rice Paddy were mainly dry until October 2008. Since that time they have been progressively flooded primarily with fresh water intermittently mixed with some saline water. The water level on Samphire Flats has remained largely constant at approximately 0.5m, apart from some drying out during the time the SG system was closed, whereas the Rice Paddy has remained wet but not always flooded.

Figures 2 and **3** show Samphire Flats under dry and flooded conditions.

The constant presence of water, whether from rainfall or tidal flow, resulted in increased numbers and diversity of bird species at Tomago Wetlands as discussed below. The benefit of the SG system will be to allow the Wetlands to be independent of rainfall and provide greater consistency by letting tidal water into the Wetlands even during periods of inconsistent rainfall and when drought conditions return. The surveys after the SG system resumed in June 2010 may not represent the anticipated long-term condition of the Samphire Flat habitat because inundation primarily involved fresh as opposed to estuarine water as a consequence of the exceptionally high rainfall during this period. These factors influencing the ongoing changes in habitat are important to understanding the changes in the bird populations which occurred during the surveys.

The Appendix contains a list of the 131 species seen during the surveys and an indication of the areas where they occurred. A summary of records follows with emphasis on the two wetland sites, Rice Paddy and Samphire Flats. For each species the reporting rate is shown in parentheses as a percentage immediately following the species name (i.e. a species seen on five of the 59 surveys has a reporting rate of 8.5%). The reporting rates apply only to the species observed on Rice Paddy and Samphire Flats.

Waterbirds

Three locally common, breeding species of waterfowl, Black Swan *Cygnus atratus*, Chestnut Teal *Anas castanea* and Pacific Black Duck *Anas superciliosa* were present in small numbers, mostly on Samphire Flats. The maximum count of six Black Swans (23.7%) occurred in May and June 2011 with two birds building a nest in May. Cygnets were seen near the nest in August. The numbers of both Chestnut Teal (8.5%) and Pacific Black Duck (16.9%) built up to 35 in March 2012. In January 2012 a pair of Pacific Black Duck was seen with six ducklings.

The fish-eating species arrived in small numbers from November 2010: Little Pied Cormorant *Microcarbo melanoleucos* (8.5%), Little Black Cormorant *Phalacrocorax sulcirostris* (11.9%), Australasian Darter *Anhinga novaehollandiae* (6.8%) in February 2011, and in February 2012 Australian Pelican *Pelecanus conspicillatus* (3.4%).

Three species of bitterns were seen, Australasian Bittern *Botaurus poiciloptilus*, Australian Little Bittern *Ixobrychus dubius* and Black Bittern *Ixobrychus flavicollis*. The Australasian Bittern (22%) was seen over seven months from April to October 2009 on the Rice Paddy with a maximum of four birds in August and September. Birds were flushed from the stand of Common Reed and, although breeding was not definitely established, its continued presence over this period in the same general area may be indicative of a breeding event. This species was also seen by the authors on a number of occasions outside the survey dates and external to the four survey sites. The Australian Little Bittern was heard on Samphire Flats in

December 2010 outside the survey period and in March 2011 one was seen at exactly the same spot. There was only one sighting of the rare Black Bittern, seen in mature mangroves near the Smart Gates site in April 2011.

Of the four species of egrets observed, only the Eastern Great Egret *Ardea modesta* (39%) was consistently present with a maximum of 10 birds in November 2011. The other three species were seen only once; two Intermediate Egrets *Ardea intermedia* and one Little Egret *Egretta garzetta* in January 2012 and six Cattle Egrets *Ardea ibis* in December 2011.

Both local species of heron were observed with maximum counts of 48 White-faced Herons *Egretta novaehollandiae* (57.6%) in July 2011 and 26 White-necked Herons *Ardea pacifica* (11.9%) in November 2008.

Two species of ibis and one spoonbill occurred during the survey period. Australian White Ibis *Threskiornis molucca* (25.4%), a breeding resident in the Hunter Region (Stuart 2011), increased to a maximum of 130 in November 2011. Small numbers of the inland-breeding Straw-necked Ibis *Threskiornis spinicollis* (10.2%) occurred intermittently with a maximum of 74 in September 2009. After heavy rain broke the drought conditions inland none was seen again until five birds reappeared in November 2011. The Royal Spoonbill *Platalea flavipes* (16.9%) was also an intermittent visitor, with numbers increasing gradually from October 2011 to a maximum of 54 in March 2012.

The first Purple Swamphen *Porphyrio porphyrio* (30.5%) appeared in January 2010 on Samphire Flats with a maximum of 39 in June 2011.

Shorebirds

Two migratory species, Latham's Snipe *Gallinago hardwickii* (11.9%) and Sharp-tailed Sandpiper *Calidris acuminata* (5.1%) were seen in small numbers. Latham's Snipe, maximum of two birds, occurred on both the Rice Paddy and Samphire Flats. Three were seen on a non-survey visit.

Sharp-tailed Sandpiper was seen only on Samphire Flats with a maximum of 26 in December 2009, one juvenile bird in October 2010 and one adult in September 2011. However, outside the survey dates 7, 4, 23 and 35 birds were seen in October 2007, December 2009, January 2010 and October 2011 respectively (A. Lindsey, P. Svoboda and N. McNaughton pers.comm.).

Three species of resident shorebird occurred, but only on Samphire Flats, These included 27 Black-winged Stilts *Himantopus himantopus* (3.4%), the majority of which were in juvenile plumage, in May 2011, and a single record of three Banded Lapwings *Vanellus tricolor,* an uncommon species in the Hunter Region, in October 2007. The Masked Lapwing was more commonly recorded (35.6%) with a maximum of 44 in February 2011.

Other Species

The Stubble Quail *Coturnix pectoralis* (6.8%) and Brown Quail *Coturnix ypsilophora* (10.2%) were seen in small numbers. A sighting of King Quail *Excalfactoria chinensis* was made outside the regular surveys when two birds, male and female, were flushed on Samphire Flats in February 2010 (Stuart 2011). This species is rare in the Hunter Region and previous records in 1994 (Stuart 1995) and in 2000 (Stuart 2001) were from west of the Hunter Estuary.

Eight species of raptor were recorded, the most common being Swamp Harrier *Circus approximans* (71.2%) and Nankeen Kestrel *Falco cenchroides* (42.4%). The increasingly rare Little Eagle *Hieraaetus morphnoides* was seen only once in April 2011. In November 2006 the authors observed a single Spotted Harrier *Circus assimilis* before systematic surveys commenced.

Several species of passerines were recorded over the five years. The maximum of 12 White-fronted Chats *Epthianura albifrons* (18.6%) occurred in June 2008. The Southern Emu-wren *Stipiturus malachurus* (76.3%) was found mostly on the drier edges where, despite some saline influence, Swamp Oak saplings continue to grow, particularly around the Rice Paddy. Parties of up to 12 birds were recorded. The most common passerine was the Golden-headed Cisticola *Cisticola exilis* (100%) followed by Australasian Pipit *Anthus novaeseelandiae* (95%). In 2007, the Brown Songlark *Cincloramphus cruralis* (16.9%) was present for five successive months with a maximum of 7 in October. In that year there was an influx of this species into the Hunter Region including areas as far east as the Hunter Estuary from which it is normally absent (Stuart 2008).

DISCUSSION

The surveys document a gradual increase in the diversity and abundance of waterbirds over the duration of the study. During the baseline period, when the Rice Paddy and Samphire Flats were mainly dry, between two and five species were present. However, mainly as a result of consistent rainfall from December 2009 until March 2012 water was usually present on these sites, particularly in the case of Samphire Flats. The bird populations responded to this change and the number of species increased to a maximum of 10 in January and February 2012. Numbers of birds also increased, but remained modest compared with other wetlands of comparable size (e.g. Ash Island and Morpeth Waste Water Treatment Works (see tables in Stuart 2011) where numbers are regularly ten times higher than those in this study.

The Australasian Bittern, although a rare resident of the Hunter Region (Stuart 2011), is consistently seen over several areas in the Hunter Estuary. Our surveys established that both the Rice Paddy and Samphire Flats are important habitat for this species and there were indications that the Rice Paddy may be a breeding site. It remains to be seen whether future increased presence of salt water resulting from ongoing SG system operation will impact negatively on this species which prefers a freshwater environment. However, as the Rice Paddy will receive salt water intermittently the Australasian Bittern may not be affected at this site.

According to Clarke & van Gessel (1983: 117-144) the open Samphire meadows on the western shore of Fullerton Cove supported a diverse and numerous population of shorebirds including Sharp-tailed Sandpiper, Pacific Golden Plover *Pluvialis fulva*, Latham's Snipe, Common Greenshank *Tringa nebularia*, Marsh Sandpiper *Tringa stagnatilis* and Wood Sandpiper *Tringa glareola*. During the five years of this study, only two species of migratory shorebirds occurred, both only occasionally and in small numbers. Since the process of habitat restoration is ongoing and given the propensity of many shorebird species to return to the same sites despite long absences, albeit for a variety of reasons (Van de Kam *et al*. 2004: 301), it is likely that more species will return in the future. The Sharp-tailed Sandpiper and the Black-winged Stilt are examples of shorebirds which have already indicated their ability to exploit the area opportunistically.

The regular presence of raptors, three of the eight species recorded occurring regularly, is indicative of the value of the Tomago Wetlands. The mix of species and their abundance showed little variation between the periods of wet and dry conditions during our surveys.

The increase in water levels has resulted in a loss of dry habitat supporting passerine species, but edge habitat will remain and this should be sufficient to prevent a loss of species diversity. Water levels in wetlands fluctuate naturally and wetland-dependent passerines seem capable of adapting to prevailing conditions. The White-fronted Chat may benefit from the spread of saltmarsh which is its preferred habitat (NSW Scientific Committee website accessed June 2012).

Four species listed under the *NSW Threatened Species Conservation Act 1995* occurred during the surveys. Australasian Bittern is listed as Endangered and three species, Black Bittern, Little Eagle and White-fronted Chat are listed as Vulnerable. The Australasian Bittern is also listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as Endangered. All migratory shorebirds including the Latham's Snipe and Sharp-tailed Sandpiper are listed under the EPBC Act.

CONCLUSION

When habitat is modified or an attempt is made to restore it to a former condition there is a maturation period associated with the change (Maron *et al*. 2012). In the case of the Samphire Flats area the restoration process has been compromised by two factors. Firstly, the closure of the SG system between February 2009 and June 2010 following the breach of the levee wall, after a mere four months of salt water inundation and secondly, by the abnormally high rainfall throughout the entire period from December 2009 and after June 2010 when the SG system was again operational. Consequently, further changes in the Samphire Flat habitat are anticipated. The assessment of the effectiveness of the Samphire Flat restoration is further complicated by the fact that abnormally wet conditions in inland Australia attracted many species of waterbirds and shorebirds away from the Hunter Region. Rice Paddy is unlikely to return to optimal shorebird habitat unless it is specifically managed with this objective in mind. It will be possible to assess fully

the effectiveness of the Tomago Wetlands Project in the future only when there has been an uninterrupted period of tidal flow to the Wetlands and there is a return to drier climatic conditions, particularly drought, when bird species are forced from the inland and use the Hunter Estuary as a refuge. Our surveys provide promising indications of future success exemplified by 26 White-necked Herons present in November 2008. This species is described as being moderately often recorded as 1-2 birds throughout the Region (Stuart 2009) although larger than usual numbers were recorded in 2008 due to the dry conditions.

Although the restoration project relates to shorebird and fish habitat, it has benefited many other aquatic species. The continuation of regular bird monitoring will contribute to the future management of Tomago Wetlands and increase knowledge about the outcomes of wetland restoration. In the longer term nocturnal surveys could be undertaken to establish whether migratory shorebirds are returning at night to roost as they have done in the past. In view of the loss of wetland habitat in the Hunter Region over the last two hundred years, the restoration of the Tomago Wetlands is an important and positive initiative for the future of wetland avifauna.

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APPENDIX - Summary of bird species recorded during surveys at Tomago Wetlands

Species	Scientific Name	Survey Days Present	Max. No.	Number of surveys present at sub-sites			
				Rice Paddy	Samphire Flats	Smart Gates	House Flats
Stubble Quail	*Coturnix pectoralis*	6	8	1	4	2	0
Brown Quail	*Coturnix ypsilophora*	7	3	0	6	1	0
King Quail *(1)	*Excalfactoria chinensis*	0	0	0	0	0	0
Black Swan	*Cygnus atratus*	14	9	0	14	0	0
Grey Teal	*Anas gracilis*	2	3	0	0	2	0
Chestnut Teal	*Anas castanea*	38	36	2	3	22	12
Pacific Black Duck	*Anas superciliosa*	42	35	1	14	25	8
Hardhead	*Aythya australis*	1	2	0	0	0	1
Australasian Grebe	*Tachybaptus novaehollandiae*	1	1	0	0	1	0
Rock Dove	*Columba livia*	1	3	0	1	0	0
Crested Pigeon	*Ocyphaps lophotes*	19	3	0	1	3	15
Bar-shouldered	*Geopelia humeralis*	19	2	0	0	11	8
Topknot Pigeon	*Lopholaimus antarcticus*	2	12	0	0	0	2
White-throated Needletail	*Hirundapus caudacutus*	1	2	0	0	0	1
Australasian Darter	*Anhinga novaehollandiae*	19	2	2	2	16	1
Little Pied Cormorant	*Microcarbo melanoleucos*	21	3	1	4	15	4
Great Cormorant	*Phalacrocorax carbo*	4	2	0	0	3	1
Little Black Cormorant	*Phalacrocorax sulcirostris*	22	27	1	7	15	3
Pied Cormorant	*Phalacrocorax varius*	11	5	0	0	8	3
Australian Pelican	*Pelecanus conspicillatus*	5	3	1	1	0	3
Australasian Bittern	*Botaurus poiciloptilus*	14	4	9	3	4	0
Australian Little Bittern (3)	*Ixobrychus dubius*	1	1	0	1	0	0
Black Bittern	*Ixobrychus flavicollis*	1	1	0	0	1	0
White-necked Heron	*Ardea pacifica*	8	26	5	4	1	0
Eastern Great Egret	*Ardea modesta*	32	21	3	22	10	9
Intermediate Egret	*Ardea intermedia*	2	6	0	1	0	1
Cattle Egret	*Ardea ibis*	4	10	0	1	0	3
Striated Heron	*Butorides striata*	2	1	0	0	1	1
White-faced Heron	*Egretta novaehollandiae*	51	48	8	31	14	37
Little Egret	*Egretta garzetta*	1	1	0	1	0	0
Australian White Ibis	*Threskiornis molucca*	32	130	7	12	11	12
Straw-necked Ibis	*Threskiornis spinicollis*	9	74	4	3	3	2
Royal Spoonbill	*Platalea regia*	17	54	5	9	2	6
Eastern Osprey	*Pandion cristatus*	1	1	0	0	0	1
Black-shouldered Kite	*Elanus axillaris*	26	3	5	7	4	13
White-bellied Sea-Eagle	*Haliaeetus leucogaster*	38	2	2	11	13	19
Whistling Kite	*Haliastur sphenurus*	22	4	4	11	8	3
Brahminy Kite	*Haliastur indus*	1	1	0	0	0	1
Brown Goshawk	*Accipter fasciatus*	1	1	0	0	1	0
Spotted Harrier *(4)	*Circus assimilis*	0	0	0	0	0	0
Swamp Harrier	*Circus approximans*	57	5	25	32	22	30
Wedge-tailed Eagle	*Aquila audax*	1	1	0	0	1	0
Little Eagle	*Hieraaetus morphnoides*	1	1	1	0	0	0
Nankeen Kestrel	*Falco cenchroides*	32	2	3	24	5	7
Brown Falcon	*Falco berigora*	5	2	0	3	3	2

Note: * No records for survey dates.
Footnotes (1) to (8) refer to sightings of these birds during visits additional to the surveys.
(1) Two seen at Smart Gates on 13/02/2010.
(2) Single birds at Samphire Flats, Rice Paddy and Smart Gates on five, one and one non-survey occasions respectively.
(3) One seen at Samphire Flats on 29/12/2010.
(4) One seen at Samphire Flats on 18/11/2006.

Summary of bird species recorded during surveys at Tomago Wetlands cont.

Species	Scientific Name	Survey Days Present	Max. No.	Number of surveys present at sub-sites			
				Rice Paddy	Samphire Flats	Smart Gates	House Flats
Australian Hobby	*Falco longipennis*	15	2	4	5	0	7
Peregrine Falcon	*Falco peregrinus*	1	1	0	0	1	0
Purple Swamphen	*Porphyrio porphyrio*	18	39	0	18	0	0
Black-winged Stilt	*Himantopus himantopus*	2	27	0	2	0	0
Banded Lapwing	*Vanellus tricolor*	1	3	0	1	0	0
Masked Lapwing	*Vanellus miles*	35	44	2	20	1	23
Latham's Snipe (5)	*Gallinago hardwickii*	7	2	2	5	1	0
Sharp-tailed Sandpiper (6)	*Calidris acuminata*	3	26	0	3	0	0
Caspian Tern	*Hydroprogne caspia*	3	3	0	0	0	3
Crested Tern	*Thalasseus bergii*	1	1	0	0	0	1
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	3	25	0	1	0	2
Galah	*Eolophus roseicapillus*	23	12	2	0	11	13
Rainbow Lorikeet	*Trichoglossus haematodus*	8	18	0	0	3	6
Scaly-breasted Lorikeet	*Trichoglossus chlorolepidotus*	1	6	0	0	1	0
Eastern Rosella	*Platycercus eximius*	51	14	1	4	22	40
Red-rumped Parrot	*Psephotus haematonotus*	2	2	0	0	1	1
Pheasant Coucal	*Centropus phasianinus*	14	1	2	0	7	10
Eastern Koel	*Eudynamys orientalis*	7	2	0	0	0	7
Channel-billed Cuckoo	*Scythrops novaehollandiae*	13	3	0	0	1	12
Horsfield's Bronze-Cuckoo	*Chalcites basalis*	4	1	1	0	2	1
Shining Bronze-Cuckoo	*Chalcites lucidus*	12	4	0	0	11	1
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	25	3	0	0	22	5
Brush Cuckoo	*Cacomantis variolosus*	3	1	0	0	3	0
Southern Boobook *(7)	*Ninox novaeseelandiae*	0	0	0	0	0	0
Eastern Grass Owl *(8)	*Tyto longimembris*	0	0	0	0	0	0
Azure Kingfisher	*Ceyx azureus*	22	2	0	0	21	2
Laughing Kookaburra	*Dacelo novaeguineae*	14	6	0	1	4	10
Sacred Kingfisher	*Todiramphus sanctus*	23	2	0	1	15	10
Dollarbird	*Eurystomus orientalis*	6	2	0	0	1	5
White-throated Treecreeper	*Cormobates leucophaea*	10	1	0	0	10	0
Superb Fairy-wren	*Malurus cyaneus*	51	21	32	21	40	26
Variegated Fairy-wren	*Malurus lamberti*	4	4	1	1	2	0
Southern Emu-wren	*Stipiturus malachurus*	44	18	38	24	24	9
Brown Gerygone	*Gerygone mouki*	2	5	0	0	0	2
Mangrove Gerygone	*Gerygone levigaster*	6	2	0	0	5	1
Yellow Thornbill	*Acanthiza nana*	19	6	0	3	17	0
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	2	6	0	0	2	0
Brown Thornbill	*Acanthiza pusilla*	9	5	1	3	6	0
Eastern Spinebill	*Acanthorhynchus tenuirostris*	3	1	0	0	3	0
Lewin's Honeyeater	*Meliphaga lewinii*	2	2	0	0	1	1
Yellow-faced Honeyeater	*Lichenostomus chrysops*	12	31	0	2	9	2
White-plumed Honeyeater	*Lichenostomus penicillatus*	2	1	0	0	0	2
Noisy Miner	*Manorina melanocephala*	18	5	0	0	1	17
Red Wattlebird	*Anthochaera carunculata*	4	2	0	0	0	4

Note: * Not seen on survey days.
Footnotes (1) to (8) refer to sightings of these birds during visits additional to the surveys.
(5) Two and three seen at Samphire Flats on 28/12/2009 and 1/10/2011 respectively.
(6) Seven, four, 23 and 35 seen at Samphire Flats on 19/10/2007, 28/12/2009, 2/1/2010 and 1/10/2011 respectively.
(7) One and two recorded at House Flats and Smart Gates on 8/1/2011 and 5/9/2011 respectively.
(8) One seen at Samphire Flats on 14/11/2011.

Summary of bird species recorded during surveys at Tomago Wetlands cont.

Species	Scientific Name	Survey Days Present	Max. No.	Number of surveys present at sub-sites			
				Rice Paddy	Samphire Flats	Smart Gates	House Flats
White-fronted Chat	*Epthianura albifrons*	12	12	0	11	1	0
Scarlet Honeyeater	*Myzomela sanguinolenta*	2	2	0	0	2	0
Brown Honeyeater	*Lichmera indistincta*	30	5	0	0	29	1
Noisy Friarbird	*Philemon corniculatus*	9	100	0	0	9	0
Striped Honeyeater	*Plectorhyncha lanceolata*	40	3	0	10	36	3
Eastern Whipbird	*Psophodes olivaceus*	3	1	0	0	1	2
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	35	6	5	9	20	10
White-winged Triller	*Lalage sueurii*	1	1	0	0	0	1
Golden Whistler	*Pachycephala pectoralis*	24	2	0	0	21	3
Rufous Whistler	*Pachycephala rufiventris*	18	2	0	2	12	4
Grey Shrike-thrush	*Colluricincla harmonica*	30	6	0	7	26	3
Australasian Figbird	*Sphecotheres vieilloti*	5	3	0	0	0	5
Olive-backed Oriole	*Oriolus sagittatus*	18	5	0	7	11	2
White-breasted Woodswallow	*Artamus leucorynchus*	6	5	1	0	2	3
Grey Butcherbird	*Cracticus torquatus*	39	5	0	6	31	10
Pied Butcherbird	*Cracticus nigrogularis*	33	5	1	10	8	23
Australian Magpie	*Cracticus tibicen*	48	30	13	30	17	41
Pied Currawong	*Strepera graculina*	10	8	0	0	2	9
Spangled Drongo	*Dicrurus bracteatus*	5	2	0	0	6	1
Rufous Fantail	*Rhipidura rufifrons*	1	1	0	0	1	0
Grey Fantail	*Rhipidura albiscapa*	37	6	2	4	37	7
Willie Wagtail	*Rhipidura leucophrys*	16	4	4	6	5	5
Australian Raven	*Corvus coronoides*	43	9	7	9	21	22
Torresian Crow	*Corvus orru*	5	2	0	2	2	1
Leaden Flycatcher	*Myiagra rubecula*	2	2	0	0	1	1
Magpie-lark	*Grallina cyanoleuca*	25	10	4	14	6	8
Eastern Yellow Robin	*Eopsaltria australis*	13	3	0	0	12	2
Golden-headed Cisticola	*Cisticola exilis*	59	36	57	51	26	13
Australian Reed-Warbler	*Acrocephalus australis*	24	4	9	3	11	2
Tawny Grassbird	*Megalurus timoriensis*	55	7	30	20	26	15
Little Grassbird	*Megalurus gramineus*	47	12	37	14	18	14
Brown Songlark	*Cincloramphus cruralis*	10	7	1	9	0	0
Silvereye	*Zosterops lateralis*	37	33	1	1	31	9
Welcome Swallow	*Hirundo neoxena*	24	50	2	13	10	1
Fairy Martin	*Petrochelidon ariel*	10	40	2	6	5	0
Tree Martin	*Petrochelidon nigricans*	5	100	1	1	3	0
Common Starling	*Sturnus vulgaris*	2	2	0	0	0	2
Common Myna	*Sturnus tristis*	7	2	0	0	0	7
Mistletoebird	*Dicaeum hirundinaceum*	25	3	0	0	25	0
Red-browed Finch	*Neochmia temporalis*	23	25	0	0	16	6
Chestnut-breasted Mannikin	*Lonchura castaneothorax*	10	12	0	0	1	9
Australasian Pipit	*Anthus novaeseelandiae*	56	14	18	56	4	24
European Goldfinch	*Carduelis carduelis*	1	2	0	0	1	0

A census of waterbird populations (2003 - 2012) at Walka Recreation and Wildlife Reserve near Maitland, NSW

Paul Baird[1], James Smart[2] and Lorna Mee[3]

[1] 503 Butterwick Road, Duns Creek, NSW 2321, Australia pbaird@mail-safe.org
[2] 41 Burg Street, East Maitland, NSW 2323, Australia jimsmart@iinet.net.au
[3] 15 Fairchild Street, Raymond Terrace, NSW 2324, Australia lornamee33@gmail.com

The lake at Walka Recreation and Wildlife Reserve (locally known as Walka Water Works) near Maitland NSW is subject to increasing social pressure as a consequence of the rapid urban expansion of Maitland. The lake is of high environmental significance in the Lower Hunter Region as it supports a diversity of waterbirds and it is also one of three regional wetlands with habitat requirements to support a resident population of the deep-water specialist, Great Crested Grebe *Podiceps cristatus*. The 18-hectare wetland is characterised by permanent, open, deep freshwater with fringing vegetation.

Straightforward methodology is used in this long-term study to acquire site-specific base-line data of diversity, frequency of occurrence, relative abundance and possible population change of waterbirds supported by the Walka Lake. The base data, presented in the comprehensive appendices, may be analysed and interpreted to inform future studies and also assist the development of land management strategies necessary to maintain the environmental health of this ecosystem. To assist future monitoring potential indicator species are identified and discussed. The role of the Walka Lake as a refuge for waterbirds during extended dry seasons elsewhere and as a potential site to promote the conservation of the near-threatened Blue-billed Duck *Oxyura australis* is also considered.

INTRODUCTION

Site Location: The site is located at 55 Scobies Lane, Oakhampton Heights, Maitland, NSW (32°42'52" S, 151°32'57" E).

Land use: The Walka Water Works site has served the people of the Maitland and Lower Hunter Region throughout its recorded history. The discovery of artefacts and other evidence indicate that the site was used by indigenous people of the area before European settlement (Brayshaw 1986) and later the first European settlers used it for agriculture. The socially significant Walka Water Works scheme, designed by William Clarke, was constructed during 1882 to 1886 to provide a permanent supply of filtered, potable water for Newcastle, Maitland and the developing settlements in the lower Hunter (Turner 1986). The scheme was fully operational from 1887 to 1929 and was subsequently operated for emergency use until its closure in 1945. To meet post WW II demands for electricity a prefabricated powerhouse was operated from 1951 to 1978 (Turner 1986). Since 1978 the site has continued to serve the people of the region as a recreational and wildlife reserve.

Habitat Significance: The original natural swamp, bounded on the northern and western edges by a ridge line rising 30 metres above the level of the Hunter River, was changed irrevocably in 1882 by the construction of a 335 metre long embankment which formed the dam wall for the water storage impoundment for the Walka Water Works and which separates the impoundment from the ephemeral wetlands of the Hunter River flood plain. It should be noted that the existing sandstone-faced wall, the buildings and their related infrastructure are of outstanding cultural significance in the regional context and are heritage listed at both State and Federal levels.

The Lower Hunter Region has several water bodies associated with the Hunter River flood plain but amongst these Walka is exceptional due to its elevated position above the floodplain. Walka has an irregular shape and an open water surface area of 18 hectares, which is larger than most wetlands in the lower Hunter flood plain (Pressey 1981). The extensive, crenulated shoreline is a significant feature of the water body (**Figure 1**). The verge supports sub-emergent and emergent vegetation and has a healthy, but discontinuous, band of the conspicuous macrophyte *Typha orientalis* along a large proportion of its length. The *Typha* sp. band

is notable as it forms the essential habitat required for productive foraging, provision of shelter and the conditions necessary for the breeding success of waterbirds.

Figure 1. Walka Lake showing irregular shape and extensive verge compared to surface area.

The bottom profile of the lake is important as it dictates the depth of the water, which is rarely less than one metre close to the edges and reaches a maximum depth of 7.5 metres near the centre of the water body. Pressey (1981), in a survey of wetlands, estimated that deep open freshwater makes up only two percent of wetland area in the Lower Hunter. Deep water is necessary for waterbirds that primarily forage by diving; consequently water depth is a determining factor contributing to both the species composition at Walka and to the regional significance of this wetland. When the Walka Water Works complex was operational water was pumped from the Hunter River into the lake but since its closure in 1945 rainfall and surface drainage only supply water to the system. As the size of the catchment area is only four times the area of the lake there is restricted inflow of water to the lake. Additionally there is minimal outflow of water via the by-wash in the dam wall. This limited potential for flushing has resulted in significant nutrient loads and low levels of dissolved oxygen. Water levels fluctuate approximately 1 metre vertically in response to variable rainfall, the inflow of surface drainage water from the northern and western ridges, the evaporation rate and natural seepage.

The irregular fluctuations of the water level assist nutrient cycling and produce exposed sections of organically rich mud and benthic invertebrate populations which in turn provide foraging habitat for a number of species e.g. the Black-fronted Dotterel *Elseyornis melanops* and the migratory shorebird, Latham's Snipe *Gallinago hardwickii*. There are several ephemeral water bodies on the floodplain, separated from the lake by the dam wall, which provide similar foraging habitat.

Walka is a highly significant wetland as it is the only large body of open, permanent, deep freshwater with substantial fringing vegetation located in the Maitland Local Government area. Additionally, Walka is one of only three water bodies suitable for resident populations of the deep-water specialists, Great Crested Grebe *Podiceps cristatus)*, Hoary-headed Grebe *Poliocephalus poliocephalus* and Musk Duck *Biziura lobata* in the Lower Hunter Region. The others are Grahamstown Dam, and the imminently, industrially threatened Deep Pond on Kooragang Island (A. Stuart pers. comm.).

Rationale/Purpose: A major threat to both water birds and woodland birds is habitat loss. At Walka this threat is associated with the location of the site within the rapidly expanding urban matrix of Maitland. There is limited separation of the wetland from this urban development, afforded to the east of the site by the designated floodplain of the Hunter River. Social pressures will potentially escalate as the estimated resident population of Maitland City has increased, during the period of this study, from 56,492 residents to 70,296 (Australian Bureau of Statistics 2011). Population projections, from the same source, estimate 80,000 residents by 2020 and 110,000 by 2036. There is, therefore, a need for sensitive management of the Walka resource to ensure its long-term ecological integrity. Hence, there is a need for reliable ecological base-line data on which to base future decision-making by land managers.

The current study aims to place on record the results of a long-term (110 months) study that focuses on the diversity, occurrence and abundance of the common waterbirds that utilise the Walka Lake. Hence it considers only a selection of avian species, and even then deals only with those species that were observed on survey days. It is to be emphasised that many bird species other than waterbirds are regularly present while others make temporary use of the reserve. The very uncommon Australian Little Bittern *Ixobrychus dubius*, the endangered Australasian Bittern *Botaurus poiciloptilus*, the vulnerable Black Bittern *Ixobrychus flavicollis* and the vulnerable Eastern Osprey *Pandion cristatus* have been recorded historically as utilising the site. Therefore the results of this study present only a partial indication of the overall significance of the site to avian species.

The study will yield insights into the use of Walka as a dry-season refuge for waterbirds and as a potential site to enhance the conservation of the Blue-billed Duck *Oxyura australis*. It will generate a baseline against which future changes in frequency of occurrence, abundance and diversity of populations may be assessed.

Research has shown that birds are effective indicators of environmental health. This study seeks to identify those waterbird species that are relatively common, are easily recognised, possess specific habitat requirements and are potentially responsive to disturbance. It is proposed that species so identified would be suitable indicators to alert land managers to undesirable changes in the environmental health of the water body and its verging vegetation to allow implementation of timely management strategies.

METHODS

Data Collection: The approach used to survey the waterbirds of Walka Lake, its immediate verge and the flood plain below the dam wall involved a fixed route and constant effort. The same team of three observers conducted 110 monthly surveys during the period April 2003 to May 2012. Surveys were conducted on, or as close as practical to, the second Wednesday of each month commencing at 0700 hours, with an average duration 2.5 hours.

The fixed route of 2.5 kilometres closely followed the edge of the water body providing excellent accessibility and ease of observation by binoculars and telescope. The shape of the water body and the diligence of the observers helped to reduce the chance of double counting. Any residual effects of double counting would be minimised by the long-term nature of the study.

A count of all waterbirds detected, (including those heard, and flying over) was recorded and these data have been published annually in the Hunter Bird Observers Club Annual Bird Report (Stuart 2004 - 2012). Data were also submitted to the Birds Australia Ongoing Atlas Project. Waterbirds verified as breeding at Walka during the survey period were noted. The presence of woodland birds was noted but these data do not form part of the analysis.

Note: The consistent use of the same observers, same route and same relative time for each survey should yield a high level of reliability in the data for its temporal analysis. Further, failure to observe cryptic species such as Baillon's Crake *Porzana pusilla*, Spotless Crake *Porzana tabuensis*, Buff-banded Rail *Gallirallus philippensis*, as indicated by a zero in the data bases does not necessarily mean that such species are absent (Barrett *et al*. 2003).

Data Analysis: The species *diversity* for the site was recorded as: the waterbird species present by taxonomic family; the number of different waterbird species present for each monthly survey for the period 2003 to 2012; the total number of different species for 2003 to 2012. Waterbird species known to breed regularly at Walka Lake were also recorded.

To assess the *frequency of occurrence* of a given species a percentage reporting rate (%RR) was used. For a stated time period, the %RR is the ratio of the number of surveys in which the species was recorded to the total number of surveys for that period, expressed as a percentage. The large sample size and systematic acquisition of data should result in reliable reporting rates as a measure of the frequency of occurrence (Barrett *et al.* 2003). Trends in occurrence were evaluated as variation in annual and monthly percentage reporting rates. The overall %RR for the period 2003-2012 was used to assign a species occurrence rating as follows: %RR >80, occurs *Regularly;* %RR 60-79, occurs *Frequently*; %RR 40-59, occurs *Often*; %RR 20-39, occurs *Moderately often*; %RR<20 occurs *Occasionally.*

Species *abundance*, for a given time period, was indicated by the mean number of birds of each species present (when present) per survey (N). Abundance ratings were assigned as High (N>10), Moderate (5<N<10), Low (N<5). The maximum number of birds of a given species present, when used in conjunction with %RR, allowed irruptive species to be identified.

To identify any *population changes*, the survey period of 110 surveys was divided into two sets of 55 surveys, before and after 31 October 2007. As indicators of possible population change, two change ratios (CR) were calculated for each species, one based on frequency data (CR_{RR}) and the other on abundance data (CR_N). The change ratio CR_{RR} is the ratio of the number of surveys in which a species was present in the first set of surveys compared to the second set of surveys. The change ratio CR_N was calculated for each species as the mean number of birds present per survey (when present) for the first set of surveys compared with the mean number of birds present per survey (when present) for the second set of surveys. A change ratio equal to one (CR=1) indicates no change while a change ratio greater than one (CR>1) indicates the possibility of a population decrease and a change ratio less than one (CR<1) represents a possible population increase. For the purposes of this study a variation greater than 20% in the change ratio, (CR>1.2, or CR< 0.8) was arbitrarily regarded as meaningful.

Note: Only count data directly collected by the observers as part of the regular surveys have been used to generate indicators of diversity, frequency of occurrence, abundance, and population change. Supplementary data sourced elsewhere have been used for discussion purposes. It should also be noted that a straightforward approach was used to examine the data for change and that the indicators were not subject to

rigorous statistical evaluation. They are however, considered to be sufficiently discriminating to develop meaningful outcomes consistent with the aims of the study.

RESULTS

The raw data acquired during the survey process has been tabulated and published in the Hunter Bird Observers Club Inc publication the Annual Bird Report 2003–2011 (Stuart 2004-2012). Data derived from the raw data and used in the analysis are included in **Appendices A–C**. Species nomenclature has followed Christidis & Boles (2008).

Species Diversity

A total of 35 waterbird species belonging to ten families was recorded during the survey period (**Table 1**). Some species, viz. Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *Threskiornis spinicollis*, were almost exclusively associated with the ephemeral water bodies situated on the Hunter River flood plain situated below the Walka Lake dam wall

The level of species diversity was indicated by the mean number of species present each month (rounded up to the nearest whole number) (see **Appendix A, Table A1**). On average 19 waterbird species were detected each month for the period 2003 - 2012. The highest level of annual diversity, 22 species/month occurred in 2009; the lowest level, 16 species/month was recorded in 2003.

During the survey period breeding records were noted for eight of the 35 waterbird species recorded (**Table 2**).

Table 2. Waterbirds known to breed at Walka Lake

Musk Duck	Pacific Black Duck	Australasian Grebe
Black Swan	Eurasian Coot	Great Crested Grebe
Dusky Moorhen	Purple Swamphen	Blue-billed Duck*

* Breeding records for the Blue-billed Duck were noted during the 1970s when this species was known to breed at Walka (A. Stuart pers. comm.). Although breeding was suspected, due to the presence of apparently dependent young birds, a breeding record for the Blue-billed Duck was not verified during the period of this study.

Table 1. Waterbird species - Walka Lake and verge.

Order	Family	Species
Anseriformes	Anatidae	Musk Duck *Biziura lobata*, Black Swan *Cygnus atratus*, Australian Wood Duck *Chenonetta jubata*, Pink-eared Duck *Malacorhynchus membranaceus,* Australasian Shoveler *Anas rhynchotis*, Grey Teal *Anas gracilis*, Chestnut Teal *Anas castanea*, Pacific Black Duck *Anas superciliosa*, Hardhead *Aythya australis*, Blue-billed Duck *Oxyura australis*
Podicipediformes	Podicipedidae	Australasian Grebe *Tachybaptus novaehollandiae*, Hoary-headed Grebe *Poliocephalus poliocephalus*, Great Crested Grebe *Podiceps cristatus*
Phalacrocoraciformes	Anhingidae	Australasian Darter *Anhinga novaehollandiae*
	Phalacrocoracidae	Little Pied Cormorant *Microcarbo melanoleucos*, Great Cormorant *Phalacrocorax carbo*, Little Black Cormorant *Phalacrocorax sulcirostris*, Pied Cormorant *Phalacrocorax varius*
Ciconiiformes	Pelecanidae	Australian Pelican *Pelecanus conspicillatus*
	Ardeidae	Eastern Great Egret *Ardea modesta*, Intermediate Egret *Ardea intermedia*, White-faced Heron *Egretta novaehollandiae*, Little Egret *Egretta garzetta*
	Threskiornithidae	Australian White Ibis *Threskiornis molucca*, Straw-necked Ibis *Threskiornis spinicollis*, Royal Spoonbill *Platalea regia*
Gruiformes	Rallidae	Purple Swamphen *Porphyrio porphyrio*, Buff-banded Rail *Gallirallus philippensis*, Baillon's Crake *Porzana pusilla*, Spotless Crake *Porzana tabuensis*, Dusky Moorhen *Gallinula tenebrosa*, Eurasian Coot *Fulica atra*
Charadriiformes	Charadriidae	Black-fronted Dotterel *Elseyornis melanops*, Masked Lapwing *Vanellus miles*
	Scolopacidae	Latham's Snipe *Gallinago hardwickii*

Frequency of Occurrence

The overall percentage Reporting Rate (%RR) for each species for the period April 2003-May 2012 was calculated. Fourteen species were recorded as occurring *regularly* (%RR >80), three species were *frequently* reported (60<%RR<79), ten species were *often* or *moderately often* recorded (20<%RR<59) while six species were only *occasionally* reported (%RR<20) (**Table 3**).

Species Abundance

The Eurasian Coot was by far the most abundant species, with the highest mean monthly number of birds, 71 birds, a maximum number of 319 birds and an overall %RR = 96. The Pink-eared Duck, showing the third highest mean number of birds (25), when present, and a maximum number of 111 was only occasionally present with a %RR = 12. The Pink-eared Duck is therefore considered an irruptive species at Walka. The least abundant species recorded was the Spotless Crake with a %RR = 7 and a low mean number of birds present (one bird). Due to its elusive and cryptic nature the probability of finding this species is low but it is most likely under recorded, as the habitat of the surrounding verge is appropriate for this species. **Table 4** lists species with High (N>10), Moderate (5<N<10) and Low (N<5) abundance levels in descending order of the abundance indicator (N).

Table 3. Species Frequency of Occurrence according to Overall Reporting Rate (%RR)

Occasionally (%RR<20)	**Moderately Often** (20<%RR<39)	**Often** (40<%RR<59)	**Frequently** (60<%RR<79)	**Regularly** (%RR>80)
Pink-eared Duck (12) Intermediate Egret (12) Latham's Snipe (9) Spotless Crake (7) Baillon's Crake (6) Buff-banded Rail (5)	Eastern Great Egret (39) Little Egret (28) Australasian Darter (25) Australasian Shoveler (23) Australian White Ibis (22) Blue-billed Duck (21) Straw-necked Ibis (20)	Black-fronted Dotterel (45) Australian Pelican (42) Royal Spoonbill (40)	White-faced Heron (67) Hoary-headed Grebe (66) Australian Wood Duck (66)	Pacific Black Duck (100) Dusky Moorhen (98) Purple Swamphen (97) Eurasian Coot (96) Great Crested Grebe (95) Little Black Cormorant (94) Little Pied Cormorant (93) Chestnut Teal (91) Black Swan (91) Australasian Grebe (89) Hardhead (86) Grey Teal (86) Musk Duck (84) Masked Lapwing (83)

Table 4. Abundance level

High Abundance (N, Nmax, %RR)	**Moderate Abundance** (N, Nmax, %RR)	**Low Abundance** (N, Nmax, %RR)
Eurasian Coot (71,319,96) Hardhead (35,422,86) Pink-eared Duck (25,111,12) Pacific Black Duck (23,72,100) Grey Teal (18,97,86) Australasian Grebe (18,85,89) Dusky Moorhen (16,90,98) Chestnut Teal (14,105,91) Great Crested Grebe (13,41,95) Little Black Cormorant (13,66,94) Purple Swamphen (10,66,97)	Hoary-headed Grebe (8,45,66) Australian Pelican (7,87,42) Australian Wood Duck (7,42,66) Little Pied Cormorant (6,28,95)	Masked Lapwing (4,20,83) Black Swan (4,17,91) Australasian Shoveler (4,9,23) Black-fronted Dotterel (4,13,40) Royal Spoonbill (4,13,40) Musk Duck (3,10,84) Latham's Snipe (3,4 9,8) Australasian Darter (3,10,25) White-faced Heron (2,15,67) Blue-billed Duck (2,7,21) Buff-banded Rail (2,3,5) Eastern Great Egret (1,4,39) Baillon's Crake (1,2,6) Little Egret (1,3,28) Intermediate Egret (1,3,12) Spotless Crake (1,2,7)

N= Mean number of birds present (when present) per monthly survey.
Nmax= Maximum number of birds recorded on any one occasion.
%RR= Overall percentage reporting rate.

Population Change

The assignment of species population change classifications was based primarily on the change ratios derived from the frequency data (CR_{RR}) while in some cases (e.g. Hoary-headed Grebe, Australian Pelican) consideration was given to the change ratios based on abundance (CR_N). By including an arbitrary factor of +/- 20% to accommodate variability, a stable population was generally defined as having a change ratio (CR_{RR}) range between 0.8 and 1.2. A CR_{RR} less than 0.8 is indicative of possible population increase and CR_{RR} greater than 1.2, a possible decrease in population. (It should be noted that this arbitrary measure, although regarded as meaningful in this context, is not necessarily a strong test of population change as indicated by Chi-square tests conducted at various percentage reporting rates. These tests indicate that a change ratio, e.g. CR_{RR} = 1.2 falls somewhat short of the value required for significant confidence in a change not occurring by chance at the p=0.05 level). **Table 5** provides a baseline against which future population changes can be assessed.

DISCUSSION

Walka provides valuable habitat that supports a high diversity of waterbird species, including deep-water specialists, on a permanent and recurring basis. Although this study provides evidence of the fluctuating occurrence, relative abundance, species composition and possible population changes of the common waterbirds frequenting the Walka site, it does not attempt to fully explain this variability for all species included in the study. Rather it seeks, with limited interpretation, to provide base-line data for future studies and to inform the development of management strategies particularly with respect to possible indicator species, the use of the site as a drought refuge and also as a potential site to enhance the conservation of the Blue-billed Duck.

Potential Indicator Species

The selection of potential indicator species to assist land managers to monitor the site was based on both site specific environmental attributes (permanent, deep freshwater with substantial marginal vegetation) and the desirable criteria for indicator species (relatively common at the site, stable population, easy identification, specific environmental requirements, and potentially responsive to change). Permanent deep water and the verge vegetation habitats appear to be the determining factors for the suite of birds frequently reported at the site, as a significant proportion comprise the deep-water specialists, such as Great Crested Grebe, Hoary-headed Grebe, Musk Duck, and Hardhead. Other birds such as the cormorant species, Australasian Darter, Australasian Grebe and, to a lesser extent, the Eurasian Coot are also reliant on deep water for feeding. The generally

Table 5. Population change for the period before 31 October 2007 compared to after 31 October 2007.

Species showing a possible population increase (CR_{RR}, CR_N)	**Species showing a stable population** (CR_{RR}, CR_N)	**Species showing a possible population decrease** (CR_{RR}, CR_N)
Australian Wood Duck (0.6, 0.4)	Musk Duck (1.1, 1.0)	Pink-eared Duck (2.3, 1.0)
Blue-billed Duck (0.4, 0.5)	Black Swan (0.9, 1.3)	Intermediate Egret (11, 1.25)
Australasian Darter (0.1, 0.6)	Australasian Shoveler (1.2, 1.3)	Little Egret (4.2, 0.8)
Eastern Great Egret (0.6, 0.7)	Grey Teal (1.2, 0.8)	Buff-banded Rail (6.0, 1.5)
White-faced Heron (0.7, 0.9)	Great Crested Grebe (1.0, 0.5)	Spotless Crake (5.0, 1.2)
Baillon's Crake (0.4, 0.8)	Chestnut Teal (0.8, 0.8)	Black-fronted Dotterel (2.4, 2.0)
	Pacific Black Duck (1.0, 1.0)	Latham's Snipe (2.3, 3.1)
	Hardhead (0.8, 1.9)	
	Australasian Grebe (0.8, 1.0)	
	Hoary-headed Grebe (1.3, 0.9)	
	Little Pied Cormorant (0.9, 0.8)	
	Little Black Cormorant (1.0, 1.1)	
	Royal Spoonbill (0.8, 0.6)	
	Purple Swamphen (1.0, 0.8)	
	Dusky Moorhen (1.0, 0.6)	
	Eurasian Coot (0.9, 1.0)	
	Masked Lapwing (1.1, 0.9)	
	Australian Pelican (1.9, 0.2)	

CR_{RR}= Change ratio based on the occurrence indicator %RR.
CR_N = Change Ratio based on abundance indicator, mean number birds present/month (N)

high water level and the verge vegetation provide food, shelter, breeding stimulus, and nesting materials necessary for breeding success and population stability.

Site specific data for potential indicator species, shown in **Table 6**, has been derived from data included in the Results and **Appendices B** and **C**. The table is included here as a summary for discussion purposes.

The species listed in **Table 6** satisfy the habitat requirements as outlined above, although some species fulfil the role of an indicator species better than others. The Eurasian Coot and the Australian Grebe were regularly reported, have high abundance and stable populations. However their widespread distributions negatively impact on their suitability. The Pacific Black Duck, not listed due to its variable habitat and widespread distribution, was the only species to have a percentage reporting rate of 100%. Interestingly this species has the capacity to exploit environments, such as public parklands, where interaction with humans is common (Chapman & Jones 2012, Feletti & Feletti 2012). Hence there is the potential for the Pacific Black Duck population, which is presently stable (**Table 5**), to increase in response to increasing urbanisation. Any future population increase of the Pacific Black Duck at Walka could be one factor indicative of increasing anthropogenic influence.

The Hardhead is a deep-water specialist. **Table 1** in **Appendix C** shows the considerable variation in its monthly abundance levels and this, together with a high maximum number of birds, reflects the irruptive nature of this species. This precludes it as an effective indicator of environmental health at Walka. The Blue-billed Duck and the Musk Duck are also recognised deep-water specialists but the indicated low abundance levels for both these species reduce their suitability as indicators. While the restricted distribution of the Hoary-headed Grebe and its reliance on a deep-water habitat are positive selection attributes the non-breeding status of this species at Walka is an impediment to its selection.

Inspection of the data (Stuart 2004-2012) and the **Appendices A–C** reveals that a number of species suffered an unexpected decrease in numbers around June 2007 followed by a short recovery period. Notably the Great Crested Grebe was one of these species (others included: Little Black Cormorant, Little Pied Cormorant, Australasian Grebe, Chestnut Teal, Grey Teal and Hardhead.) At that time, the puddle core (clay/sand mixture) of the dam wall started to dry due to the very low water level resulting from the extended drought period. To prevent damage, turbid water was pumped from the Hunter River into the lake to wet the core by restoring the water level.

Table 6. Site-specific data for potential indicator species.

Species	Occurrence	Abundance	Population	Distribution	Status	Breeding	Habitat
Great Crested Grebe	Regular	High	Stable	Very restricted in lower Hunter Valley	Resident	Yes	Deep freshwater and dense marginal vegetation
Hoary-headed Grebe	Frequent	Moderate	Stable	Very restricted in lower Hunter Valley	Present throughout the year	No	Larger wetlands, fresh and brackish water
Musk Duck	Regular	Low	Stable	Several locations in lower Hunter Valley	Resident	Yes	Permanent, open water, well vegetated margins
Blue-billed Duck	Moderately often	Low	Possible increase during survey period	Restricted in lower Hunter Valley	Vulnerable *Threatened Species Conservation Act 1995* Uncommon visitor	Past records	Deep freshwater, dense vegetation e.g. *Typha*
Hardhead	Regular	High	Stable	Widespread	Irruptive visitor	No	Deep, vegetated, permanent open water
Australasian Grebe	Regular	High	Stable	Widespread	Resident	Yes	Permanent, open water, well vegetated margins
Eurasian Coot	Regular	High	Stable	Widespread	Resident	Yes	Deep, vegetated, permanent open water

This action increased the turbidity in some sections of the lake, and this physical change to water conditions may offer a potential explanation for the observed short-term decrease in abundance of the Great Crested Grebe at that time and be indicative of this species' responsiveness to environmental change at the site, a desirable attribute of an indicator species. (Further investigation of the effects of turbidity would be warranted before a firm conclusion could be drawn in this case). Additionally the Great Crested Grebe has the specific habitat requirements provided by Walka, restricted distribution in the Lower Hunter valley, regular frequency of occurrence with high abundance level, breeding success and a stable population against which future changes could be assessed. These features coupled with ease of identification and visual appeal support this species as a suitable indicator species for the environmental health of Walka Lake.

Drought Refuge

In times of extended dry seasons waterbirds are forced to move great distances in search of habitat refuges. This movement has a bias towards the coast (Scott 1997). These habitat refuges often provide food resources that will ultimately determine the number of birds that can take advantage of the next breeding opportunity (Maher 1991). Briggs (1994) regards the support of these residual populations through the use of drought refuges so that they may later recolonise affected breeding habitats, as a waterbird conservation priority. Kingsford, as cited in Scott (1997) contends that the decline in the area of wetland in western NSW will have a long-term impact on waterbird numbers, further highlighting the importance of drought refuges. During the first half of the survey period the Lower Hunter and extensive areas of NSW were subject to below-average rainfall and drought conditions. The presence of permanent deep freshwater and fringing vegetation at Walka provide habitat suitable for a drought refuge.

This study has provided evidence to strengthen the proposition that Walka has a role as a drought refuge for some species. Roderick & Stuart (2010) report that Walka appears to be the most consistent area in the Hunter Region for records of the Blue-billed Duck and that local sightings seem to be consistent with the Region being a drought refuge. The annual percentage reporting rate for the Musk Duck showed a substantial downward trend from its peak in 2009 until the end of the survey period. This decrease may be a reflection of the increased availability of suitable habitat elsewhere due to the widespread inland rains since the break of the drought mid-2007. Prior to the drought breaking in 2007 abundance levels of the Hardhead increased, peaking in 2007. Since then abundance has decreased possibly due to the replenishment of wetland habitats elsewhere. The annual percentage reporting rate for the Pink-eared Duck also peaked in 2007 and with the exception of 2009 decreased markedly in the second half of the survey. Similarly, the annual percentage reporting rate for the Hoary-headed Grebe declined after 2007. Further long-term study is needed to verify the proposition by establishing species movements correlated with rainfall in the Upper Hunter Valley and western NSW.

Blue-billed Duck Conservation

The frequency of occurrence (**Appendix B - Table B1**) and abundance (**Appendix C - Table C1**) data reflect the fluctuating use of the Walka site by the Blue-billed Duck over the survey period and past breeding records support the proposition that Walka could provide future breeding habitat. The increases in frequency and abundance (2007 to 2011) may be a response to the higher water level at Walka due to the above-average rainfall. High water levels result in water surrounding the verge vegetation and this may act as one stimulus to breeding. Experienced breeding birds tend to be more site faithful while younger birds move to the non-breeding areas (Scott 1997). The maintenance of dense marginal vegetation, especially *Typha sp*. is critical to breeding success. The Blue-billed Duck is classified as "vulnerable" under the *NSW Threatened Species Conservation Act 1995* and "near threatened" under the International Union for the Conservation of Nature (Roderick & Stuart 2010). Walka, as a wetland fulfilling this species' habitat requirements, has potential to support its conservation.

CONCLUSIONS / RECOMMENDATIONS

The data sets, generated through basic methodology and presented in this paper, provide a useful baseline to inform both future local and regional studies and the development of site management strategies.

Ecological systems, such as the Walka wetland, exhibit a high level of natural variability so the detection of any long-term change in the occurrence, abundance and diversity of avian species is difficult to substantiate. There is a need

for constant effort monitoring over many years to establish these changes. However, comprehensive monitoring of all species may not always be possible so the use of an indicator species may assist the process. It is proposed that, for ease of monitoring, the Great Crested Grebe would be a suitable site-specific indicator species for land managers to use to monitor the long-term environmental health of the Walka wetland. The Pacific Black Duck, through its capacity to exploit increasingly urbanised environments, also has a potential role as an indicator species.

Within the Lower Hunter Valley, Walka has the habitat attributes of an effective drought refuge suitable for a range of waterbirds, including the deep-water specialists. As effective refuges are regarded as a priority for waterbird conservation, it is strongly recommended that the existing verge vegetation at Walka be retained and enhanced to ensure the availability of food resources and nesting habitat in times of extended dry seasons elsewhere. The implementation of sensitive management practices to limit human impact on the Walka site must be regarded as a priority in order to preserve the ecological integrity of the Walka wetland. Deep water and a healthy, undisturbed verge habitat at Walka will not only sustain existing levels of diversity but also develop suitable foraging and breeding habitat vital for the conservation of the Blue-billed Duck which is classified as vulnerable in NSW.

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APPENDICES

Appendix A. Species diversity

Table A1. Species diversity- Mean number of species /monthly survey 2003-2012

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean No. Spec/Month/Yr
2003	NR	NR	NR	14	19	19	16	15	17	10	18	16	**16**
2004	17	14	13	12	16	24	18	20	20	17	17	18	**17**
2005	18	19	21	18	22	20	18	17	18	19	20	20	**19**
2006	17	22	25	23	19	19	17	18	20	21	22	21	**20**
2007	20	26	22	20	19	13	16	15	17	16	18	13	**18**
2008	15	15	14	17	19	19	24	24	24	17	18	22	**19**
2009	21	21	20	22	20	24	22	22	23	23	23	26	**22**
2010	24	17	14	21	18	18	16	15	16	18	14	12	**17**
2011	23	13	15	16	18	18	19	21	19	23	19	18	**19**
2012	18	17	16	17	18	NA	NA	NA	NA	NA	NA	NA	**17**
Mean No. Species /Month	**19**	**18**	**18**	**18**	**19**	**19**	**18**	**19**	**19**	**18**	**19**	**18**	**Mean No. Species /Month all years: 19**

Appendix B. Frequency of occurrence

Table B1. Annual variation - percentage reporting rate (%RR) 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Musk Duck	100	75	92	92	100	100	100	75	67	0
Black Swan	78	92	92	83	83	92	100	92	100	100
Australian Wood Duck	44	42	67	67	75	100	83	75	92	100
Pink-eared Duck	22	17	8	17	25	8	25	0	8	0
Australasian Shoveler	11	25	17	33	42	42	42	8	0	0
Grey Teal	89	92	83	100	100	92	100	50	67	60
Chestnut Teal	89	100	58	92	83	100	100	100	92	100
Pacific Black Duck	100	100	100	100	100	100	100	100	100	100
Hardhead	33	67	92	100	92	100	100	83	83	100
Blue-billed Duck	0	0	8	8	50	25	50	25	25	0
Australasian Grebe	67	50	100	100	83	92	100	100	100	100
Hoary-headed Grebe	89	42	58	83	92	67	75	8	75	60
Great Crested Grebe	89	100	100	92	83	100	100	83	100	100
Australasian Darter	0	0	33	0	0	0	58	50	92	80
Little Pied Cormorant	100	100	100	92	50	100	100	92	100	100
Little Black Cormorant	78	100	100	100	58	100	100	100	100	100
Australian Pelican	33	42	67	67	50	50	33	33	17	0
Eastern Great Egret	44	17	33	25	25	67	67	25	25	80
Intermediate Egret	0	17	58	25	0	0	8	0	0	0
White-faced Heron	56	58	50	42	67	58	83	83	100	100
Little Egret	56	50	58	33	25	33	8	0	8	0
Australian White Ibis	0	8	8	25	8	50	67	8	25	0
Straw-necked Ibis	11	17	8	42	17	33	50	17	25	20
Royal Spoonbill	67	25	25	42	25	25	92	58	17	20

Appendix B. Frequency of occurrence cont.

Table B1. Annual variation - percentage reporting rate (%RR) 2003-2012 cont.

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Purple Swamphen	89	92	92	100	100	100	100	100	100	100
Buff-banded Rail	0	8	17	17	8	0	0	0	0	0
Baillon's Crake	0	0	0	17	0	0	17	8	17	0
Spotless Crake	0	8	8	33	0	8	8	0	0	0
Dusky Moorhen	89	100	92	100	100	100	100	100	100	100
Eurasian Coot	56	100	100	100	100	92	100	100	100	100
Black-fronted Dotterel	22	75	92	100	58	33	42	25	33	0
Masked Lapwing	89	92	83	83	83	33	92	92	83	100
Latham's Snipe	0	8	17	25	8	0	25	0	0	0

Table B2. Monthly Variation - percentage reporting rate (% RR)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Musk Duck	89	67	67	80	80	100	89	89	89	100	78	89
Black Swan	89	78	78	90	100	100	100	89	100	89	89	89
Australian Wood Duck	78	78	56	60	70	100	67	78	67	78	78	78
Pink-eared Duck	22	11	22	20	0	0	22	0	11	11	22	22
Australasian Shoveler	33	11	11	21	0	33	44	22	22	22	44	22
Grey Teal	100	89	67	80	90	100	67	78	89	78	89	89
Chestnut Teal	100	100	100	100	80	56	89	78	89	100	100	100
Pacific Black Duck	100	100	100	100	100	100	100	100	100	100	100	100
Hardhead	100	67	67	80	80	89	89	100	78	89	100	89
Blue-billed Duck	44	22	0	0	0	33	22	22	44	22	22	22
Australasian Grebe	78	89	89	90	100	89	100	100	100	89	78	67
Hoary-headed Grebe	56	33	44	60	60	78	67	78	89	78	78	56
Great Crested Grebe	100	100	100	100	100	89	67	78	100	100	100	100
Australasian Darter	33	33	22	30	30	33	22	22	33	33	33	22
Little Pied Cormorant	100	100	100	100	100	89	89	78	89	89	89	89
Little Black Cormorant	100	100	100	100	100	89	89	89	100	78	89	89
Australian Pelican	78	56	33	10	40	33	22	44	44	33	67	44
Eastern Great Egret	56	44	33	40	60	33	33	22	44	44	11	33
Intermediate Egret	0	0	22	20	20	22	22	11	22	0	0	0
White-faced Heron	56	89	78	60	60	56	56	78	67	78	56	89
Little Egret	11	22	22	20	30	33	44	44	33	11	22	44
Australian White Ibis	0	11	0	30	10	56	33	22	22	44	11	22
Straw-necked Ibis	0	11	33	10	50	44	44	56	22	11	0	11
Royal Spoonbill	33	33	56	50	60	56	56	44	44	22	11	11
Purple Swamphen	89	89	100	100	100	100	100	100	100	89	100	100
Buff-banded Rail	0	22	0	10	10	0	0	0	0	0	11	11
Baillon's Crake	11	0	0	0	0	0	0	0	0	22	22	22
Spotless Crake	0	22	11	10	10	0	11	11	0	0	0	11
Dusky Moorhen	100	89	100	100	100	100	100	100	100	100	100	100
Eurasian Coot	100	100	100	90	90	89	89	100	100	89	100	100
Black-fronted Dotterel	67	44	78	50	60	67	22	33	44	44	56	56
Masked Lapwing	10	78	56	90	90	67	89	89	89	89	89	56
Latham's Snipe	0	33	33	0	0	0	0	0	0	0	33	11

Appendix C. Abundance

Table C1. Annual Variation - mean numbers/survey when present 2003-2012

Species	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Musk Duck	3.1	3.1	3.9	4.1	2.5	2.9	4.0	3.7	3.3	0
Black Swan	3.0	5.2	5.1	3.4	4.7	3.5	3.5	3.6	2.7	2.6
Australian Wood Duck	3.0	5.2	4.3	2.8	7.1	8.3	13.5	6.0	6.5	11.6
Pink-eared Duck	49.0	1.5	2.0	2.5	41.7	4.0	38.3	0	3.0	0
Australasian Shoveler	1.0	5.0	3.0	2.0	3.2	5.8	2.0	2.0	0	0
Grey Teal	29.6	16.8	8.1	15.6	13.8	15.9	32.5	9.8	27.0	7.7
Chestnut Teal	13.0	14.1	6.3	8.7	14.7	16.3	16.3	12.5	11.0	17.4
Pacific Black Duck	36.8	24.9	15.4	18.8	19.7	27.8	25.2	25.4	24.8	14.2
Hardhead	28.0	39.4	18.6	34.3	92.5	43.0	33.6	9.6	18.3	11.0
Blue-billed Duck	0	0	1.0	2.0	1.3	1.0	4.3	1.3	1.0	0
Australasian Grebe	6.7	11.8	25.8	27.1	10.8	12.5	33.3	10.5	16.8	15.6
Hoary-headed Grebe	5.4	7.4	14.4	6.3	4.6	3.9	16.8	9.0	5.7	7.7
Great Crested Grebe	7.0	9.3	9.7	9.5	5.4	22.5	19.8	17	14.9	17.4
Australasian Darter	0	0	1.3	0	0	0	2.4	1.8	4.0	2.5
Little Pied Cormorant	5.7	5.3	5.3	5.5	2.5	5.0	9.2	6.0	5.4	5.6
Little Black Cormorant	15.7	14.7	13.6	14.8	9.0	8.0	17.8	15.7	9.1	10.8
Australian Pelican	1.7	2.2	2.3	4.5	1.8	22.8	3.5	5.8	9.5	0
Eastern Great Egret	1.0	2.0	1.0	1.3	1.0	1.8	1.6	1.0	1.3	1.8
Intermediate Egret	0	1.0	1.4	1.0	0	0	1.0	0	0	0
White-faced Heron	1.6	1.9	1.5	1.6	3.6	2.0	3.5	1.8	2.0	2.0
Little Egret	1.6	1.5	1.1	1.0	1.0	2.0	1.0	0	1.0	0
Australian White Ibis	0	1.0	1.0	1.0	1.0	4.5	4.3	2.0	8.3	0
Straw-necked Ibis	109.0	54.5	1.0	106.0	53.5	14.5	20.7	9.5	28.0	24.0
Royal Spoonbill	3.8	3.0	1.0	2.4	3.0	5.0	4.5	4.4	4.5	1.0
Purple Swamphen	14.5	6.5	4.3	13.3	8.6	9.3	13.3	11.3	9.8	17.8
Buff-banded Rail	0	2.0	1.0	2.0	1.0	0	0	0	0	0
Baillon's Crake	0	0	0	1.0	0	0	1.0	2.0	1.0	0
Spotless Crake	0	1.0	1.0	1.3	0	1.0	1.0	0	0	0
Dusky Moorhen	17.3	10.4	9.4	10.7	9.7	17.4	24.8	19.9	19.6	18.6
Eurasian Coot	50.8	67.6	94.8	67.8	55.7	56.0	119.8	27.9	62.4	129
Black-fronted Dotterel	1.5	2.7	3.5	3.4	9.1	2.5	2.4	1.7	3.0	0
Masked Lapwing	4.6	5.7	3.0	3.6	2.4	2.8	5.0	2.4	4.0	6.0
Latham's Snipe	0	8.0	1.5	2.0	5.0	0	1.0	0	0	0

Appendix C. Abundance cont.

Table C2. Monthly variation - mean numbers /survey cont.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Musk Duck	4.0	2.5	3.2	2.6	2.8	3.7	2.9	3.5	3.3	4.4	4.7	3.0
Black Swan	5.1	4.7	3.0	3.1	3.1	4.8	3.4	4.4	3.6	3.4	4.3	3.0
Australian Wood Duck	8.7	6.3	9.0	8.7	9.4	4.3	4.2	3.3	4.7	7.7	10.6	9.4
Pink-eared Duck	66.5	92.0	6.5	47.0	0	0	2.0	0	4.0	6.0	1.5	3.0
Australasian Shoveler	3.3	2.0	8.0	3.0	0	2.7	3.8	7.5	3.0	1.0	1.3	5.0
Grey Teal	19.4	8.0	11.8	20.1	8.0	27.8	14.0	21.0	22.3	30.9	24.8	12.1
Chestnut Teal	14.6	8.9	10.1	11.7	18.5	34.4	12.6	9.4	15.0	10.2	10.1	11.0
Pacific Black Duck	21.0	22.9	27.9	28.8	30.9	32.7	22.9	24.8	16.8	13.9	20.1	18.0
Hardhead	11.1	22.7	16.8	12.4	17.3	16.5	54.9	79.0	73.7	80.0	18.8	13.1
Blue-billed Duck	1.0	1.5	0	0	0	1.0	4.0	4.0	3.0	1.0	1.5	2.0
Australasian Grebe	11.3	6.3	12.0	21.3	23.9	28.0	31.1	22.1	17.3	13.6	9.4	17.8
Hoary-headed Grebe	6.6	4.3	5.8	3.8	6.2	9.6	3.7	7.4	10.3	10.6	9.0	14.2
Great Crested Grebe	13.1	18.1	19.1	17.1	18.4	10.4	8.2	9.6	9.2	7.0	11.3	14.3
Australasian Darter	3.3	2.3	3.0	5.0	1.3	1.0	1.0	2.0	2.3	3.3	4.3	3.0
Little Pied Cormorant	5.2	4.0	7.2	7.7	8.3	6.0	6.4	5.7	6.3	2.6	4.4	3.8
Little Black Cormorant	21.7	22.7	10.7	17.9	8.3	10.0	10.5	10.0	10.2	7.6	14.1	11.4
Australian Pelican	3.0	4.2	1.3	1.0	8.0	1.7	45.4	10.5	7.0	2.0	1.3	3.8
Eastern Great Egret	1.2	1.0	2.0	1.8	1.5	1.7	1.7	1.5	1.8	1.0	1.0	1.0
Intermediate Egret	0	0	1.0	1.0	1.0	1.0	2.0	2.0	1.0	0	0	0
White-faced Heron	2.2	2.4	1.4	3.8	2.3	2.0	4.4	1.7	1.3	2.4	2.0	1.5
Little Egret	1.0	1.0	1.0	1.0	1.0	1.3	2.0	1.8	1.7	1.0	1.0	1.3
Australian White Ibis	0	2.0	0	8.0	1.0	2.0	7.0	6.0	2.0	4.0	1.0	1.5
Straw-necked Ibis	0	3.0	182.0	33.0	30.2	46.3	16.8	29.0	11.0	12.0	0	1.0
Royal Spoonbill	5.7	3.3	3.4	4.6	2.8	3.6	4.4	3.8	3.0	3.5	1.0	3.0
Purple Swamphen	10.8	9.6	10.6	10.1	11.4	9.2	10.2	16.0	9.6	8.6	8.4	9.8
Buff-banded Rail	0	1.0	0	1.0	1.0	0	0	0	0	0	3.0	2.0
Baillon's Crake	2.0	0	0	0	0	0	0	0	0	1.0	1.0	1.0
Spotless Crake	0	1.0	1.0	2.0	1.0	0	1.0	1.0	0	0	0	1.0
Dusky Moorhen	11.1	16.5	24.2	16.4	13.9	18.7	22.1	18.2	13.9	12.8	9.8	9.3
Eurasian Coot	97.7	56.8	47.8	47.6	51.1	69.9	74.9	80.6	86.3	78.3	102.3	61.2
Black-fronted Dotterel	2.5	3.8	5.6	6.8	5.0	2.8	3.0	5.0	2.0	1.8	2.2	2.6
Masked Lapwing	4.4	3.7	4.0	3.6	5.2	7.2	3.5	3.5	2.0	3.4	3.4	3.6
Latham's Snipe	0	2.7	1.0	0	0	0	0	0	0	0	2.0	8.0

Development of a non-intrusive method for investigating the calling patterns of Rufous Scrub-birds

Alan Stuart[1], Mike Newman[2], Peter Struik[3] and Ian Martin[4]

[1]81 Queens Road, New Lambton, NSW 2337, Australia almarosa@bigpond.com
[2]7 Glenurie Close, Woodville, NSW 2321, Australia omgnewman@bigpond.com
[3]PO Box 295, Toronto, NSW 2283, Australia swampbush@gmail.com
[4]19 Caroona Close, Adamstown Heights, NSW 2289, Australia ian.martin@exemail.com.au

Male Rufous Scrub-birds *Atrichornis rufescens* have loud characteristic calls which can be used to locate territories. The effectiveness of a monitoring program based on the detection of calling birds is dependent on good understandings of how their calling patterns vary with season, time of day, and local conditions. Since the presence of observers can affect a scrub-bird's behaviour, a non-intrusive method for investigating the calling patterns would have advantages. This study describes the development of a non-intrusive censusing method using a digital recording device programmed to record sonograms at a known or potential territory at pre-determined times, with the sonogram data analysed after they are later recovered from the instrument. Some progress has been made towards automated electronic analysis of the data using a "recogniser" developed from previously recorded "chipping" calls of a male Rufous Scrub-bird.

A male Rufous Scrub-bird was found to call very frequently in September, at the start of what is generally considered to be the breeding season. Its frequency of calling decreased outside the breeding season. The seasonal calling patterns for this scrub-bird were similar to those identified 30 years earlier.

Sonogram analysis of the characteristic chipping call of the Rufous Scrub-bird has shown that the first two syllables of a phrase have a narrower frequency range (less low frequency contribution) than the subsequent syllables, and the interval between the first and second syllables is greater than the intervals between each subsequent syllable. The numbers of syllables within individual phrases in a bout were often found to increase, from 1-3 syllables initially to 6-8 (or more) syllables later. This study has also confirmed previous findings that the individual syllables may be either downwardly or upwardly inflected, but that all the syllables in a phrase have the same inflection.

INTRODUCTION

The Rufous Scrub-bird *Atrichornis rufescens* is classified as Vulnerable under the New South Wales *Threatened Species Conservation Act 1995*. It has disappeared from lowland areas of its former range and it is now either extinct or very rare at altitudes below 600m (Ferrier 1984). Its modern range is restricted to five high altitude locations, extending from the Queensland/NSW Border Ranges south to the Barrington/Gloucester Tops area (Gole & Newman 2010). The southern sub-species *A. r. ferrieri* occurs in the Barrington Tops National Park (particularly the Gloucester Tops section of it).

The present Rufous Scrub-bird locations are high altitude "islands" which potentially will reduce in size or disappear as a consequence of climate change (Roderick & Stuart 2010, Watson 2010). To help develop appropriate conservation strategies and review their success, it is important that the Rufous Scrub-bird status be closely monitored. However, this poses problems as it is a cryptic skulking bird of dense undergrowth, which does not reliably respond to call playback.

Fortunately, male Rufous Scrub-birds are very vocal at times. Their loud penetrating calls can be heard from distances of >150m under favourable conditions (Ferrier 1984). Rufous Scrub-birds have a wide repertoire of calls and are renowned mimics. Their main song has been described as a "chipping" call. It consists of repeated phrases, each involving several one-note syllables. An effective method for monitoring Rufous Scrub-birds is to walk transects through likely habitat and listen for calling birds (Ferrier 1984, Ekert 2002, Newman & Stuart 2011). Greatest reliance is placed on records where the "chipping" call is

heard as this is call is readily recognised, having a resonant metallic quality which is easily distinguished from other species by experienced surveyors.

In order to maximise the usefulness of this survey method, good understandings are needed about how male Rufous Scrub-birds vary their calling patterns as a function of season, time of day, and local conditions. Ferrier (1984, 1985) developed important insights about this through an extensive series of transects through known territories. Under favourable conditions during the breeding season, Ferrier found the detection rate to exceed 80% (Ferrier 1984). He found that birds called in all months of the year, with detectability highest in the breeding season and favoured by low wind and high humidity. Jackson (1920) suggested that males called less frequently while the female was nesting, but Ferrier found the probability of males being heard calling was very high in the breeding season. Jackson spent long periods at individual Rufous Scrub-bird territories and his presence may have influenced the outcome.

Ferrier's study involved single pass transects through multiple Rufous Scrub-bird territories at different times of the year. He used a statistical approach to analyse the results, and he developed an empirical algorithm to predict the probability of hearing a scrub-bird during transects walked at 2.5 km/h through its territory. His intent was to develop a procedure which could be used to estimate the density of scrub-bird territories by conducting single visit transects. For instance, using his algorithm, if two territories are detected along a transect, under conditions for which the detection rate is 50%, it is predicted that there are four territories within 150m either side of that transect.

In 2010, through a program using volunteers and involving multiple as opposed to single transect surveys, we demonstrated similar densities of scrub-bird territories to those found by Ferrier in the Gloucester Tops (Newman & Stuart 2011). Because of differences both in the experience of the team and the transect sampling rates (1 km/h instead of 2.5 km/h), we were unable to relate Ferrier's algorithm to our results.

Since 2010, our objectives have become: (a) to determine whether previously known Rufous Scrub-bird territories were still occupied and (b) to determine any new territories. To achieve these objectives we continue to conduct surveys but when necessary spend extra time in the vicinity of known or suspected territories. The question is how much survey effort is required before we can conclude that a territory is no longer occupied?

Our preferred approach to resolving this question is to study intensively the calling pattern of a bird at a known territory and to apply this knowledge to the evaluation of other territories. We and others (Ferrier 1984) have noticed that the calling behaviour of scrub-birds can be affected by the presence of people in the vicinity of their territory, unless the observers are unobtrusive. This militates against using stationary observers to study the calling patterns; also, there is a finite (and relatively short) limit to how long observers are prepared to remain in position especially when weather conditions are unfavourable. Thus, a non-intrusive method for studying the calling pattern of Rufous Scrub-birds was required. This paper reports the development of such a method, involving capture and analysis of sonograms of calling Rufous Scrub-birds, and a comparison with intrusive transect-based census methods.

METHODS

A digital recording device (Wildlife Acoustics Inc. Song Meter™ model SM2) with two omnidirectional microphones was selected for the study. The Song Meter™ was programmed to record at fixed periods during the day, typically from just before dawn until after dusk, and sometimes to record overnight. For each session, the Song Meter™, encased within a steel mesh cage to help prevent damage, was installed at the edge of a calling node in a known Rufous Scrub-bird territory in the Gloucester Tops (32° 5±2' S, 151° 35±2' E) and left there for several days. It was placed 0.5-1m above ground, for example on a log or tree stump. **Figure 1** (see next page) shows the Song Meter™ installed at one such territory.

The data were recorded onto 8GB SD cards, which later were transferred to computer and analysed using Wildlife Acoustics Inc. Song Scope™ software. To date, most analysis has been by visual inspection of the Song Scope™ charts, with aural confirmation of suspected scrub-bird calls. Considerable effort has also gone towards developing an electronic "recogniser" whereby the chipping calls of the Rufous Scrub-bird will be able to be detected using the Song Scope™ software. To develop a "recogniser" using the Song Scope™ software, first a suite of confirmed calls are selected. The software analyses this suite, deconvoluting the signals to find an electronic pattern which is common to all of them. It is preferable to use calls recorded in the field to build the "recogniser" as this automatically takes into account instrument settings, microphone performance and electronic white noise. However, the varying quality of such recordings,

with their random background noise (due to wind, rain, other bird calls, etc.), militate against achieving a high quality (error free) recogniser.

Figure 1. The Song Meter™ installed at the Munro Hut Rufous Scrub-bird territory.

Nomenclature

In discussing the calling patterns of Rufous Scrub-birds, the following terms have been used, which in the main follow Ferrier's (1984) definitions:

Syllable: the single sound unit (e.g. "chip" or "seep").

Phrase: the collection of syllables that constitute one call event.

Bout: a period during which the bird utters the same type of phrase repetitively at intervals of <1 minute.

Calling Session: a period in which the bird delivers many bouts, with <10 minute intervals between bouts.

RESULTS AND DISCUSSION

Most of our effort focussed on a Rufous Scrub-bird territory located near the junction of the Careys Peak walking track and the track to the Munro Hut bushwalkers hut. This territory, belonging to what is sometimes referred to as the "Munro Hut scrub-bird", is conveniently accessed and the bird was known to be a reliable caller, at least in spring and summer, when the majority of our visits to the Gloucester Tops have occurred.

We recorded at the Munro Hut scrub-bird territory several times over 2011-2012, usually for periods of 2-3 days. Details are summarised in **Table 1**. We also installed the Song Meter™ for shorter periods (hours to 1-2 days) at three other known territories situated ~ 1km (Kerripit Road), ~3km (Gloucester Tops Road) and ~5km (Gloucester Falls) distance respectively from the Munro Hut scrub-bird. Overall, >300 hours of sonograms have been recorded, at four territories in the Gloucester Tops.

Table 1. Summary of the monitoring effort at Rufous Scrub-bird territories using the Song Meter™

Munro Hut	February 10-12 2011
Munro Hut	September 20-22 2011
Munro Hut	May 16-22 2012
Gloucester Falls	October 17 2011
Gloucester Tops Road	October 17-18 2011
Kerripit Road	October 19-20 2011

Chipping call of the Rufous Scrub-bird

The distinctive chipping call of the Rufous Scrub-bird involves a one-syllable sound repeated several times. Each call ("phrase") consists of between 2 and 8 (occasionally >8) syllables. In 2-syllable calls, the syllables seem almost identical. Multi-syllable calls have some different features. By way of example, **Figure 2** is a sonogram of a seven syllable phrase. It illustrates the following:

- The inflection of a syllable can be upwards or downwards (i.e. rising or descending); the direction of inflection is constant within a phrase (downward in **Figure 2**).
- The frequency range of each main syllable in multi-syllable calls is large (approximately 2.5kHz to 6.5kHz). This also is the case with the calls containing only 2-syllable calls discussed above.
- In multi-syllable calls the first two syllables have smaller frequency range than the subsequent syllables.
- The first syllable has only ~0.5kHz range. It is quite faint (and is unlikely to be heard unless the bird is very close).
- The interval between the first and second syllables is slightly greater than the intervals between each of the subsequent syllables.

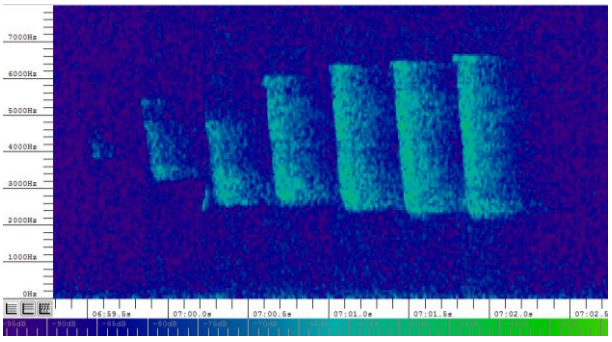

Figure 2. Example of a multi-syllable chipping call sonogram

During an extended observation of a calling male scrub-bird in the field, it was noted that when producing the first two syllables of the multi-syllable phrase, the bird had a horizontal stance and kept its head still. For the remaining syllables of the phrase it went into an upright stance with much more marked head movement as it called (AS pers. obs.).

In a typical calling bout, the Rufous Scrub-bird utters >20 multiple syllable phrases, at a rate usually between 3-5 phrases per minute. **Figure 3** is an excerpt from a sustained calling bout by the Munro Hut scrub-bird, illustrating the regular repetition of multi-syllable phrases (in this example, a mixture of 7-syllable and 8-syllable phrases) which occur during a calling bout. **Figure 4** shows an expanded view of part of the same sequence.

As indicated earlier, Ferrier (1984) found that the syllables of a phrase could be either ascending (upwardly inflected) or descending (downwardly inflected) but that the inflection did not change within an individual phrase. He also found that the southern subspecies uttered phrases of fewer syllables than the northern subspecies – with the latter at times delivering phrases of 18-20+ syllables. Our findings are in agreement; the Munro Hut scrub-bird typically delivered 4-8 syllable chipping calls, with 11 syllables being the maximum recorded to date.

Ferrier found very little variation to the number of syllables in the phrases within a bout. He reported the average standard deviation of the number of syllables in a bout to be 0.69. In contrast, the behaviour of the Munro Hut bird in the present study was quite different. Its bouts of chipping calls typically began with 1-3 syllable phrases, which steadily increased to 6-8 syllables (occasionally more) during the course of the bout. The limited data that we have obtained for other territories (e.g. **Table 1**) suggest this pattern of increasing number of syllables during a bout is common for Rufous Scrub-birds in the Gloucester Tops.

Sonograms of other Rufous Scrub-bird calls

Aside from mimicry of other species, the Rufous Scrub-bird utters several characteristic calls. In the main, these appear electronically as single syllable variants of the multiple chipping calls. The single "chip", "whistle" and "thrip" calls are all similar to one another, mainly varying in their frequency range. They differ audibly and electronically, but there is a gradation and to an extent it is a somewhat arbitrary decision to assign a call to one of these categories. The "seep" call is also single syllable, but it has a smaller frequency range (only ~1kHz, spanning 4.5-5.5kHz) and has a distinctive slope towards the higher frequency sounds in the latter part of the call (syllable). The Rufous Scrub-bird also delivers a contact call, which is a lower frequency (~2kHz) note which tails away noticeably in the sonogram. **Figure 5** shows some examples of "seep" and contact calls made by the Munro Hut scrub-bird.

Two birds in a territory

Ferrier (1984) noted a small number of examples of duetting by Rufous Scrub-birds, describing this as an interaction between a male and female bird and with the female uttering soft "tick" calls. We have noted some instances of this type of duetting during the intensive survey effort walking transects to locate calling scrub-birds.

An instance of two birds calling at the Munro Hut territory was recorded on the Song Meter™ and is presented as **Figure 6**. It shows one scrub-bird uttering single syllable calls and the second bird making 5-syllable calls. Note that, at 13 minutes and 26 seconds into the recording session, both scrub-birds called simultaneously. The behaviour differs from Ferrier's descriptions of duetting and possibly is an interaction between two male birds.

Calling patterns of the Munro Hut Rufous Scrub-bird in September 2011

The Song Meter™ was installed at the edge of the Munro Hut Rufous Scrub-bird territory shortly before 4pm on 20 September 2011. The scrub-bird resumed calling ~15 minutes after the intrusion into its territory. Initially the recordings were faint and the bird appeared to have moved to the other side of its territory. We analysed in detail the calling patterns from 4:30-5:30pm that afternoon, when the bird was closer to the Song Meter™. For comparison purposes we also analysed a one-hour period from 8:00am the following morning, when the bird was again close to the Song Meter™. **Table 2** summarises the results of the analysis while **Table 3** provides a more detailed breakdown.

In the 1-hour afternoon period, the scrub-bird delivered 245 song phrases during 12 calling bouts. The first bout was already underway at 4:30pm and the final bout continued after 5:30pm.

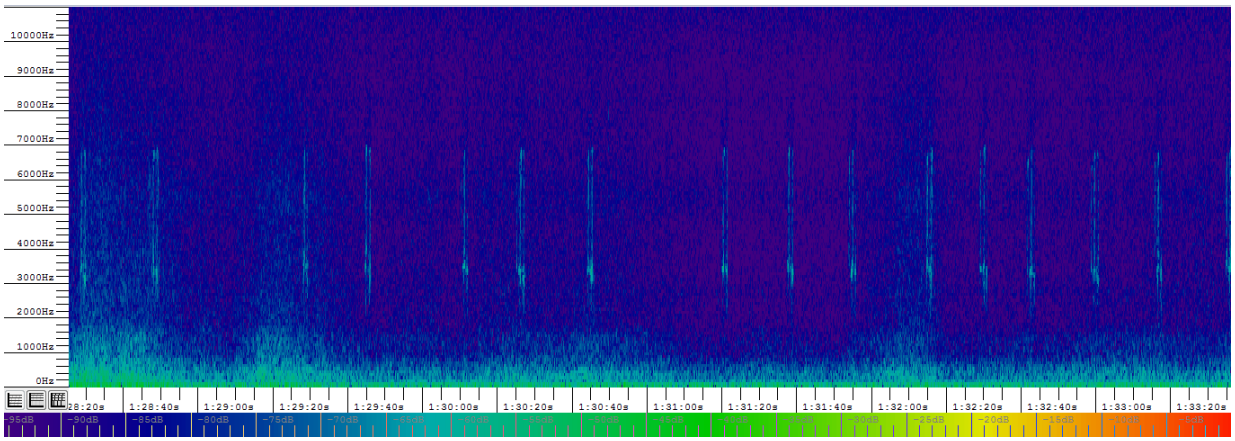

Figure 3. Extract from a calling bout: 7-syllable and 8-syllable chipping call sonograms at 15-20 second intervals.

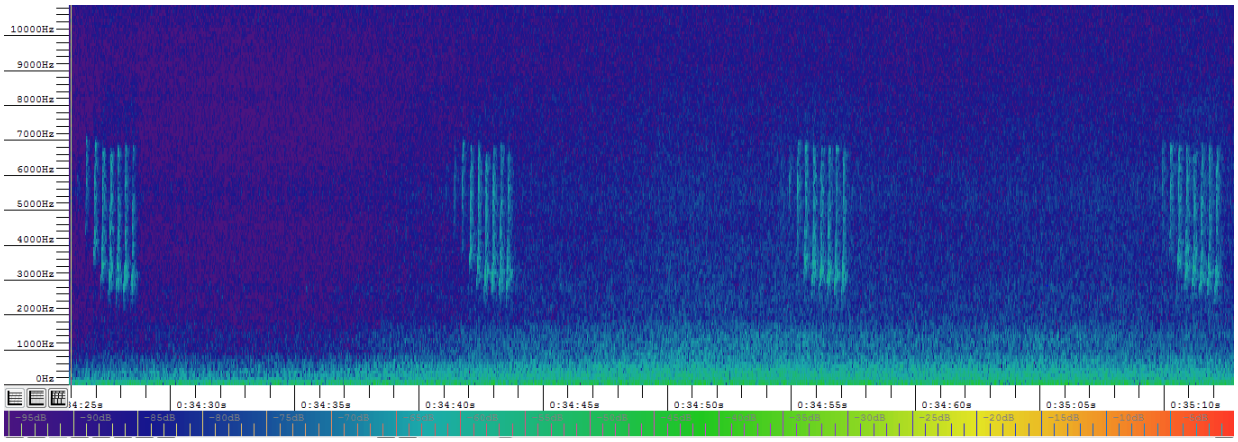

Figure 4. Detail from Figure 3: 7-syllable and 8-syllable chipping call sonograms at 15-20 second intervals.

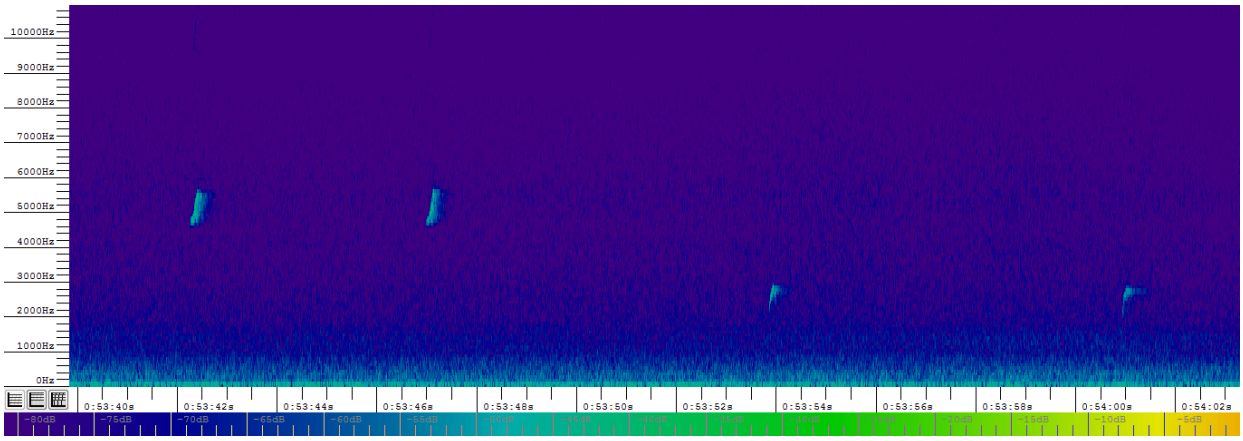

Figure 5. Sonograms of two “seep” calls followed by two contact calls.

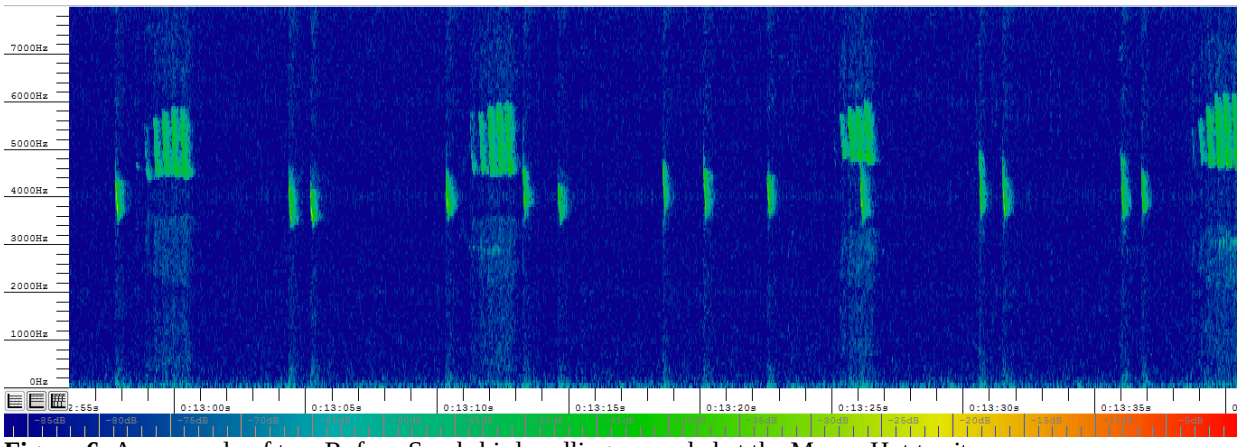

Figure 6. An example of two Rufous Scrub-birds calling, recorded at the Munro Hut territory.

53% of the phrases delivered in the period were multiple syllable chipping calls, with the balance being various single syllable phrases. The following morning, 193 phrases were delivered during 11 calling bouts (two of these extended before / after the selected time period). 48% of the phrases were multi-syllable ones, with 45% being single syllable phrases and the balance (7%) assigned to mimicry.

Table 2. Summary of the Munro Hut Rufous Scrub-bird calling patterns in two one-hour sessions

Calling Patterns	20 Sep 16:30-17:30	21 Sep 8:00-9:00
Number of bouts	12	11
Number of phrases delivered	245	193
% of multiple chip phrases	53%	48%
% time spent in calling bouts	79.6%	70.2%
Longest calling bout (sec)	1470	926
Shortest calling bout (sec)	27	28
Longest period silent (sec)	351	709

The longest bout in the afternoon session lasted for 24.5 minutes and involved 93 multi-syllable chip calls uttered at an average interval of 13 seconds. This bout was preceded by a 33 second bout of "seep" calls with only a short pause between the two. That is, there was around 25 minutes of near-continuous calling. Over the full hour, only two of the pauses between bouts exceeded 100 seconds, with the longest pause being 351 seconds. The scrub-bird was calling for almost 80% of the time.

The next morning, the longest bout lasted nearly 15.5 minutes. It was followed by 11.8 minutes of silence. There were two additional long duration calling sessions, 476 seconds and 527 seconds (~8 minutes, ~9 minutes) respectively, which involved a change from single to multiple syllable phrases part way through. In each case, the intervals between the two types of bout were <10 seconds. The scrub-bird called for around 70% of the one hour morning period.

In the shorter multiple syllable bouts, the number of syllables per phrase was predominantly 4 and a maximum of 5. In the more prolonged bouts the number of syllables increased during the bout, generally reaching a maximum of 7 syllables. The 24.5 minute bout on 20 September included a few 9-syllable phrases. Most bouts started with a succession of double syllable chip phrases before building up.

In the multiple syllable bouts, the typical interval between phrases was 13-23 seconds (range 9-45 seconds). In contrast, the single syllable calls were usually more closely spaced, with intervals typically of 4-14 seconds (range 1-33 seconds).

The intensive analysis of two one-hour periods at the Munro Hut territory in September 2011 is instructive in terms of what may be expected when a scrub-bird is actively calling. An obvious question is how often this is the case. The following chronological account addresses this point:

<u>September 20</u>
15:50: Song Meter™ installed
16:10: Bird resumed calling
16:30-17:30: See detailed analysis above
17:41: Last recorded (contact calls)

<u>September 21</u>
5:37: First recorded call (multiple chipping)
To 8:00: Calling very frequently
8:00-9:00: See detailed analysis above
All day: Calling very frequently
17:41: Last recorded (multiple chipping)

<u>September 22</u>
5:33: First recorded call (whistles)
To 6:20: Calling very frequently
6:20-6:40: Silent
6:52-8:22: Silent
8:36-9:36: Silent
9:37-10:50: Occasional calls heard
10:51-11:27: Calling very frequently
11:55: Song Meter™ removed

The Song Meter™ recorded throughout both nights; no Rufous Scrub-bird calls were detected. In the period 21-23 September, dawn was at 5:44am and sundown at 5:49pm. The scrub-bird began calling 5-10 minutes before dawn, and became silent 8 minutes before dusk.

It was not feasible to analyse in detail the calling pattern throughout the entire time, mainly because on several occasions the recordings were too faint for reliable analysis. At such times, presumably the bird was further away from the Song Meter™. Nevertheless, it was obvious that the calling patterns throughout daylight hours on 21 September were similar to those found in the detailed 1-hour analyses. Multi-syllable chipping calls were predominant, and a variety of single syllable phrases were also delivered. By extrapolation from the two 1-hour detailed analyses, where the calling rate was found to be 11-12 bouts/hour and 200-250 phrases/hour, the scrub-bird issued 2,500-3,000 calls in 130-150 calling bouts on 21 September. In effect, the day appeared to be one continuous calling session.

Table 3. Calling patterns of Munro Hut Rufous Scrub-bird in two one-hour sessions.

Calling Bouts				Phrases in the Calling Bout				Syllables per Phrase	
Start time	**Finish time**	**Duration (s)**	**Pause time before next bout (s)**	**Type**	**Number in bout**	**Average interval (s)**	**Range of intervals (s)**	**Average No.**	**Range**
16:30:00*	16:33:18	>198*	22	Multiple chips	>7*	30	11-45	4	4
16:33:40	16:36:32	172	351	Seep	19	9	2-13	1	1
16:42:23	16:43:43	80	4	Contact call	15	5	3-8	1	1
16:42:23	16:45:03	76	52	Whistle	11	7	5-12	1	1
16:44:31	16:47:57	122	21	Single chip	15	8	1-16	1	1
16:46:54	16:53:28	310	12	Multiple chips	22	13	9-39	4	2-7
16:52:16	16:54:07	27	38	Contact call	20	1.3	1-5	1	1
16:53:21	16:57:37	172	86	Multiple chips	8	18	15-27	4	4-5
16:57:39	16:59:36	33	12	Seep	2	33	33	1	1
16:58:24	17:24:18	1470	118	Multiple chips	93	13	7-33	5.6	2-9
17:24:52	17:27:48	92	18	Contact call	20	5	3-9	1	1
17:26:42	17:30:00*	>118*	N/A	Thrip	>13*	9.5	6-14	1.3	1-2
Next morning									
8:00:01*	8:05:03	>302*	-	Single chip	>35*	9	4-16	1	1
8:05:03	8:07:57	174	20	1-3 chips	14	12	5-19	2.4	1-3
8:08:16	8:09:38	82	21	Whistle	14	7	4-10	1	1
8:09:59	8:10:27	28	22	Mimicry	3	16	12-22	2.6	2-3
8:10:49	8:14:22	213	195	Multiple chips	10	23	14-41	4.2	4-5
8:17:37	8:19:50	133	-	Whistle	10	13	9-17	1.6	1-2
8:19:50	8:26:24	394	31	Multiple chips	24	17	9-28	3.1	1-4
8:26:55	8:28:21	86	61	Whistle	24	4	1-13	1	1
8:29:22	8:32:16	174	14	Mimicry	11	17	11-25	1	1
8:32:30	8:47:56	926	709	Multiple chips	45	21	14-42	5.6	3-7
8:59:45	9:00:02*	>17*	N/A	1-2 chips	>4*	9	8-9	1.3	1-2

**Bout incomplete as either in progress or continuing when analysis period started or finished*

The contrast in calling pattern on 22 September is quite striking. The scrub-bird began calling shortly before dawn, and called often during the following 47 minutes, much like the previous day. However, in the subsequent 3.5 hours, only about 30 minutes of calling bouts were detected. Later, from around 10:50am, the calling rate increased.

It is possible that on 22 September the scrub-bird was recorded less frequently because it may sometimes have been out of range of the microphones, and not detected. For example, at 9:36am, very faint chipping calls could be discerned which over the next 15 minutes became progressively louder, followed by 6 minutes in which loud calls were recorded, to 9:56am. After then, the bird became silent, except for occasional faint (and presumably, distant) calls until 10:51am, when a new pattern of frequent calling began.

At this stage, there seems no ready alternative explanation for the different calling behaviour on the two days.

Calling patterns of the Munro Hut Rufous Scrub-bird in other months

February 2011

The Song Meter™ was in position for ~50 hours, from 12:45pm on 10 February. It recorded from 5:30am to 8:30pm daily. The weather conditions are believed to have been favourable for at least the majority of the time that the Song Meter™ was in place.

In this first attempt at long-term monitoring, the unit was not placed as close to the calling node of the territory and this made detailed analysis of the bird's behaviour difficult. It began calling just after 6:30am both mornings, shortly after dawn. The first morning involved a 30-minute calling session, with some multi-syllable phrases. Dawn calling on the second morning was for just 15 minutes. Over all three days, the scrub-bird only called intermittently. Most of the bouts involved single syllable phrases, delivered in calling sessions of <10 minutes. Often there was an interval of an hour or so before the next calling session began. Multi-syllable phrases were uncommon, and usually involved a maximum of 4 syllables. Leading up to dusk on the first evening, the bird called for 10 minutes using 7-syllable phrases. However, the following evening it only uttered sporadic calls before dusk, with most of these being single syllable phrases.

May 2012

The Song Meter™ was in place for ~148 hours, from 9:30am on 16 May. It recorded from 6:30am to 7:00pm daily. The weather conditions during the recording session were not always favourable, as evidenced by the frequently recorded presence of background noise due to wind, in particular in the final 2 days.

The scrub-bird commenced a 20-30 minute calling session at about 6:30am each day. During each day, there were several calling sessions, typically lasting for 15-30 minutes. At other times, the bird was silent or issued single phrases occasionally. In general, each calling session involved several bouts in between which the bird was silent for a few minutes.

Although many multiple syllable phrases were delivered during each day, it was uncommon for them to be of >3 syllables. Single syllable phrases predominated. Also there was a higher proportion of calls assigned to mimicry. However, in the late afternoon leading into dusk, the scrub-bird had longer calling sessions. These lasted for 1-2 hours and involved many multi-syllable phrases, up to a maximum of 11 syllables in a calling session which commenced at 3:15 pm on 18 May. A 1-hour calling session from 8:20am on 19 May also involved many multi-syllable phrases, including some of 10 syllables.

Detectability of Rufous Scrub-birds by intrusive and non-intrusive methods

Transects walked at 1 km/h

Under ideal conditions, an experienced surveyor can hear a calling scrub-bird from >150m away (Ferrier 1984). For transects conducted at 1km/h (Newman & Stuart 2011) on walking tracks through potential scrub-bird territories, the surveyor will spend 12-20 minutes within earshot of a scrub-bird if it calls (the time depends on how far in from the track the bird happens to be). The probability that a diligent surveyor will detect a scrub-bird depends on whether the bird calls during the time that the surveyor passes through the territory. On 21 September, and in the afternoon of 20 September, the probability that the scrub-bird would have been detected is 100%, as the intervals between calling sessions were <10 minutes. The following day, the bird only called for a total of 26 minutes between 6:20 am and 9:36 am and the probability of its being detected during that period is low (estimated at <15%). Its

detectability then increased since it began calling more often.

In February 2011, the Munro Hut scrub-bird called infrequently, in sessions lasting <10 minutes and with long intervals between sessions. The probability that it would have been detected is low. In May 2012, the scrub-bird was readily detectable for periods around dawn and dusk. For the remainder of the day, it called for periods of 15-30 minutes with silence or occasional single syllables in the intervening times. The probability of it having been detected in May, in a single transect through the territory at 1km/h, was estimated to be in the range 25-50%.

For a surveyor only able to reliably detect the multi-syllable chipping call, the scrub-bird's detectability is further decreased since many of the calling bouts, especially in February and May, involved single syllable calls or mimicry.

Transects at 2.5 km/h by an experienced surveyor

At 2.5km/h there would be a period of 4-6 minutes, depending how far from the track the bird was, in which a surveyor would hear the bird if it was calling. Applying this faster transect pace to the Munro Hut scrub-bird would appreciably lower its detectability, particularly for an observer relying on the chipping call being used. However, an experienced surveyor who is able to recognise other calls of the Rufous Scrub-bird has greater opportunities to detect the bird.

Ferrier (1984) developed an algorithm to predict the detectability of Rufous Scrub-birds in transects walked a single time at 2.5km/h by an experienced surveyor. The results from the present study fit moderately well with Ferrier's predictions. **Figure 7** superimposes our estimates of the detectability of the Munro Hut scrub-bird in transect surveys walked at 2.5 km/h onto plots of Ferrier's algorithm for Gloucester Tops scrub-birds under three sets of conditions:

- Most favourable conditions (humidity >85%, no wind/mist)
- Poor conditions (humidity <60%, moderate wind, some mist)
- Very adverse conditions (humidity <60%, high wind, dense mist)

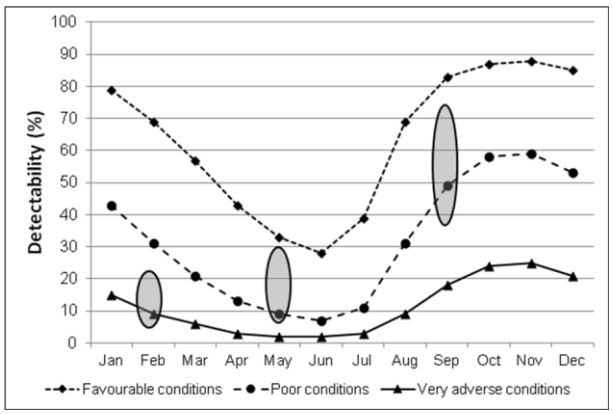

Figure 7. Predicted detectability of the Munro Hut Rufous Scrub-bird in February, May and September, superimposed on the predictions by Ferrier (1984) for Gloucester Tops scrub-birds.

In **Figure 7**, ranges are used for predicting the detectability of the Munro Hut Rufous Scrub-bird in February, May and September. The ranges reflect that sometimes the scrub-bird called more frequently than at other times. More precise predictions of the detectability are beyond the scope of this paper. The superficial agreement between our analysis and Ferrier's algorithm is good for the May and September periods. However, in February 2011, when the conditions are understood to have been generally favourable, we found the detectability of the Munro Hut bird to be much lower than predicted from Ferrier's algorithm. It is important to note that the algorithm was derived for a population of Rufous Scrub-birds and the behaviour of individual birds is probably less readily predicted.

A stationary surveyor

It is useful to consider how long a surveyor need remain at a suspected Rufous Scrub-bird territory in order to confirm that it is occupied. In September, the longest interval between calling sessions was 90 minutes, in the morning of 22 September. Most of the calling sessions had far shorter intervals. In February and May, the scrub-bird had calling sessions at intervals usually of less than 1 hour, although often these were only a few minutes duration and did not involve multi-syllable chipping calls. The longest interval between calling sessions was 102 minutes (on 10 February).

If a surveyor had waited for 2 hours at the Munro Hut scrub-bird territory in February, May or September, they would have detected the bird provided that they were familiar with the full repertoire of Rufous Scrub-bird calls and that they

remained diligent throughout their wait (and that weather conditions did not become adverse).

The alternative to a fixed surveyor is to use a Song Meter™. This has marked advantages if the unit is deployed overnight because our studies indicate periods of increased calling activity near dawn and dusk, when it is difficult logistically to have a surveyor in place given Rufous Scrub-birds live in remote areas. Indeed if a Song Meter™ deployed for 24 hours failed to detect a calling Rufous Scrub-bird in the breeding season it could be confidently concluded that a territory was unoccupied.

Automated analysis of recordings

Using the Song Scope™ software, an electronic "recogniser" for the multi-syllable chipping call of the Rufous Scrub-bird has been developed, based on a set of calls made by the Munro Hut scrub-bird. Because of the varied quality of recordings, the "recogniser" is far from ideal as yet. Of the 222 multi-syllable calls delivered during the two 1-hour detailed analyses, only 23.6% were detected by the "recogniser". Therefore, it is not able to be used for detailed analysis of recordings. However, as Rufous Scrub-bird calling bouts can involve 20 or more phrases, the probability of detecting at least one multi-syllable chipping call during a bout is very high. For example, for a bout of 20 calls, the probability of detecting the bout is >99.5%.

The electronic "recogniser" has successfully identified calls by scrub-birds in recordings made at the other sites listed in **Table 1**. Thus, it can be used to assist rapid screening of whether a scrub-bird is present at a particular site, or to check if it made any calls within some period of interest.

CONCLUSIONS

The Song Meter™ has been shown to be an effective and non-intrusive means of studying Rufous Scrub-birds. Their calling patterns have been shown to vary during the year. This has implications for the monitoring program, as sometimes there will be only a low probability of successfully detecting a scrub-bird at its territory. It will be important to further improve the understandings about how the scrub-bird's calling patterns vary during the year.

Some progress has been made in developing a software-based means of rapid and automated scanning a Song Meter™ recording for Rufous Scrub-bird multi-syllable calls. Although it fails to detect many individual phrases, the probability of detecting a bout of calls is high.

Future directions

One aspect of the future work will be to record the Munro Hut scrub-bird in many other months of the year, to improve understandings of how the calling patterns vary. We also aim to extend this seasonal study to some other Rufous Scrub-bird territories in the Gloucester Tops, to see if the patterns are similar for those other birds. Anecdotal evidence suggests that the Munro Hut bird calls more frequently than other scrub-birds in the Gloucester Tops area.

Further development of the software-based "recogniser" will be targeted. This will improve its usefulness as a tool that assists the ongoing studies. Extension to "recognisers" for other Rufous Scrub-bird calls, for example "seeps" and "whistles", will also be addressed. This software development will make it easier to screen for scrub-birds at suspected or previously inhabited territories.

Of longer-term interest will be to investigate whether individual scrub-birds can be identified from their sonogram signals. If so, that potentially will allow non-intrusive studies of the longevity of individual birds. The technique has been used successfully for some species, for example Rufous Bristlebirds *Dasyornis broadbenti* (Rogers & Paton 2005). However, Noisy Scrub-birds *A. clamorus* could not be identified individually (Portelli 2004) and Portelli was pessimistic about the prospects with *A. rufescens*.

Finally, it is clear that the non-intrusive nature of the Song Meter™ has a potential role in the monitoring of other cryptic territorial species, for example bitterns, crakes, owls.

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Australian Pied Oystercatchers leapfrog to reproductive success in the Worimi Conservation Lands

Nadine Russell and Robyn George

National Parks & Wildlife Service, 7B Teramby Road, Nelson Bay NSW 2315, Australia
Nadine.Russell@environment.nsw.gov.au
Robyn.George@environment.nsw.gov.au

A pair of Australian Pied Oystercatchers *Haematopus longirostris* successfully raised one juvenile in the Worimi Conservation Lands north of Newcastle, NSW. Oystercatcher breeding success is very low at this location, which is subject to extremely high levels of recreational disturbance. Reproductive success was achieved by adopting a strategy which involved the selection of a nest site in a physically protected midden area and flying in food to provision the chick throughout the fledging period. This strategy is similar to that used in "Leapfrog Territories" in the Netherlands. However, there may be penalties associated with this strategy and the Netherlands experience suggests that when more than one chick is involved they usually starve.

INTRODUCTION

During our regular patrols of the Worimi Conservation Lands north of Newcastle NSW (previously known as Stockton Beach) as part of our role as Visitor Service Assistants for National Parks and Wildlife Service, we took the opportunity to monitor the breeding activities of the Australian Pied Oystercatcher *Haematopus longirostris*. Five pairs of oystercatchers hold territories along the 32km length of the Worimi Conservation Lands. In the 2011/12 season one pair fledged a chick, which is very unusual on this particular beach. In this note we document the breeding event and explain the strategy adopted by the birds to overcome the extreme disturbance associated with recreational activities in the park, which normally results in breeding failure.

OBSERVATIONS

Oystercatcher numbers and breeding activity were observed and recorded during routine beach patrols, which are conducted approximately five times per week in off-road vehicles.

In recent years the resident oystercatchers' nests were mainly found at the base of the frontal dunes, and they were almost always unsuccessful. By nesting in this location, they were subject to high levels of disturbance due to high-density traffic (which can exceed 1200 vehicles/day during peak periods), domestic dogs, campers, high tides and various natural predators. In the 2011 breeding season we perceived a change in nesting behaviour. The oystercatchers were observed more frequently nesting behind the frontal dunes and away from heavy traffic flow along the beach. On 15 September 2011 we discovered four oystercatcher nests in this new location and a further three nests over the following month and a half (**Table 1**). We believe that five pairs of oystercatchers were involved, all occupying territories within an approximately 4km strip of beach south from nest 7 (**Table 1**), which was located at 32°47.77' S 151°59.89' E.

Table 1. Summary of clutch information for Australian Pied Oystercatchers nesting in the Worimi Conservation Lands during 2011.

Nest	Date found	Number of eggs	Date failed[1]
1	15 Sept.	2	19 Sept.
2	15 Sept.	1 [2]	10 Oct.
3	15 Sept.	2	25 Sept.
4	15 Sept.	2	26 Sept.
5 [3]	14 Oct.	2	Unknown
6	14 Oct.	1	Unknown
7	2 Nov.	2	Successful

[1] Date first noticed that eggs were missing and no evidence of young.
[2] Second egg present on 19 September.
[3] Nests 5 and 6 are thought to be repeat attempts of some of the pairs involved in nests 1 to 4.

Nest 7 was located in a Midden Protection Area which is surrounded by bollards and into which entry by any vehicle is prohibited. The Midden Protection Area is heavily vegetated in places making it an ideal place for nesting parents to hide their young. The nest site, which was approximately 300 metres from the high-tide mark and well behind the frontal dunes, was a scrape in open ground located near broken bits of dead wood. The bird sitting on the nest was well camouflaged and difficult to spot. The other bird, when not on the shore foraging, would be at the top of the dune closest to the nest, watching for threats and calling out a warning to its partner sitting on the nest. To our knowledge this was the first breeding attempt for this pair during the 2011 season.

During a routine check of the nest on 9 December we discovered that there was no bird sitting on the eggs. We approached the nest to find one egg gone with no shell remnants remaining and the other still intact and completely cold. The parents were not in sight, but there had been a lot of activity around the nest, which was evident from footprints. We tracked the bird prints to a clump of Bitou Bush in the Midden Protection Area. One chick was hiding in the sand among a few small leaves under the bush. Meanwhile the parents were calling vigorously and attempting to distract us from their young. After sighting the chick and very, very thrilled to know that the egg had hatched, we left.

The next sighting of the chick was on 19 December. We came across the parents taking the chick towards the shore. Once our presence became known the oystercatchers began to call to the chick, which ran and hid in the roots of some Bitou Bush about 150 to 200m from the high-tide mark. The chick appeared to have doubled in size and we estimated it to be around two to three weeks old.

During the next few weeks we did not spot the chick. One adult bird would feed on the shore and the other would remain in the Midden Protection Area, but the location of the adult bird and footprints suggested that the chick had been moved further into the dune system to an area approximately 500m from the high-tide mark where the Bitou Bush cover was heavier. We never saw the chick on the shore feeding, so we assumed that the parents flew food into the area, at least during the day time.

On 13 January 2012 while checking the vicinity of the nest site we saw the juvenile flying with one of the parent oystercatchers. When the adult alighted and called, the juvenile flew to it, moving a distance of 50 to 80 m from one midden site to another. The first sighting of the family on the shore was on 2 February 2012. All three were at the water's edge foraging for food and presumably teaching the juvenile about life outside the Midden Protection Area. The young bird, now about 8 or 9 weeks old, was well grown.

On 21 February we saw a juvenile bird, immediately distinguished by its darker bill tip, pale legs and browner plumage, on its own approximately 4 to 5km south of the nest site and foraging independently. We assumed that this bird was the successfully fledged chick, but the possibility of a juvenile oystercatcher which had been bred somewhere else cannot be excluded.

DISCUSSION

Ideally oystercatchers nest near the high tide mark (Fletcher & Newman 2010) and from an early age onwards chicks follow their foraging parents out to the foraging area as the tide falls and are fed prey as soon as it is captured (Ens *et al*. 1992). However, in the Netherlands many of the breeding Eurasian Oystercatchers *Haematopus ostralegus* studied by Ens were unable to secure a beachfront territory and had to nest in inferior territories behind the pairs nesting immediately adjacent to the feeding areas. These inferior territories were named leapfrog territories because the oystercatchers breeding in them had to fly food from their foraging territory to their chicks, which remained within their breeding territory until they were able to fly with their parents to the water's edge. Adults breeding in leapfrog territories adopted this strategy as a consequence of the strongly territorial behaviour of the oystercatchers breeding in the superior territories at the beachfront. It would be extremely unsafe if chicks were walked twice daily through the territory of another pair, with the possibility of fatal attacks on the chicks by the resident birds. The strategy adopted by the successful oystercatcher pair at the Worimi Conservation Lands in many respects mirrors those of leapfrog territory parents in the Netherlands, except that the need to breed in an inferior territory is a consequence of human recreational disturbance rather than to avoid competition with another pair of oystercatchers. At peak times over 1200 vehicles enter the northern entrance of the Worimi Conservation Lands and at these times the beach resembles a highway, making it impossible for unfledged chicks to walk

to the water's edge and feed with the adults (when disturbed, chicks often freeze and would be run over by vehicles).

In previous seasons the oystercatchers holding this territory have used nest sites in the dune system near the edge of the beach. Such sites, used by these and other pairs, are often located in open areas between dunes which are vulnerable to inundation by king tides and suffer disturbance from vehicles. In response to these threats a number of pairs have selected nest sites well back in the dune system, as occurred in this successful breeding attempt. On this occasion the oystercatchers selected a site in a midden area which is marked and protected by permanent bollards, approximately 300m from where the adults forage. Vehicles are supposed to avoid middens because of their cultural heritage importance. It is suggested that the oystercatchers identified the midden area as a preferred site because it was subject to less disturbance. It is also a flat, slightly elevated area providing some protection from tidal inundation with excellent visibility for the incubating bird. This is important as a predator defence, both for the incubating adults (e.g. from foxes and cats) and also for the protection of the eggs from predators like Australian Ravens *Corvus coronoides* (Fletcher & Newman 2010), which are locally abundant (there is no shelter for ravens from aerial attack by parental oystercatchers).

During the fledging period we never observed the parents feeding the chick on the beach where the adults foraged exclusively (there are no foraging opportunities in the dunes). As we patrolled the beach most days it can be concluded that diurnal feeding of the chick at the water's edge, either did not occur, or was extremely rare until the bird fledged. However, we cannot discount the possibility that the chick was moved to the beach at night when there was no disturbance. Initially the chick remained hidden under a Bitou Bush close to the nest site, where it was fed. After about two weeks the chick was moved further into the dune system and hidden in an area where there were more Bitou Bushes offering protective cover options, but increasing the distance the adults had to fly food to the chick up to 500m. Presumably the disadvantage of flying food the extra distance was more than offset by decreased risk of injury through recreational activities and of predation, it being less obvious where the chick was hidden.

The studies in the Netherlands found that on average the breeding success rate was 3.5 times lower for oystercatchers breeding in leapfrog territories compared with the situations where the chicks could be taken out and fed by the adults on mud flats. Chick mortality was found to increase as the number of chicks being fed increased, primarily due to starvation, which was particularly pronounced during the period immediately before the chicks were able to fly. At this time leapfrog parents would need to spend approximately 1.1 hours extra time flying food to the chick each low-water period to provide as much food as a chick being fed at the water's edge; no parent was ever observed achieving this level of support. As a consequence leapfrog chicks took on average 4 days, or 10% longer to fledge and were 58g, or approximately 15% lighter than chicks which foraged with their parents. As the Australian Pied Oystercatcher is larger than the European species, these differences may be expected to be greater for oystercatchers breeding in leapfrog-type territories in the Worimi Conservation Lands.

The juvenile observed feeding independently approximately 3 weeks after the chick was last seen with the adults and 6 weeks after fledging was assumed to be from this breeding event. However, Australian Pied Oystercatchers often allow their young to remain in their territories for more extended periods (M. Newman pers. comm.) so the possibility that the juvenile died after fledging cannot be excluded. Later in the year several juvenile oystercatchers were observed foraging on the beach to the south of the rather limited stretch of beach where the five pairs breed.

CONCLUSIONS

A pair of Australian Pied Oystercatchers breeding on the Worimi Conservation Lands adopted a successful strategy which traded off increased safety during both the incubation and the chick-rearing stages of the breeding cycle against increased effort in provisioning the chick. It was probably advantageous that only one egg hatched as the probability of chick starvation in the period immediately before fledging would have increased if the adults had been feeding two siblings as opposed to a single chick.

Dual management priorities for the Worimi Conservation Lands are the protection of cultural, heritage and wildlife values. In this instance the protection of a midden contributed to the breeding success of a pair of Australian Pied Oystercatchers.

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Pacific Black Ducks: insights on their behaviour in an urban backyard

Grahame Feletti and Anne Feletti

7 Hooper Street, Charlestown, NSW 2290, Australia
feletti@hunterlink.net.au

This report highlights findings from an intensive study of a pair of Pacific Black Ducks *Anas superciliosa*, which regularly visited our suburban backyard in a six-month period from October 2011 to April 2012. Close observations of digital photographs enabled us to identify the duck from the drake non-invasively. This in turn helped us to assign sex differences in their feeding and social behaviour with some confidence. We report on four areas of interest that emerge from over 100 observations of this pair. The first concerns the optimal identification of each sex. The second concerns their social, sexual and agonistic behaviour in a suburban context, since researchers have little previous knowledge outside the nesting environment in natural habitats. The third concerns 'sex-linked' (or at least individual) differences in feeding and general behaviour of this pair, including interaction with other suburban birds. The fourth relates to their social interaction as a pair, and to the drake's behaviour in the absence of the duck.

INTRODUCTION

The Pacific Black Duck (PBD) is not only well known across Australia and neighbouring Pacific island nations but has been carefully studied by biologists in terms of its morphology and breeding characteristics, and the general behaviour of conspecifics in natural habitats like rural waterways and river systems (Marchant & Higgins 1990). This species is also attracting human contact as a 'de facto' pet in domestic and urban locations, as a quick Internet search ('Pacific Black Duck') of photos and video-clips on YouTube shows. Recent research by urban ecologists has focussed on PBDs' newly observed feeding behaviours when given bread by visitors at urban waterways, lakes and public recreation areas in south-eastern Queensland (Chapman & Jones 2012). Such behaviour may be indicative of native species' capacity to survive in close contact with humans in urban environments. To date, research on sex differences in PBDs' feeding and social behaviour are rare – whether away from conspecifics, or in different habitats (Johnsgard 1960) but may add useful insights into their adaptability. One inherent difficulty for researchers is that the PBD is sexually isomorphic; hence the basic challenge to identify the sex of these birds reliably and non-invasively.

METHODS

We reviewed two main data sources on the PBD. One was the comprehensive report in Marchant & Higgins (1990) on its geographical distribution, morphology and behaviour in natural environments. The second was annual bird count data on the PBD in the Hunter Region, summarised in Stuart (1994-2011).

We began observing two PBDs in our suburban backyard in Charlestown (32º 57' 33" S, 151º 04' 09" E), when they made three visits on 20 October 2011. In the period to 1 December, we noted the number and time of day of visits, whether they arrived singly or together, and digitally photographed them feeding from a distance of 3-10m. We related our photos and observations to descriptions given in Marchant & Higgins (1990) in attempts to identify the sex of each bird. This source was useful on most aspects of the PBDs' morphology and behaviour, but their large-scale research summary from Australia and New Zealand had two limitations. First, in the absence of non-invasive methods for determining the sex of PBDs (Marchant & Higgins 1990) observation alone could not accurately identify sex of PBD; their behaviour was also important. Guidelines for invasive (genital) recognition are described by Dunstan (2010), but this method would have been inappropriate here. Second, previous studies related to sexual and social behaviour in natural habitats (i.e. with conspecifics, in open water). Our context was quite different. Consulting other references on bird behaviour and field guides also had limitations, but using 10x42 binoculars, 7.2 megapixel photographs and close observations, we defined key features to help identify their sex.

These waterbirds may have been attracted to our yard initially by bird seed we spread on the lawn for pigeons and parrots. When the PBD visits became regular (in November) we changed to commercial poultry food, with a minimum 15% protein, 2% fat, 7.5% crude fibre and 0.3% salt, from a mix of crushed peas, lupins, sorghum, chaff, maize, black sunflower seeds and various vitamins to supplement oil to feathers and egg production. We spread up to half a cup per half-day visit to replenish this source, in a feed zone 1-2m from a water bowl filled with rainwater.

In the period 3 December 2011 to 30 April 2012 (when visits ceased) a more detailed diary of the PBDs' behaviour was kept, including direction of arrival and departure, duration, number and time of day of visit, sex of duck and its general social and feeding behaviour, plus any relevant incidents. During, and after this period, we made field observations of PBDs at several other public habitats – the main one being Charlestown Golf Club (32º 57' 46" S, 151º 40' 29" E), one km away. Records of these observations enabled us to test working hypotheses from backyard observations.

RESULTS

Our review of PBD observation summaries in this region indicated that it is thriving in the Hunter Region – with reported numbers of at least 50 at up to 20 small to large wetlands since 1993. Detailed records from 2001-11 show peak counts over 300 in less populated and protected waterways around Newcastle (554, Apr 2011 near Morpeth; 308, Feb 2010 in the Hunter Estuary; 350, Sep 2008 near Minmi; and 831, Nov 2008 near Hexham). Counts are also steady or rising on a seasonal monthly basis at various suburban parks and lakes (e.g. 21-100 at Hunter Wetlands Centre 2010-12: Paddy Lightfoot pers. comm.).

In the period from October 2011 to April 2012 we observed PBDs in our yard 117 of 192 days. There were four days when we made no recordings at all; these were not consecutive. As **Table 1** shows, there were substantive periods of daily visits by one or both birds, as well as periods when neither bird appeared (70 days). Visits were typically made twice daily (pre-dawn to 0800h; 1600h to dusk), and always involved feeding. At times their visits seemed sporadic. The birds were observed arriving together on at least 50 visits; but more often they were seen feeding together (113 visits). No intra-specific aggression between the pair was observed when feeding; however some consistent differences were noted in the rate and pattern of each bird's feeding behaviour. Their arrival to and departure from our backyard was either west (towards Charlestown Golf Club) or east (40 m to a neighbour's chlorinated pool).

Table 1. Sequence and numbers of visits by PBDs for given periods

Period (no. of days) Oct 2011-Apr 2012	Days 1 or 2 ducks seen	Arrived together	Fed together
Oct 20-27 (8)	8	NR	17
Oct 28-Nov 5 (9)	0	0	0
Nov 6-11 (6)	6	11	11
Nov 12-30 (19)	0	0	0
Dec 3-Jan 7 (38)	37	9	19
Jan 8-Feb 2 (26)	0	0	0
Feb 3-8 (6)	6	10	11
Feb 9-19 (11)	0	0	0
Feb 20-Apr 6 (46)	46	18#(30 NR)	50
Apr 7-11 (5)	0	0	0
Apr 12-29 (18)	14	2	5
Total (192)	**117**	**50#**	**113**

#Totals are under-estimates; NR indicates Non-Recorded data

Physical features of the PBD, a dabbling duck, are broadly described in Marchant & Higgins (1990, p.1320). Normally it is not possible to visually separate duck and drake PBDs in the field. However, in our context of seeing the pair of birds feeding together, it was possible to discern key features like relative size, feet colour, and subtle differences in plumage and overall colour. The most helpful features we used, which have been determined using invasive examination of captured birds in previous studies, are as follows. The drake's plumage appeared dark brown due to thinner buff margins on the upper wing and back feathers; it had mustard-coloured feet. The duck appeared lighter brown due to broader buff margins on its upper wing and back feathers; it had a distinctive and irregular pattern of brown and buff lines down its back, and it had dark brown feet. Repeated observation of these distinguishing features enabled us to identify their sex reliably, and thus tag their behaviour when they visited singly or together.

It was also noted that the green-purple (iridescent) speculum feathers appear on both duck and drake. Our photographs also showed either sex covering its speculum - on different occasions, standing or swimming.

Social, Sexual and Agonistic Behaviour

Being able to reliably distinguish duck from drake allowed us to identify each bird's visit frequency and behaviour. Of the 117 days either appeared,

the duck was present 87 days (128 visits) compared with the drake's 116 days (178 visits). The duck did not appear for 37 days after 28 December, nor again after 20 April. We did not see them perform any mating rituals, but they usually self-preened beside each other. We also do not know if the duck was laying/incubating or raising a brood (its exclusive role) in the 192-day period – whether at the golf course or nearby. Their non-visit periods do not seem long enough for successful breeding – based on data in Marchant & Higgins (1990, p. 1328). Interestingly, when they arrived separately it was often within (5-30) minutes of each other, and from either west or east. If the duck arrived first, it began feeding rapidly and departed within 15 minutes - if the drake had not yet arrived. Conversely, if the drake arrived first, sometimes it waited 30-60 minutes before feeding and departing. When the birds arrived together, they tended to stay (on average, 10 minutes) longer than either stayed if it arrived alone. In either case the bird(s) then flew to the neighbour's yard, where they would loaf beside the pool; but they also revisited from that location to feed.

We noted the drake's agonistic behaviour (22 February 2012, 0718h) when three PBD arrived in our yard. Two walked down to the feed zone and water bowl; the third remained where it landed several metres away, seeming unsure of the situation. One of the pair (presumably our 'residents') broke away from feeding and confronted the third where it stood, chest to chest. The resident identified as the drake then engaged in wing joint and beak biting for about five seconds before the third bird, also a drake, started to retreat. The resident drake then chased the other round the yard on foot and without either calling for one minute before both flew off in the direction they arrived. Meanwhile the duck continued feeding and drinking; it took no part in the altercation. The resident drake returned several minutes later and the pair resumed feeding before departing. All this happened in five minutes (our photographs confirmed the sex and identity of the three birds).

The duck also exhibited 'exploratory' behaviour in this suburban context, especially after the pair returned from a substantial 'non-visit' period. They would arrive together, move to the familiar feeding zone and resume previous feeding patterns. After feeding, the duck would wander around the yard, or under our verandah – perhaps exploring nesting or resting sites. The drake would follow her into long grass in the yard, but held back when she ventured under the house. Once, after taking off, the duck perched in and briefly inspected the fork of a neighbour's Silky Oak tree (*Grevillea robusta*), a recent nest site of Laughing Kookaburras *Dacelo novaeguineae*. Both birds also perched on our fences, barbeque or shed roof – just observing their surroundings.

Feeding Behaviour

Most striking was the difference in their feeding patterns, recorded over 113 visits together. Soon after the duck landed it would scurry over to the water bowl, sip several times or feed rapidly on the poultry grain mix. It repeated this two-step sequence every few minutes – some 3-5 times per visit. The duck invariably added a third behaviour to its pattern, using its bill to add nearby sand or loose dirt to the water bowl and 'suzzle' the mix, as if filter-feeding at the bottom. A fourth step involved preening its breast and upper wing feathers with the muddy water. By contrast, the drake on arrival would invariably nibble the grain and 'chatter', finish early and then stand still near the duck – seeming more attentive than it to local bird sounds and movement. When the duck had finished its cycles of feeding, drinking, mixing and preening, it walked out to the open lawn, repeated a head-nod signal and took off. The drake quickly followed. The drake was not seen to drink from the bowl when the duck was present (and had made the mud-mix). Neither bird 'competed' for food or water in this context, and typically fed next to each other. As mentioned before, if the duck had not arrived, the drake's feeding pattern reversed – in that it often waited a considerable period before feeding, and then typically flew off to the pool.

On numerous occasions, when feeding singly or together, the PBDs were joined by up to nine Crested Pigeons *Ocyphaps lophotes* and Eastern Rosellas *Platycercus eximius* also seeking the grain. Occasionally we observed mock-nipping from the duck when these birds brushed feathers but no pursuits or defence of its feeding zone. On three occasions an Australian Magpie *Cracticus tibicen* swooped and landed, attempting to intimidate them while feeding. The drake immediately confronted it, head down and neck extended, and the Magpie flew away. On other occasions, both birds seemed alert to calls of roving Laughing Kookaburras, Pied Currawongs *Strepera graculina* and Australian Ravens *Corvus coronoides*.

Interaction with Observer

Two unexpected and remarkable behaviours of the drake occurred in the presence of GF, during the period 21-29 April when the duck had stopped visiting. On the first day post-separation the drake seemed more wary and unsettled when it arrived to feed at 0645h and again at 1655h. It displayed a familiar 'full threat' behaviour pattern seen previously whenever GF walked past both birds on the way down to the feed zone. Similar intra-specific aggressive behaviour has been described of Mallards by Lorenz (1967, pp. 49-50), but in our case the PBD drake's pattern included: (1) head and neck extended low to the ground; (2) bill open as if to bite anything close; and (3) initially walking in the same direction (towards the feed zone) with its head and neck at an angle to its body line, effectively looking over its shoulder. Its path seemed to loop around and behind GF (to the left or right). Once GF had overtaken it, the drake resumed the same natural gait as the duck when the two fed together. A fourth sign of its wariness was to stay back two metres until the grain mix had been spread out and GF withdrew. For the next few days post-separation the drake fed steadily for up to 10 minutes (often surrounded by 5-9 Crested Pigeons), and then rested for 20-30 minutes on open lawn. Its departure pattern was also typical; the drake would suddenly seem alert, give a quark-like call several times and listen, then fly off.

By 24 April, the drake's behaviour changed noticeably. First, its threat pattern dropped in intensity on all four signs above and his general behaviour was more like the duck's, i.e. normal gait despite GF's presence nearby. Second, the drake moved away from the feed zone to the middle of the lawn after feeding. This put him only five metres from GF – sitting quietly under the verandah, wearing a baseball cap; this may be a visual feature the duck used to identify GF. When GF nodded several times to it; the drake lifted its head and neck, as if fully attentive. After a 15-second pause GF nodded again, and the drake paused, turned to face east (the direction of the pool) and flew off. This did not appear to be a fright response. The same scenario presented itself over five more days. Each time the drake finished feeding, it walked to the middle of the lawn. GF waited a minute, and started head nodding when the drake looked his way. Again, the same response from the drake; head erect and slight shuffle of feet, before taking off – just as we had observed previously when the duck gave the same signal.

DISCUSSION

Any short-term intensive study has its limitations, but our records show consistency (i.e. reliability) over many observations (determining sex of duck and drake) and of their observed behaviours. Social and agonistic behaviours reported of the drake in this suburban context match those we have also observed, and have been reported of PBDs, in more natural habitats with conspecifics. Our study also offers new insights into the remarkable adaptability of the drake, and raises the question of how flexible (or vulnerable) are seemingly instinctive behaviours like its response to take-off signals by GF in the last week when the duck was absent. This response was evoked five days in a week. Similar imprinting behaviours have been reported by Lorenz (1967) in captive and tame but wild birds of 'higher intelligence'.

The drake's protective behaviour clearly extended far beyond its nest site in natural habitats; our backyard was a very different, urban setting. GF regularly observed its ritual threat display towards him when the duck was nearby, and its sudden and intense intra-specific aggression towards the stray male PBD. Equally surprising was the progressive decrease in the threat display when the duck was not present. Controlled experimental studies of the kind described by Lorenz (1967) may shed light on this. Other research questions relate to the pair's dietary needs and differences in feeding behaviour. Why did the duck eat the grain mix so rapidly compared to the drake, and why drink so often? Why did it mix dirt into the water and proceed to drink and preen with it? Are these also esoteric (learned) behaviours, or sex-linked, or species-specific, and/or related to her breeding cycle? A plausible hypothesis (such as the duck's need for substantial protein intake related to egg laying and brooding) could be made if the pair was breeding during the period of observation. If not, expert advice or controlled research on the pair's normal metabolism may be helpful.

Our observations and literature reviews add fresh perspectives on the pair's capacity to adapt to (new) urban environments - a process called synurbanisation by Luniak (2004). Few species of Anatidae may have the physiological capability to brood rapidly in either tree- or ground-nesting contexts. Apart from that, the duck's exploratory behaviour in our backyard, its rapid feeding behaviour and its signalling when and where to take off accentuate her stake in their successful breeding – under the watchful, protective behaviour of the drake. The question remains on

whether our observations are generalizable to same-sex or species-specific behaviour, or simply represent individual differences in this pair. Either way, the PBD warrants more research and public education in its growing interface with humans in urban settings.

ACKNOWLEDGEMENTS

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Observations of Regent Honeyeaters in the lower Hunter Valley of New South Wales during winter 2012

Michael Roderick and Dean Anthony Ingwersen

BirdLife Australia, 60 Leicester Street, Carlton, VIC 3053, Australia

The Regent Honeyeater *Anthochaera phrygia* is an endangered species of honeyeater that occurs in open forests and woodlands from south-east Queensland to Central Victoria. Its range formerly extended into South Australia but it is now considered extinct there (Geering & Ingwersen, in prep.). The species has undergone a severe contraction in range and drop in population such that it is now listed nationally as 'Endangered' and as 'Critically Endangered' within New South Wales (NSW), the state which forms the stronghold for the species. It is generally accepted that the total population of Regent Honeyeaters is fewer than 1000 birds, but a review of recent data suggests it may be significantly lower than this (Regent Honeyeater Recovery Team unpublished data).

Regent Honeyeaters occur regularly within the Hunter Valley (e.g. Stuart 1994-2011; Roderick & Stuart 2010; Barrett *et al.* 2003) and the area has traditionally been recognised as an important supplementary or subsidiary foraging area for the Capertee Valley sub-population (Geering & Mason 2009; Geering & Ingwersen in prep.). The species also occurs in areas proximate to the Hunter Valley, particularly around Lake Macquarie and the NSW Central Coast (Barrett *et al.* 2003; A. Morris pers. comm.).

In the lower Hunter Valley (defined as those parts of the valley coastward of about Jerrys Plains), Regent Honeyeaters predominantly occur in the dry open forests in association with the seasonal blossoming of winter-flowering Eucalypts such as Spotted Gum *Corymbia maculata.* The species may persist and breed if blossoming occurs in spring-flowering Eucalypts such as Forest Red Gum *Eucalyptus tereticornis,* Broad-leaved Ironbark *E. fibrosa* and Brown / Blue-leaved Stringybarks *E. capitellata / E. agglomerata.*

In early April 2012 it was evident that Spotted Gums were beginning to flower across a broad area centred on the Cessnock Local Government Area (LGA). Significant blossom started to appear at Pelton within Werakata State Conservation Area at this time and it had been noted that many Spotted Gum trees in the area had been carrying substantial bud for at least 18 months (M. Roderick pers. obs.).

The first record of Regent Honeyeaters came on 6 May 2012, when 2 individuals were seen along the Kearsley South Fire Trail in Werakata National Park near Kitchener (D. Lyons pers. comm.). The number of birds recorded at this site built to a maximum of 27 during the national survey weekend co-ordinated by BirdLife Australia on 20 May. During that same survey, 4 birds were also recorded at Pelton and a further 16 birds on private property at Quorrobolong. Surveys on the Quorrobolong property 3 days later, including areas that were not surveyed on 20 May, revealed >40 birds indicating that at least 71 Regent Honeyeaters were present in the lower Hunter Valley on 20 May.

In the ensuing weeks, greater numbers were seen at the Quorrobolong property. On 30 May, observations suggested that there were 50+ birds on that property alone suggesting that the previous minimum estimate should be raised from 71 to at least 80. Further to this and the other sites surveyed on 20 May, Regent Honeyeaters were also recorded on two separate parcels of Crown Land south of Kurri Kurri and in bushland south of Ellalong; with two of these sites being in areas where they had not been previously recorded (Regent Honeyeater Recovery Team unpublished data). The total number of birds at these three latter sites was counted as approximately 40 (authors pers. obs.).

The birds south of Ellalong and south of Kurri Kurri almost certainly were distinct from the Quorrobolong and Kitchener birds. We have concluded that all of the sightings of Regent Honeyeaters involve distinct groups due to the availability of blossom at each site and the fact

that the Quorrobolong birds appeared to be a stable group that had dispersed locally, as opposed to travelling to sites up to 10km away (as those other sites are). In other words, it is probable that the birds at Quorrobolong had dispersed within the broader "Quorrobolong area" and that the initial counts of 40-50 birds were of recent arrivals to the area, given their "flocking" behaviour.

In summary, it is probable that at any given time during the May to July period, conservatively at least 80 and almost certainly more than 100 Regent Honeyeaters were in residence within the lower Hunter Valley woodlands of the Cessnock LGA (all within a 10km radius of 32° 52' 10" S, 151° 22' 12" E). Furthermore, large areas of potential habitat were not surveyed, so this count may significantly underestimate the number of birds.

This constitutes the maximum known concentration of Regent Honeyeaters anywhere across the range of the species since 2005 and comprises a significant proportion (probably >10%) of the total population of the species. It is also of significance that during the previous Spotted Gum flowering "event" (in 2009) up to 60 birds were recorded across the same area of the lower Hunter Valley (authors pers. obs.). Furthermore, in summer 2007 a successful "semi-communal" breeding event took place on forested land zoned for industrial development as part of the Hunter Economic Zone in an area that was likely used as a breeding locality in the past (Regent Honeyeater Recovery Team unpublished data; A. Zoneff pers. comm.). Nesting has also been recorded over several seasons in recent years at the Quorrobolong property, though no fledged young have been observed at that site (A. Morris and R. Miller pers. comm.).

In light of the recent significant numbers of Regent Honeyeaters and past breeding records, the lower Hunter Valley dry open forests should be recognised as being of crucial importance to this critically endangered species, both in terms of providing an essential winter food source and significant opportunity for birds to breed.

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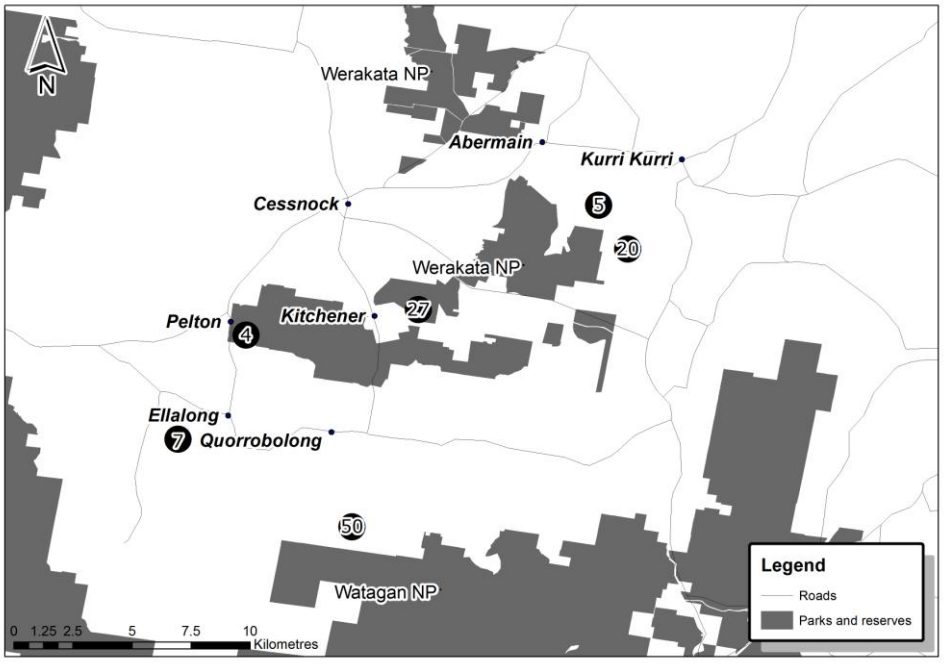

Figure 1. Numbers and locations of Regent Honeyeaters in the lower Hunter Valley woodlands of Cessnock LGA during May - July 2012.

The status of the Pink-eared Duck in the Hunter Region

Mike Newman

7 Glenurie Close, Woodville, NSW 2321, Australia
omgnewman@bigpond.com

The sight of hundreds of Pink-eared Duck *Malacorhynchus membranaceus* congregated on a confined area of open water, foraging as pairs performing figure-of-eight patterns round each other, is one of the most exhilarating moments of bird watching I have experienced. Unfortunately, it is not a regular occurrence in the Hunter Region. As shown in the distribution map (**Figure 1**) based on Birds Australia's (now BirdLife Australia) Birdata records up to December 2011, the Pink-eared Duck has a restricted distribution, occurring in only 15 of the 151 10-minute grids which comprise the Hunter Region. Ten of these grids lie in the lower Hunter Region, emphasising the importance of the wetlands in this area.

There were large variations in the annual reporting rates (RR) of Pink-eared Ducks in the Hunter Region as indicated by **Figure 2**, with 1999, 2002 and 2003 being years when the species was more frequently recorded. In contrast 2000 and 2010 were years in which the species was scarce, a trend which continued into 2011. The results suggest that the coastal areas of the Hunter Region act as a drought refuge and the species moves inland when conditions are suitable as in the current wetter conditions associated with the La Niña cycle of 2010 - 12.

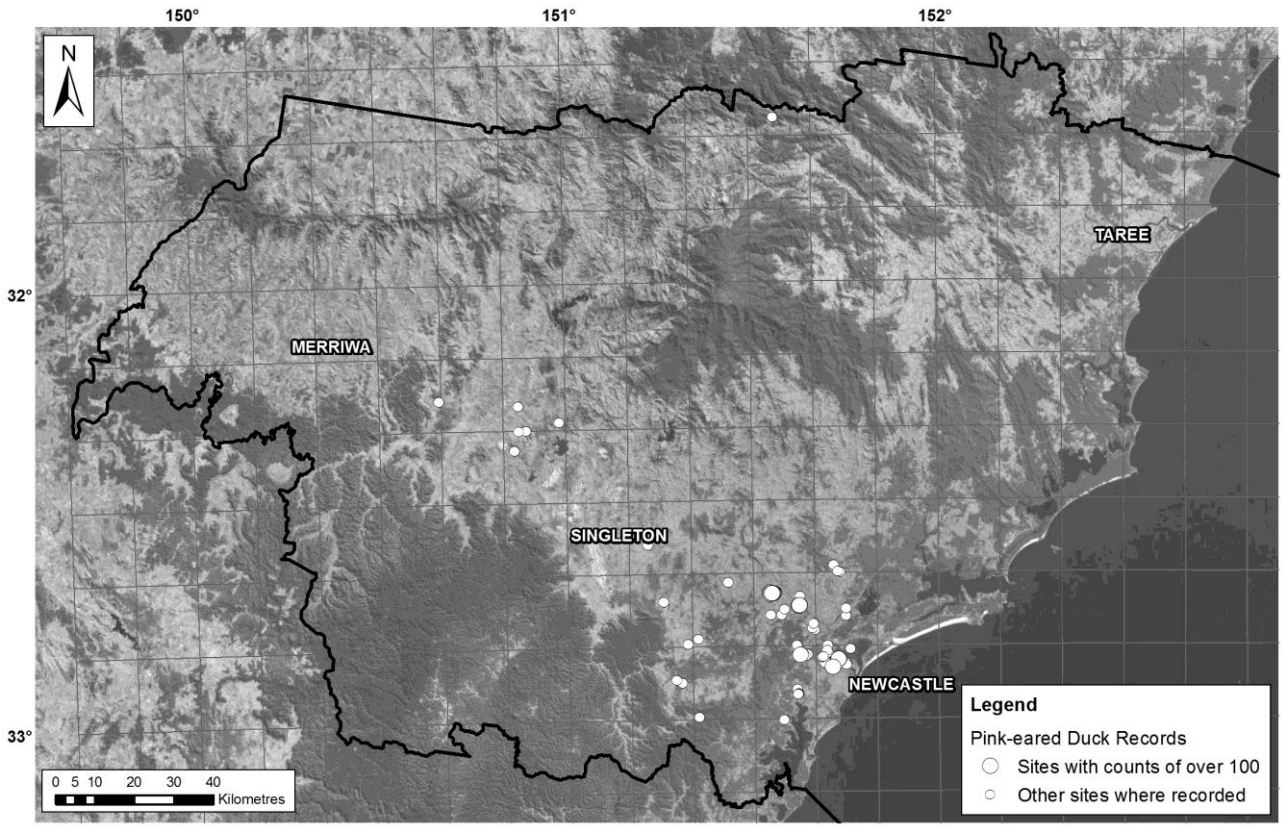

Figure 1. Distribution of Pink-eared Duck in the Hunter Region (Birdata 2ha and area surveys 1998 -2011).

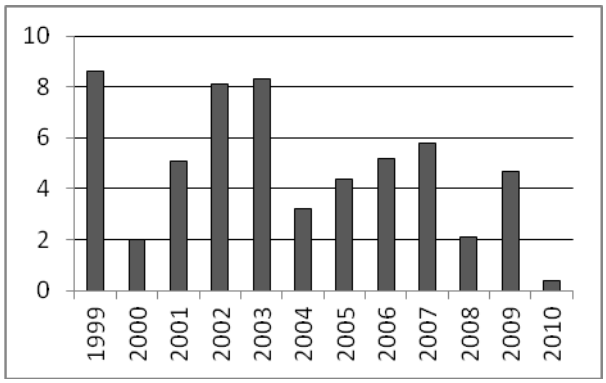

Figure 2. Variation in the annual reporting rates for Pink-eared Duck in the Hunter Region (source Birdata 2ha and area surveys 1999 – 2010; 1998 data excluded because of small sample size).

While Pink-eared Ducks were recorded in every month, they were more likely to be observed in the late spring-summer months than in winter (**Figure 3**). Many of the higher counts, involving flocks of over 100 ducks, occurred mid-year, but involved fewer records.

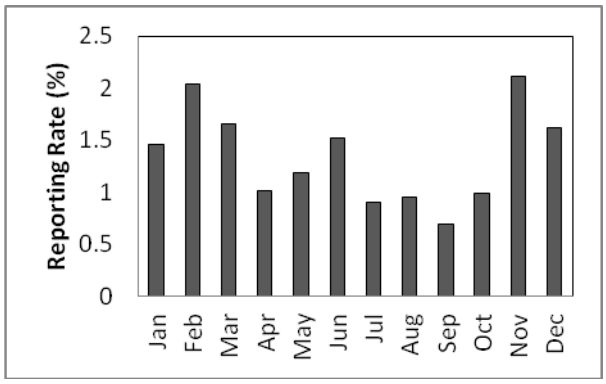

Figure 3. Monthly variations in Pink-eared Duck records in the Hunter Region (source Birdata 2ha and area search surveys 1998 – 2010).

Collectively the results (**Figures 2** and **3**) are consistent with movements found in other parts of Australia. Marchant & Higgins (1990, p. 1249) describe the Pink-eared Duck as "highly dispersive from inland Australia with movements related to availability of water. Seasonality of rainfall, however, gives some regularity to population movements." In Victoria reporting rates were highest in spring and summer in coastal areas. Dry weather inland, where the species breeds, often causes irruptions to the coast (Marchant & Higgins *op. cit.*).

There are two records of Pink-eared Duck breeding in the Hunter Region. In January/ February 1996 up to six birds were present at Seaham Swamp Nature Reserve with one pair nesting and fledging two young. The other instance involved a pair with five ducklings at a large dam near Ravensworth in September 2007.

The Pink-eared Duck has a bill which is specialized for filter feeding. Consequently, it has a preference for shallow stagnant turbid water with abundant aquatic invertebrates. In the Hunter Region it is primarily found on medium-sized shallow lagoons and is absent from large deep water reservoirs. The settling ponds of sewage treatment plants and the tailings ponds of industrial operations often provide suitable habitat. The key locations used in the Hunter Region involve small to medium-sized water bodies of moderate depth (1 to 5 m) compared with shallow water, presumably inland, habitat described in the Handbook of Australian, New Zealand and Antarctic Birds (Marchant & Higgins 1990).

During the period 1998 to 2010 the Pink-eared Duck was recorded during 187 surveys submitted to Birdata with the 10-minute grid centred on 32°45' S 151°35' E having 93, almost 50%, of the records for the Hunter Region. This grid contains both the Morpeth Wastewater Treatment Works (MWTW) and the Walka Water Works, sites important to Pink-eared Duck for which long-term data sets based on monthly counts exist (Stuart 2001 - 2011). The other important grid is centred on 32°55' S 151°45' E with 44 Pink-eared Duck records, many stemming from long-term monthly surveys on Kooragang/Ash Island, particularly at Deep Pond. Results for these regularly monitored sites, which collectively provide almost 75% of the Pink-eared Duck records for the Hunter Region, are discussed below.

Morpeth Wastewater Treatment Works

Between 2001 and 2010 Pink-eared Ducks were recorded during 71 monthly surveys (RR 60%) at MWTW. Numbers ranged from 2 to a maximum of 1010 in June 2001. They were recorded in every month, but most frequently in November and December (RR 75%) and least frequently in January and February (RR 37%). However numbers peaked between April and July. Pink-eared Ducks were recorded in every year except 2010, with flocks exceeding 100 birds observed on 16 occasions, but only once since 2006. During large irruptions the ducks were sometimes present for over six consecutive months. Inspection of rainfall distributions for inland areas of eastern Australia during the past decade

confirm the hypothesis that Pink-eared Ducks are scarce in the Hunter Region when inland rainfall is above average (2000, 2004, 2008 and 2010), RRs falling in each of these years (**Figure 2**). The ducks return to the Hunter Region as their inland breeding habitat dries out. Irruptions can be large (**Figure 4**), particularly when inland rainfall levels are well below average (2002 and 2006).

Deep Pond, Kooragang Island

One hundred and sixteen monthly surveys were carried out between 2001 and 2010 at Deep Pond. Pink-eared Duck were present on 31 occasions (RR 27%) with numbers ranging from 1 to 267. There were records for every month. The largest numbers were seen in 2005, 2007 and 2009 and in eight instances flocks exceeded 100 birds, six of these instances occurring in 2009. Pink-eared Ducks were not recorded in 2003, 2004 or 2010. Comparison of the peak annual numbers for MWTW and Deep Pond (**Figure 4**) suggests that subsequent to 2006 Deep Pond displaced MWTW as the most important site for Pink-eared Duck in the Hunter Region, which is of concern given that the future existence of Deep Pond is threatened by industrial development.

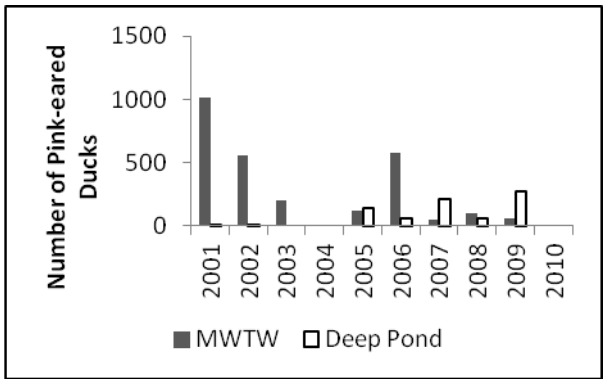

Figure 4. Annual peak numbers of Pink-eared Ducks at MWTW and Deep Pond, Kooragang Island based on monthly surveys (Source: HBOC Annual Bird Report series).

Walka Water Works

Since monthly counts commenced in April 2003 Pink-eared Ducks have been recorded at Walka Water Works on 13 occasions at a reporting rate of 12%. They were present annually between 2003 and 2009 with peak counts of 111 in January 2009 and 92 in 2003 and 2007, but from January 2009 to the end of 2011 there was just one record of three birds in July 2011. Before these monthly surveys commenced large numbers were present in May and June 2002, peaking at 350 in the middle of the latter month and similar sized flocks were recorded at the beginning of 2002.

Other Locations

Flocks exceeding 100 birds have been recorded at only three other locations, both in the lower Hunter, with over 300 present at Warabrook in July 2001, up to 600 present at Tarro Swamp between June and October 1985 (Waterhouse 1986) and up to 600 at Lenaghans Flat in July and August 2002. At all locations where large flocks occurred the ducks were often present for extended periods, which exceeded six months on occasions. Outside the core lower Hunter area Pink-eared Ducks have been recorded at a number of locations including: Mt Arthur, Bayswater Colliery, Ellalong Lagoon, Pokolbin Lake, Muswellbrook Sewage Treatment Plant and Stewarts River. This last is the only record for the north of the Hunter Region. Pink-eared Ducks are almost certainly under recorded in these areas.

In the Annual Bird Report Series of the Hunter Region the status of Pink-eared Duck is described as a "Bird of passage" which is defined as a "species present in a suitable area for a relatively short period and likely to be observed in any month of the year". This analysis endorses that statement, except for the duration of the period that these ducks stay in the Hunter Region.

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Olive groves – habitat for Speckled Warbler and other birds

Mike Newman

7 Glenurie Close, Woodville, NSW 2321, Australia
omgnewman@bigpond.com

Olive groves provide excellent bird habitat for a number of bird species, especially the Speckled Warbler *Chthonicola sagittata*, which is listed as vulnerable in the NSW *Threatened Species Conservation Act 1995*. The Double-barred Finch *Taeniopygia bichenovii* is another ground-feeding species attracted to this habitat. Unharvested olives bring in other species like the Black-faced Cuckoo-shrike *Coracina novaehollandiae*, which form flocks feasting on the rotting fruit. Insectivorous species like the thornbills and Grey Fantail *Rhipidura albiscapa* also find advantage, possibly from the mesic conditions resulting from irrigation. This paper shows how agricultural habitat can make an important contribution to the resilience of bird populations in a fragmented and highly modified landscape.

INTRODUCTION

When going bird watching the tendency is to search areas of woodland, creeks and open water; habitats known to attract birds. Instinctively olive groves are considered highly modified habitat with an expectation of limited species diversity other than a few opportunistic species. The results discussed in this paper suggest that contrary to this expectation they provide valuable bird habitat, especially for the Speckled Warbler, which is listed as vulnerable in the NSW *Threatened Species Conservation Act 1995* (Roderick & Stuart 2010).

Yaraandoo, a property of approximately 100 ha, is located at Duns Creek (32°38′25″S, 151°39′25″E) near Paterson, in the Hunter Region of NSW. In addition to grazed paddocks, there were two olive groves and a small area of grape vines when this study commenced in August 2009. During monthly surveys on the property I walked along the edges of the olive groves and noticed that I regularly observed Speckled Warblers foraging in the smaller grove. Consequently, in February 2010 I modified my survey design to include a 20-minute search of the entire smaller grove. The results of surveys at this smaller olive grove are the subject of this paper.

METHODS

The survey method I used at Yaraandoo is based on the survey techniques used in BirdLife Australia's (formerly Birds Australia) Atlas projects (Newman 2012). I have used this approach in a number of similar studies in the Paterson area (Newman 2007, Newman & Lindsey 2008, and Newman 2009).

At Yaraandoo I counted all species of birds, seen and heard, while walking along a fixed route. Initially two 2ha areas, sampling remnant patches of woodland, were selected along the route and surveyed for 20 minutes each. However, when the importance of the smaller olive grove was appreciated it was added to the survey as a third 2ha site. I compiled four lists of birds, one for each of the three 20-minute surveys and one for the birds counted on the route between the 2ha sites, ensuring birds were not double counted. Surveys typically started one hour after sunrise and took three hours to complete, thus keeping the survey effort constant. The olive grove 2ha site was reached about 2 hours after the start.

The olive grove 2ha site comprised seven rows of olive trees, most of which slightly exceeded 100m in length. There were a few large eucalypts within the grove, which was bounded on one side by a road leading to a house and on the other by a fence excluding cattle. Trees along the immediate boundaries were surveyed as they provided shelter for birds using the grove. At one end of the site there were buildings associated with the house. Food and water provided for chickens in the house complex may have benefited some of the birds observed in the adjacent olive grove.

The surveys covered three summers during which the harvesting and maintenance of the olive trees changed. In the summer of 2010 the olives were harvested, but in 2011 and 2012 they were left on the trees to rot. Failure to harvest the olives in 2011 resulted in a greatly diminished crop in 2012. In addition at the end of 2011 the trees were progressively removed from the larger olive grove.

RESULTS

During seven preliminary surveys of Yaraandoo, between August 2009 and January 2010, I observed Speckled Warblers on every survey, exclusively in the smaller olive grove, which was then made an additional site. The results of subsequent surveys of the smaller olive grove are described below.

I recorded 49 species of birds in the olive grove 2ha site during 27 surveys between February 2010 and April 2012. The mean number of species seen during the 20-minute survey was 9.4 with the bird list ranging from 3 to 17 species. The following analysis primarily involves the Speckled Warbler and other frequently present species (**Table 1**).

Speckled Warbler

Speckled Warblers primarily foraged on the bare ground at the bases of the olive trees. However, they were frequently observed in the foliage of the trees, probably taking cover in response to my approach, rather than foraging. Invariably when I stood still they soon dropped to the ground and continued to forage. I observed Speckled Warblers during 10 of 27 surveys at the olive grove site, but only recorded the species on six occasions on other parts of Yaraandoo. These other sightings were at five different locations and never on the same date that the birds were present at the olive grove site. One of these other locations was close to the olive grove site and another was on the edge of the larger grove.

Other ground-foraging species

Speckled Warblers often foraged with other small ground-feeding species, including Double-barred and Red-browed Finches, Superb Fairy-wren, Willie Wagtail and, less frequently, Yellow-rumped Thornbill *Acanthiza chrysorrhoa* and Buff-rumped Thornbill *Acanthiza reguloides* (2 records). At times these ground-foraging species formed larger flocks with other species foraging in the foliage of the olive trees (see below).

Occasionally other species were observed foraging on the ground under the olive trees. These included Painted Button-quail *Turnix varius*, Satin Bowerbird *Ptilonorhynchus violaceus*, White-winged Chough *Corcorax melanorhamphos*, and slightly more frequently Australian King-Parrot. The last three species were present as flocks of up to 20 birds.

Table 1. Species recorded at the olive grove 2ha site on Yaraandoo with a reporting rate (frequency of presence) of at least 20% during monthly surveys between February 2010 and April 2011 (n=27).

Species		**Reporting Rate (%)**	**Maximum Number**	**Average Number**
Australian King-Parrot	*Alisterus scapularis*	25.9	20	6.6
Superb Fairy-wren	*Malurus cyaneus*	37.0	9	3.5
Speckled Warbler	*Chthonicola sagittata*	37.0	4	2.0
Striated Thornbill	*Acanthiza lineata*	25.9	6	3.0
Yellow Thornbill	*Acanthiza nana*	40.7	12	3.7
Brown Thornbill	*Acanthiza pusilla*	37.0	2	1.4
Spotted Pardalote	*Pardalotus punctatus*	22.2	2	1.5
Striated Pardalote	*Pardalotus striatus*	22.2	1	1.0
Yellow-faced Honeyeater	*Lichenostomus chrysops*	74.1	4	2.0
Scarlet Honeyeater	*Myzomela sanguinolenta*	22.2	2	1.3
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	44.4	4	1.9
Grey Shrike-thrush	*Colluricincla harmonica*	25.9	1	1.0
Grey Fantail	*Rhipidura albiscapa*	63.0	5	1.5
Willie Wagtail	*Rhipidura leucophrys*	29.6	2	1.5
Australian Raven	*Corvus coronoides*	44.4	5	2.3
Jacky Winter	*Microeca fascinans*	37.0	3	1.8
Eastern Yellow Robin	*Eopsaltria australis*	29.6	2	1.5
Silvereye	*Zosterops lateralis*	29.6	40	7.5
Double-barred Finch	*Taeniopygia bichenovii*	44.4	19	5.8
Red-browed Finch	*Neochmia temporalis*	22.2	4	2.5

Species foraging in the olive trees

I regularly recorded mixed flocks of Yellow, Brown and Striated Thornbills foraging in the foliage of the olive trees. Although Silvereyes were less frequent, they were more numerous, with one flock of 40. Yellow-faced Honeyeaters (the most frequently recorded species), Grey Fantails, Eastern Yellow Robins, and Grey Shrike-thrush also regularly foraged in the foliage of the trees, sometimes loosely associated with the other species, but also occurring as solitary birds. These species had a wider range of foraging activities than the thornbills and silvereyes; e.g. the fantails hawking for insects.

Other species

Australian Ravens and Black-faced Cuckoo-shrikes also appeared to be attracted to the 2ha olive grove site, but their foraging activities were more difficult to characterise as I usually observed them flying away or perched in the eucalypts embedded in and immediately surrounding the olive trees. However, it appeared that the Black-faced Cuckoo-shrikes were taking ripe olives from the trees and then flying up into the eucalypts to devour them. Jacky Winters used the eucalypt trees and fences for perches while foraging. The canopies of the larger trees were frequented by Yellow-faced Honeyeaters, Spotted and Striated Pardalotes.

Observations at the larger olive grove

During the autumn of 2011 I noticed unusual flocks of birds in the larger olive grove where the olives had not been harvested, including Crimson Rosella *Platycercus elegans*, Eastern Rosella *P. eximius* and Pied Currawong *Strepera graculina* as well as the species mentioned earlier. Collectively the two olive groves attracted large flocks of these species with total numbers for the survey being exceptionally high for an area the size of Yaraandoo (e.g. 23 Black-faced Cuckoo-shrikes in July 2011, and 23 Satin Bowerbirds in June 2011).

In the autumn of 2012 just two rows of trees remained in the larger grove, again with unharvested olives and these continued to attract many species including a flock of eight Yellow-tufted Honeyeaters *Lichenostomus melanops*, which used the trees for foraging and as a connecting corridor across open ground to a patch of remnant woodland.

DISCUSSION

Speckled Warbler

Speckled Warblers forage on the ground and are absent from areas with dense ground cover (Newman 2010). In woodland at Green Wattle Creek near Paterson their numbers increased when light grazing reduced ground cover and understorey growth (Newman 2010). Numbers also increased when ground cover decreased following hazard reduction burns at Green Wattle Creek (Newman, unpublished information). At Yaraandoo, predominantly a cattle grazing property, bare ground under the olive trees and mown grass between the rows of trees provided a foraging niche in which Speckled Warblers were recorded 13 times more frequently than on the rest of the property, when the reporting rates were adjusted for survey effort. No other species showed this degree of selective use of the olive grove site.

Over the 34 months of the study from August 2009 to April 2012 there was a drop off in the frequency with which Speckled Warblers were found at the olive grove site. For instance, in the first six months, before the 2ha site was established, Speckled Warblers were always present, but over the subsequent 27 months the reporting rate was only 37%. This decline is attributed to intermittent maintenance of the olive grove site, involving mowing, spraying for weed control etc. The wide variation in the number of species, from 3 to 17, recorded during the 20-minute surveys supports this conclusion. Other than the olive groves, the grassy habitat of Yaraandoo appears unsuitable for Speckled Warblers and it is possible that all the observations are based on one or two family groups, which predominantly frequent the olive groves.

Other species

Of the other ground foraging species only the Double-barred Finch approaches the degree of preference for the olive grove habitat shown by the Speckled Warbler. However, unlike the latter species the Double-barred Finch is also attracted by the availability of water and food at the adjacent house. Double-barred Finches were recorded at the olive grove site (**Table 1**) twice as frequently and in double the numbers of Red-browed Finch, which is the commoner species in the area (Newman 2007 and 2009). The Double-barred Finch was also seen on a number of occasions in

and adjacent to the larger olive grove, and seldom elsewhere on Yaraandoo, suggesting that the two olive groves are preferred habitat.

Five species of thornbills were recorded at the 2ha olive grove site, with Brown, Yellow and Striated Thornbills regularly observed foraging in olive trees. Yellow-rumped and Buff-rumped Thornbills tended to spend more time foraging on the ground than the other thornbill species. As the occurrence of the Buff-rumped Thornbill at Green Wattle Creek had similar trends to the Speckled Warbler (Newman 2009) its scarcity and preference for the olive grove site on Yaraandoo were expected.

The impact of leaving the olives unharvested was difficult to assess because it was only appreciated after the event that a change in practice had occurred. While passing the edge of the bigger grove, I gained the impression that many larger birds (parrots, bowerbirds, currawongs and ravens) were feeding mainly on the ground. Unfortunately they flushed readily, allowing only obscure views which made accurate counts and observation of foraging behaviour difficult. One of the disadvantages of keeping survey effort constant is that it prevents detailed observation of bird behaviour. Also the difference in survey effort at the two groves prevented a quantitative comparison of their bird populations. However, during the 20-min surveys at the smaller olive grove site there was more opportunity for observation of behaviour. Black-faced Cuckoo-shrikes appeared to be feeding on ripe olives, which were taken from the trees. However, the dense foliage often made it difficult for them to eat while perched and they took the fruit to more secure perches in the surrounding eucalypts for consumption. In the autumn of 2012 for the first time large flocks of White-winged Chough were regularly present at the olive grove sites. This may have been in response to alternative habitat options being less suitable at that time as discussed in the next section. The other larger species, the Australian Raven, Australian King-Parrot and Pied Currawong, were more timid and once flushed seldom returned to the area while I was present.

Rainfall and irrigation

Insectivorous species like the thornbills and the Grey Fantail are attracted to mesic habitat like gullies and riparian vegetation (Palmer & Bennett 2006), particularly under drought conditions (Newman 2010), which prevailed for much of the decade 2000 to 2010. Irrigation of the olive trees would have provided an insect-rich mesic environment relative to the surrounding area and contributed to the observed high diversity of bird species, particularly at the start of the surveys. The summers of 2010/11 and 2011/12 were characterised by a change from drought to abnormally wet La Nina conditions. These conditions increased ground cover growth, which while advantageous to insectivorous species, would have been detrimental to species foraging on the ground (e.g. Speckled Warbler and White-winged Chough) making modified habitats like cultivated areas and gardens increasingly attractive to these species.

CONCLUSIONS

Olive groves support a diverse bird community attracted to bare ground under the trees and regularly mown grass, which provide a niche for both small (e.g. Speckled Warbler and Double-barred Finch) and large (e.g. White-winged Chough) ground-foraging species. The dense foliage of the trees provides both foraging and shelter opportunities for a number of species. Irrigation creates mesic conditions, which may be particularly important to small insectivorous species like thornbills and the Grey Fantail. Unharvested fruit rotting on the trees attracted a number of larger species including Black-faced Cuckoo-shrikes and several species of parrot. Lines of olive trees also provided connectivity between a remnant patch of woodland and surrounding continuous woodland. In fragmented landscapes it is important to appreciate how agricultural habitat can provide an important contribution to the resilience of bird populations.

ACKNOWLEDGEMENTS

I thank John and Caroline Booker for encouraging me to conduct bird surveys on Yaraandoo. Their ongoing interest in the project and information on the production of olives have contributed to this paper, which describes outcomes totally unexpected when the project started.

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Cattle Egret breeding at Gloucester, NSW sustained at increased level in 2011/12

Penny Drake-Brockman

20 Manning Street, Gloucester, NSW 2422, Australia
penny@pennydb.org

Breeding at the new Cattle Egret *Ardea ibis* colony at Gloucester, NSW has been sustained for a second year with an earlier commencement date and an increased number of nests. At least 217 nests were built and a minimum of 340 chicks were counted during the 2011/12 season.

INTRODUCTION

The first recorded successful breeding of Cattle Egret *Ardea ibis* in the Gloucester Valley 2010-2011 occurred in willow trees overhanging a dam opposite the Gloucester Golf Club on Bucketts Way (32º01'52"S 151º57'10"E (Drake-Brockman 2011). The following season I was pleased to find breeding birds present in November 2011.

DETAILED OBSERVATIONS

On 4 November 2011, 150 Cattle Egrets were present at the same site as the previous year, in full breeding plumage, perched or sitting on nests in the willow trees on the western side of the dam. On 8 November the count had increased with between 280 and 300 egrets present near dusk and preparing to roost for the night. Although at least 60 birds were in white plumage or showing only a suggestion of orange head/neck feathers, all the birds present were considered capable of breeding (Maddock 1989). There was an occasional display of back plumes and constant movement between perches. The dam water level was high due to heavy rain during the previous three months. An industrial site adjoining the dam had been cleared and levelled with rough barriers placed to stop run-off into the dam. This did not appear to have deterred the egrets from returning to the breeding colony.

A quick check on the colony on 14 November found over 50 nests occupied with birds incubating. I was away for four weeks and the next inspection on 20 December found over 100 adults present at nests with a few small chicks showing heads. By 3 January 2012, 63 chicks were standing away from nests, and over 150 nests were counted with many containing small chicks or with adults sitting tight. Five nests had been built in a tree previously unused for breeding on the south-east side of the dam.

On 24 January, many more egrets were present with at least 217 nests - the egrets having now built nests in every tree edging the dam. There was constant motion with egrets arriving to feed chicks and departing to search for food. Water level in the dam remained high with local flooding. The count totalled 98 adults perched, 106 adults incubating and 152 chicks perched on or near nests.

By the next visit on 7 February, many nests were empty or falling apart but 102 adults were still incubating with over 150 chicks perched. I observed one pair mating. On 13 February, conditions were similar with many chicks exercising their wings and flying to different positions within the nest trees; 188 chicks were counted with 93 adults incubating. By 7 March there were 265 chicks perched with 62 adults incubating, and on 9 March there were 334 chicks perched with only 19 adults incubating. Many chicks were flying between the nest trees and into the high grass at the edge of the dam, keeping out of sight, or to tall gums nearby. It was suspected that some young had fledged and were foraging with adults.

Numbers at the colony were now declining and on 21 March only ten adults were incubating or sitting on nestlings, with 305 chicks present. By the beginning of April only 184 chicks remained, either in or near the nest trees. Some flew to the ground where about 19 were standing beside the channel that runs into the dam. A few small chicks remained in nests with adults flying in to feed them. About six adults remained perched without feeding. A dead chick was floating in the dam with two dead chicks hanging by the neck in the willow

trees. Work had been carried out on the industrial site but again this did not seem to have disturbed the egrets.

On 11 April, 89 chicks were perched with a few adults while other adults were flying in to feed chicks. As I approached the dam, chicks flew away, leaving 28 that would most likely have flown if I had gone closer. Only three chicks appeared too immature to fly.

On 24 April 25 chicks remained. An adult flew in to feed two begging chicks, at first perching for a minute before feeding both and then departing. A second adult flew in and perched without feeding, and then a third adult arrived and immediately fed one chick four times before flying off. My last visit on 27 April found the site deserted. A drive around the Avon and Gloucester valleys found 464 adults and juveniles. This total is likely to be well below the actual number as many suitable paddocks are out of sight from public roads and I did not check the Barrington valley. After that date no egrets have used the breeding site.

DISCUSSION

Although it was not possible to say precisely when egrets first occupied the site in 2010, occupation in 2011 appeared to start approximately two months earlier, with a few adults sitting on nests by 4 November and chicks present by 20 December. Numbers built up quickly with nests constructed in every willow tree edging the dam (the previous season involved nests in trees only on the south-western and western edges), and desertion of the site before the last week of April 2012, approximately one week earlier than the previous season. It was noted that late breeders included several without the usual orange head breeding plumage, perhaps indicating they were first year breeders. Conditions at the colony became so crowded that by early March adults were roosting overnight on a small dam about 500m from the colony (observed at dawn on 8 March).

Although the highest count of chicks this season was 334 against about 310 the previous season, numbers are inaccurate due to the constant movement of adults and chicks between trees, the increased area of nests built, and the staggered dates of nest construction and hatching, with chicks departing the site by mid-March to forage with adults. It is assumed the first clutches were laid at the end of October 2011, and an adult pair was observed mating on 7 February 2012. Observation of chicks being fed at the site on 24 April 2012, supposes clutches were being laid during February.

Since the breeding site was deserted at the end of April 2012, counts around the river flats have revealed flocks of 70 to 250 which were still present in the Barrington, Gloucester and Avon valleys in May 2012, with small groups (5-10) seen at Wards River south of Gloucester, and Bundook (east of Gloucester), areas where Cattle Egret have not been previously recorded by me.

No interactions with other waterbirds were noted, although occasionally Little Black Cormorants *Phalacrocorax sulcirostris* and Little Pied Cormorants *Microcarbo melanoleucos* were roosting in the nest trees, and during January and February 2012 a juvenile Australasian Darter *Anhinga novaehollandiae* was present.

CONCLUSIONS

Breeding at the new Cattle Egret colony at Gloucester has been sustained during a second year with an earlier commencement date and an increased number of nests. All potential nest sites were occupied and there is little scope for further expansion of the colony.

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Distraction behaviour by Variegated Fairy-wrens

Joy Nicholls

89 Charlestown Road, Kotara, NSW 2289, Australia
joynicholls@optusnet.com.au

On two separate occasions I have noted distraction behaviour in Variegated Fairy-wrens *Malurus lamberti*. On both occasions birds affected a broken-wing display to distract me while I was removing other Variegated Fairy-wrens from mist nets. The first occasion occurred in May 2009 in a disused quarry in Kotara, a thick grassland habitat. One bird, either a female or sub-adult male, approached within 0.5m of me, making eye contact as I extracted a trapped juvenile from the net. On approach, the bird dropped one wing as if it were broken and appeared to limp. Having obtained my attention it walked under the net and flew to a nearby bush, perching briefly with both wings folded normally. After a few seconds the bird flew closer to the net, drooped a wing and limped under the net. These movements were repeated until the juvenile bird had been extracted and removed from sight by being placed in a bird bag. This behaviour was quite effective as a distraction technique as I found the movements fascinating and was distracted from the job of extracting the trapped bird.

The second occasion, in October 2010, occurred in dry sclerophyll forest in Blackbutt Reserve. Several Variegated Fairy-wrens, part of a group of ten birds, flew into the mist net almost simultaneously and were trapped. Three other Variegated Fairy-wrens, two males and a probable female, who had passed the net without capture, returned and fluttered around me, drooping one wing and again making eye contact with me. Although they hopped very close to the net at no time did they become trapped. Their intention was clearly to distract me from harming the trapped birds until those birds could effect an escape. They would also momentarily cease the distraction and fly normally to a perch before repeating the injured role.

Once extracted from the net, banded, measured and weighed, the trapped birds were released and rejoined their group. I have not observed this behaviour on any of the many other occasions when either Variegated or Superb Fairy-wrens *Malurus cyaneus* have been trapped. Nor have I witnessed this behaviour in other species trapped in mist nets although on some occasions, in some species, a second bird has waited in a nearby tree until a juvenile or possibly a partner was released. On these occasions the birds make contact by calling.

The Handbook of Australian, New Zealand and Antarctic Birds (Higgins *et al.* 2001, p.317) recorded Variegated Fairy-wrens displaying parental anti-predator strategies at the nest where they give a single-syllable churring alarm call repeatedly when the nest is approached. Adults may then engage in a rodent-run distraction display in which the bird scuttles along the ground with head and tail lowered, back feathers raised, and head moved from side to side. Display may be performed by all members of a group. This display is said to be more noticeable and used more often by Variegated Fairy-wrens than other fairy-wren species. The display described is not identical to what I witnessed but is certainly similar.

A Dictionary of Birds (Campbell & Lack 1985, pp. 144-145) discussed four types of distraction display. The initial approach of the bird while staring me down is a distraction threat display, probably aimed at making me drop the bird I was extracting from the mist net. The 'broken-wing' display observed subsequently falls into the 'distraction-lure category', as does the 'rodent-run'; in both cases the bird is feigning injury to a predator to entice it away from the bird presently under threat.

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Atypical habitat for an Australian Pelican colony

Alan Stuart[1], Greg Crisp[2] and Brian Crisp[2]

[1]81 Queens Rd, New Lambton, NSW 2305, Australia almarosa@bigpond.com
[2]PO Box 139, Taree, NSW 2340, Australia admin@mcglashancrisp.com.au

The Australian Pelican *Pelecanus conspicillatus* is a common resident of the Hunter Region of New South Wales (Stuart 2011). There are several breeding records from Wallis Lake (centred at 32° 15'S, 152° 29'E). Between 1994 and 2000 inclusive, there were regular reports of >100 nests on islands within the Lake (Stuart 1995-2001). There are no other known breeding records for the Region, although birds with young were seen near Pacific Palms, on the southern end of the Lake, in June 2006 (Stuart 2007).

Most breeding records have been at Pelican Island, a small flat low island about 1.5km west from Green Point and ~500m south of Yahoo Island (**Figure 1**). However, 25 nests were found on Snake Island in 2000 (Stuart 2001).

Visits on 8 August and 23 November 2011 found >100 Australian Pelican breeding pairs on Snake Island and none on Pelican Island. The colony, in the north-west section of Snake Island, had nests with eggs in August (**Figure 2**), and chicks of varying age in November.

Figure 2. Snake Island colony on 8 August 2011. Photo G. Crisp.

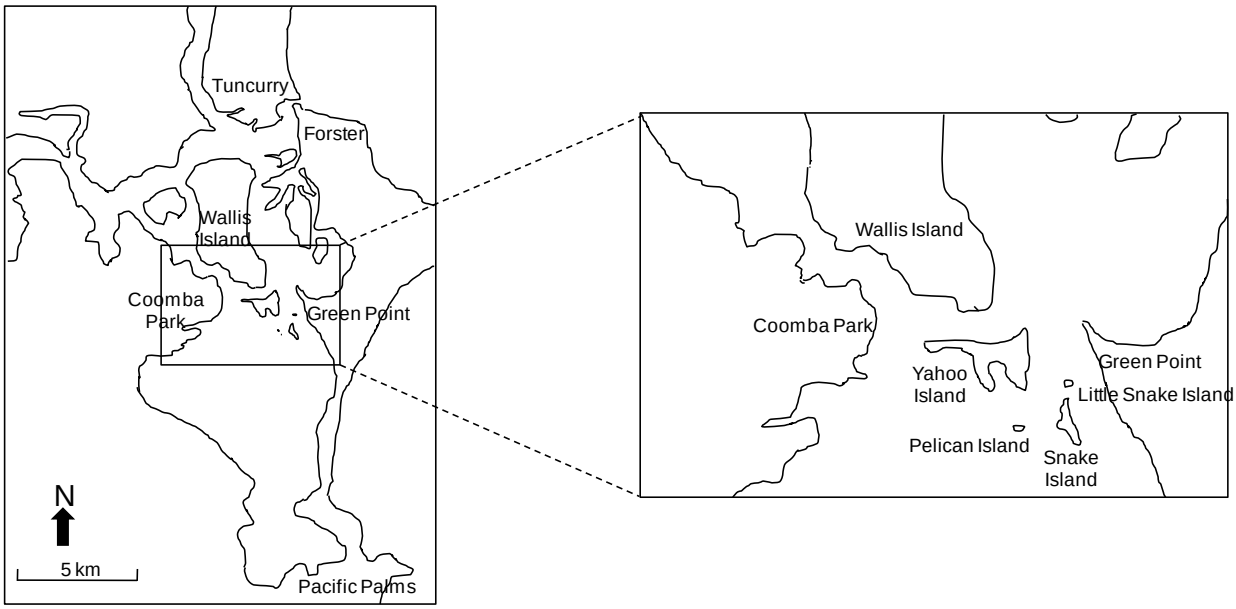

Figure 1. Wallis Lake NSW showing main locations.

Australian Pelicans typically breed colonially in simple pairs, utilising low islands or spits of sand, shell grit, mud clay or rocks, nesting on bare ground or among low vegetation (Marchant & Higgins 1990). Pelican Island fits this description well. However, the habitat where the colony is located on Snake Island is quite different.

Snake Island is fringed by a 5-10m wide belt of mangroves. The island is completely tree covered, for example *Casuarina* spp and Cabbage Palms *Livistona australis*, and has an understorey of shrubs across much of it. The Australian Pelican colony has formed in a 1-2 ha area lying directly behind mangroves. There are numerous trees throughout the colony. It appears that the birds may have trampled or otherwise removed the original understorey. The only way for birds to reach their breeding ground is to swim through the mangroves and then walk 20-50m.

There was no obvious issue about the ongoing suitability of Pelican Island for breeding. However, the colony has instead formed in atypical habitat on Snake Island.

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White-faced Herons fledge two broods in one season

Penny Drake-Brockman

20 Manning Street, Gloucester, NSW 2422, Australia
penny@pennydb.org

During October-November 2010 a pair of White-faced Herons *Egretta novaehollandiae* built a nest in an ironbark in my neighbour's garden on the northern edge of Gloucester, New South Wales (32° 00' 04" S 151° 57' 59" E) in good view from my back deck, so I was able to follow progress. However, after hatching two chicks in January 2011, one of the herons went missing and the remaining parent deserted, with the nest empty by 22nd January. Possibly one parent is not sufficient to feed two chicks.

In October 2011 I noted the presence of White-faced Herons nearby, but being away for much of that month, it was not until 3rd November that I could confirm nesting activity. On that date I saw a pair in the same tree on the same horizontal forked branch as last season's nest. This could be the surviving bird from the previous nesting attempt with a new partner. One heron was sitting tight on the rebuilt nest and the other attending and bringing more twigs. I was again away until 16th December and on return found the herons still present with one sitting tight during the day. The view of the nest from my back deck this year was hidden by regrowth, and observation was only possible from below, making it difficult to check progress. First sighting of chicks was on 11th January 2012 when two could be seen over the nest edge. On the 14th I watched them being fed, with the larger chick scramble-flying from the nest to the next tree to meet the parent. They fledged on the 23rd or 24th January 2012.

On 4th February a heron was back standing on the nest rearranging twigs, and on the 6th was observed sitting tight in high wind and rain, presumably on eggs. On the 7th one was observed standing on the nest, then sitting. On the 11th the presumed male arrived with a twig, making soft *graaw graaw* calls (Marchant & Higgins 1990) before pressing the twig into the nest; the female stood and moved her bill around in the nest, maybe rearranging eggs. On the 23rd one heron was seen standing on the nest after rain at 5.15pm, with no indication of chicks being present.

Increased activity at the nest on 1st March suggested eggs had hatched. However, the herons were very discreet attending the chicks and it was

not until 7th March that I saw two heads peering over the edge. By the 11th both adults were leaving the chicks alone or standing nearby and I could hear soft begging calls when an adult returned to the nest. By the 14th they were being left for long periods and begging calls were considerably louder. On 20th March an Australian Magpie *Cracticus tibicen* flew at the chicks aggressively as they stood beside the nest, making them duck, but did not persist in its attack, perching nearby for a minute. On 12th April both chicks were standing with necks retracted, near the nest, one being slightly larger than the other. During this time I only saw adults fly in to feed late in the afternoon, but I presume they also fed in the early morning before observations commenced. On arrival the adults made low *graaw* calls. On 17th April only one chick was present, perched away from the nest, and on the 18th it too was gone.

The breeding behaviour of the White-faced Heron is little known and there are no detailed studies (Marchant & Higgins 1990). The incubation and nestling periods are thought to be about 24 and 43 days respectively, with the fledged young noted in the vicinity of the nest for a further 18 days (Marchant & Higgins 1990).

The chronology of events described above is consistent with two broods of White-faced Heron being successfully fledged from the same nest during the 2011-2012 breeding season. Based on a requirement of 67 days for the incubation and nestling periods, the second clutch would have been completed on 10th February, 17 or 18 days after the first brood fledged.

This is the first documented instance of two broods of White-faced Heron being successfully fledged from the same nest in one season, although it has been suspected that this may occur (Marchant & Higgins 1990). It is assumed that the same pair was involved in both broods. The 2011-2012 breeding season was exceptionally wet, being the second of two successive years of La Niña conditions, which may have allowed breeding to occur over an extended period.

ACKNOWLEDGEMENTS

I wish to thank Mike Newman and Max Maddock for encouragement and assistance in publishing this note.

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Observation of White-throated Nightjars at Tahlee, New South Wales

Michael Roderick[1] and Lionel Winston Filewood[2]

[1]3 Alderson Street, Shortland, NSW 2307, Australia
[2]73 Underwood Road, Forster, NSW 2428, Australia

A group of at least six White-throated Nightjars *Eurostopodus mystacalis* was observed for a brief period on the north shore of Port Stephens on 7 April 2011. Given that the birds were very obviously detected using spotlights and had essentially 'disappeared' minutes later it is considered likely that the birds were on migration. To the authors' knowledge, this behaviour has not been documented in the Hunter Region previously and it is considered likely that migratory movements within the Region are later than those previously published.

The White-throated Nightjar *Eurostopodus mystacalis* is a breeding summer migrant to south-eastern Australia, predominantly east of the Great Dividing Range. Populations spend the austral winter in central / north east Queensland and New Guinea, with some birds resident in Queensland (Higgins 1999). Information on the migratory movements of this species is scarce, though Carter & Bright (2011) have suggested that it may make diurnal movements on migration so as to maximise

nocturnal feeding. Locally, the species is listed as a "Summer Migrant" (Stuart 2010).

On the evening of 7 April 2011, the authors gathered on the foreshore at Tahlee, on the northern shore of Port Stephens (32º40'03"S 152º 00'38"E). We were positioned within 50m of the high-tide mark where a mix of mangrove and saltmarsh vegetation occurred. We were situated on a gravel road just to the north of the mangroves and immediately south of a large paddock area with scattered trees and small sections of inundated land.

At 1810 hours one of us noticed a dark figure fly into the paddock area and alight on the ground. A spotlight was put onto the bird and it rose off the ground, revealing large 'eyeshine' on the eyes and it was immediately identified as a White-throated Nightjar. Moments later a second, then a third bird rose off the ground behind the first bird. One bird flew over from the paddock and circled the observers almost directly overhead. Then the spotlight was scanned across the paddock, revealing even more nightjars flying over the land. It was difficult to estimate numbers but the most birds visible at any given time was six, though it was agreed by us at the time that there were probably at least ten birds on the paddock.

Although no direct observations were made of the birds taking food, their flight pattern suggested that they were hawking for insects over the paddock. No calls were heard at any stage. We were present at the site until 1845h, though no observations of the nightjars were made after 1815h.

Although the migration period for White-throated Nightjars north from the Central Coast of NSW has been stated to be the end of February (Higgins 1999), it is considered likely that these birds seen in early April were on migration. It is said that this species may form loose foraging groups of up to 20 birds on passage (see "Social Organisation" in Higgins 1999).

It is probable that the migration period for this species within the Hunter Region is later than that stated in Higgins (1999). This is supported by a number of records of the species in the Region in April, as well as a record in May (Stuart 1994-2010). Furthermore, given that an adult bird with dependent young was observed by one of the authors in the Sugarloaf Range (west of Newcastle) on 5 April 2011, only two days prior to this sighting of multiple birds, it is probable that birds depart the Region in April and May.

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Flocking of Jacky Winter in paddocks during winter

Mike Newman

7 Glenurie Close, Woodville NSW 2321, Australia
omgnewman@bigpond.com

During monthly surveys of birds at Yaraandoo (32°38'S, 151°39'E), a lowland cattle property (approximately 100m altitude) near Paterson in NSW, I noted an increase in the numbers of Jacky Winter *Microeca fascinans* during the winter months of 2010. In 2011 I continued the surveys, each taking approximately three hours and following the same route, and found similar trends in monthly numbers (**Figure 1**).

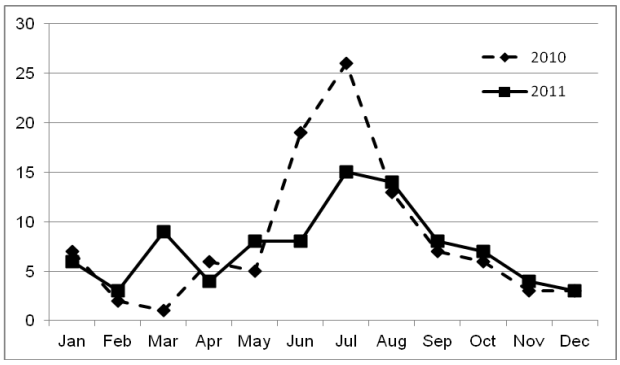

Figure 1. Seasonal variations in Jacky Winter numbers based on monthly surveys at Yaraandoo, a cattle property at Duns Creek near Paterson in NSW.

Jacky Winter were recorded during all 24 monthly surveys at Yaraandoo. In both years I found peak numbers in July, but the increase commenced earlier and the maximum count was larger in 2010 than 2011 (28 and 16 birds respectively). Jacky Winter numbers had declined substantially by August in both years. Except during the winter build-up, similar monthly numbers were recorded in both years.

During the winter period, June to August, the additional birds were primarily concentrated in open paddocks, making use of fence wires and isolated shade trees for perches while feeding. Approximately 15% of Yaraandoo comprises patches of woodland with a closed canopy, remnants now separated from surrounding woodland, which is extensive. In winter Jacky Winter were not recorded in the patches of remnant woodland.

The Handbook of Australian, New Zealand and Antarctic Birds (HANZAB) (Higgins & Peter 2002: 580) summarises the movements of the Jacky Winter as follows: 'variously described as resident, sedentary, seasonal visitor and nomadic visitor. Some movements reported, but extent or patterns not known. No large scale seasonal movements recorded.'

In NSW the breeding season of the Jacky Winter is from late August to early January (Higgins & Peter 2002: 584). Hence the dispersion of the flocks at Yaraandoo is consistent with the wintering birds departing to breed. Some birds breed on Yaraandoo, and an adult with a dependent young was seen in December 2011 on a lightly timbered slope where Jacky Winter are recorded throughout the year.

The extent and timing of movement from breeding to wintering grounds is unclear to judge from other studies summarised in HANZAB (Higgins & Peter 2002: 581). At Moruya in NSW birds arrived to breed in August-September and there were few records between January and July, where it was thought that movements were possibly just local. This proposition fits well with my observations other than that the timing of build up of numbers at Yaraandoo is well after the end of the breeding season.

In the Paterson area I have observed Jacky Winter holding territories throughout the year, both on Yaraandoo and elsewhere. In all instances these territories were in relatively open habitat at woodland edges. In contrasting style a small number of Jacky Winter, possibly a pair and their previous season's young, have in recent years maintained a territory at the edge of my property at Woodville near Paterson, again foraging in open areas, often using power lines for perching. Although I do not have detailed records, my impression is that their occupancy commences soon after the end of the breeding season. In 2011 they were first noted on 11 December.

I tentatively suggest that Jacky Winter breeding in woodland areas, as opposed to open areas with only a few isolated trees, move out of woodland after breeding as described in the Moruya study (Higgins & Peter 2002: 581). However, the timing of this partial exodus would be much earlier than the "flocking" observed on Yaraandoo, which peaks in July. Possibly Yaraandoo is used as a staging post for birds immediately before moving into surrounding areas of woodland to breed. It is also possible that some altitudinal migration occurs, with Jacky Winter moving to lowland areas like Yaraandoo in winter. Flame Robins *Petroica phoenicea* behave in this manner migrating to lower land in winter and forming flocks of up to 20 birds in open grassy habitats such as paddocks and parklands; it is the only Australasian red-breasted robin that forms flocks regularly (Higgins & Peter 2002: 666).

In studies at Green Wattle Creek, which is about 4 km from Yaraandoo, I found that the tendency of Grey Fantail *Rhipidura albiscapa* to move in winter from areas of woodland where they breed increases during periods of prolonged drought involving several successive years of below-average rainfall (Newman 2012). If similar factors drive the movement of Jacky Winter from woodland, the fact that 2010 and 2011 are part of an extended La Niña wet cycle provides a possible explanation of the lower numbers of Jacky Winter found at Yaraandoo during the winter of 2011 (i.e. woodland habitat becomes more mesic and hence more suitable for Jacky Winter throughout the year). It is also possible that the Yaraandoo winter flocks involve local birds moving directly to Yaraandoo late in the non-breeding season as woodland foraging conditions deteriorate.

The above discussion highlights an opportunity to increase the understanding of Jacky Winter movements by monitoring the timing of their occupancy of non-breeding season territories.

ADDENDUM

In a previous paper (Newman 2011) I described the reaction of groups of Jacky Winter at Yaraandoo to "pishing" during the 2010 surveys, which resulted in the birds flying at me at eye level. The birds did not show this response in 2011.

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- Appendices of raw data and annotated lists of bird species and habitats can be included in tabular form at the end of the article.
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- 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.
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- 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.
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Green, R. (1980). 'Ecology of native and exotic birds in the suburban habitat'. Ph.D. Thesis, Monash University, Victoria.

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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.)

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Please submit all manuscripts to:

Joint Editors,
Mike Newman omgnewman@bigpond.com
Harold Tarrant Harold.Tarrant@newcastle.edu.au

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