The Whistler

Rock platform birds
Waterbirds in Port Stephens
Birds on farms
Scrubwrens
Hunter Estuary mangroves
Black Falcon

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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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Birds on Newcastle's rock platforms

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Eighteen species of non-passerine birds were recorded on coastal rock platforms along Newcastle's rocky foreshore, which extends southwards from Nobbys Beach to Burwood Beach. The rock platforms are used as a roost by many waterbirds including gulls, cormorants and a variety of terns. Only a few species regularly depend on the rock platforms for foraging such as: Sooty Oystercatchers (*Haematopus fuliginosus*), Ruddy Turnstones (*Arenaria interpres*) and Eastern Reef Egrets (*Egretta sacra*). Other birds that forage, but are less regular visitors, include: Red-necked Stints (*Calidris ruficollis*), Grey-tailed Tattlers (*Heteroscelus brevipes*) and White-faced Herons (*Egretta novaehollandiae*). Some Silver Gulls (*Larus novaehollandiae*) forage on the rocks, but most forage elsewhere. Silver Gulls and Crested Terns (*Sterna bergii*) were the most abundant species and were often recorded in the hundreds. Sooty Oystercatchers were the third-most common bird with a maximum of 26 birds recorded. Ruddy Turnstones were the fourth-most abundant bird (9), although more than 50 have been recorded in the past. Common Tern (*Sterna hirundo*), White-fronted Tern (*Sterna striata*), Caspian Tern (*Sterna caspia*) and Red-necked Stints were recorded sporadically. Eighteen species have been recorded during summer since records began in 1972, reducing to 12 species during winter. Summer migrants to the rock platforms included Ruddy Turnstones, Red-necked Stints, Grey-tailed Tattlers and Common Terns. White-fronted Terns are winter migrants. The northernmost rock platform, between Nobbys Beach and Newcastle Beach (Newcastle Rock Platform), was the favoured foraging area for most species. In addition, the most important roost site was also located there, on the seaward side of Newcastle Ocean Baths.

INTRODUCTION

During 2005, Newcastle City Council commissioned the Hunter Bird Observers Club (HBOC) to examine avian use of rock platforms in the Newcastle Local Government Area. The study identified current and historical avian biodiversity and use of the rock platforms so that management options could be developed as part of a broader plan for managing natural resources within the Newcastle City landscape (Herbert 2006). The study aimed to record and discuss:

- species diversity;
- abundance;
- status of rock platform frequenting birds;
- habitat use;
- historical bird diversity and abundance;
- differences between rock platforms;
- threatening processes and disturbances;
- management options and recommendations.

The first five points are summarized below in 'Results' and the last three are addressed in 'Discussion'.

METHODS

The study involved winter and summer observations during 2005/06 on coastal rock platforms, from Nobbys Beach southwards to Burwood Beach, and recent observations from HBOC members. Data on historical bird diversity and abundance was obtained from HBOC's data base, HBOC's Annual Bird Reports, Birds Australia New Atlas and Old Atlas, New South Wales Bird Atlassers, and National Parks and Wildlife Service Wildlife Atlas Database.

Study Area

For this study Newcastle's rock platforms were grouped into three discrete rock platforms separated by sandy beaches (**Figure 1**). From north to south, these rock platforms were:

- **Newcastle Rock Platform**: from Nobbys Beach to Newcastle Beach;
- **Shepherds Hill Rock Platform**: from Newcastle Beach to Bar Beach; and
- **Merewether Rock Platform**: from Merewether Beach to Burwood Beach.

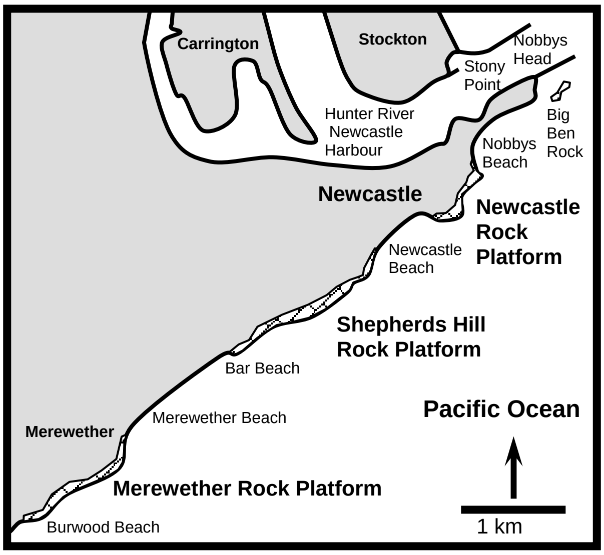


Figure 1 – Newcastle rock platforms can be grouped into three discrete platforms separated by sandy beaches: Newcastle Rock Platform; Shepherds Hill Rock Platform; and Merewether Rock Platform.

Note that when referring collectively to all three rock platforms the term "rock platforms" (uncapitalised and plural) will be used.

Observations

Three rock platforms were surveyed for birds and available habitats over three days in winter (4, 15 and 21 July 2005) and three days in summer (28, 29 and 30 January 2006). Two observers, Liz Crawford and Chris Herbert, carried out winter and summer observations and were assisted by Judith Thomas during summer observations. Binoculars and a spotting telescope were used to observe and record bird diversity, abundance and behaviour. Each rock platform was surveyed from vantage points and lookouts using binoculars and telescopes. This rapid survey method allowed observers to cover the three major rock platforms in a short time frame so that significant movements of birds were readily observed, minimising double counting. Rock platform inspections were also carried out on foot to observe behaviour and disturbances, especially at lower tides. Locations of birds were plotted on large-scale aerial photos and subsequently transferred to **Figures 2** and **3**. Most passerine birds are not obligate rock platform users and not dependant on rock platforms for their survival. Therefore, their presence was considered incidental and they were not considered in this study.

RESULTS

Species Diversity

On a daily basis, both the diversity and abundance of rock platform frequenting birds varied depending on the state of the tide. During six days of observation (three days in winter and three days in summer), the diversity of bird species on a single day on the rock platforms ranged from a maximum of six species at high tide to nine species at low tide. On any single day, Newcastle Rock Platform had the highest diversity with as many as nine species present. Merewether Rock Platform was second in diversity with as many as five species and Shepherds Hill Rock Platform had the least diversity with up to three species. Thus, the Newcastle Rock Platform supported twice the diversity of bird species compared to the Shepherds Hill and Merewether Rock Platforms (**Table 1**). There was also a seasonal change in diversity where 18 species recorded in summer decreased to 12 species in winter, mainly because of absent summer migrants (**Table 2**).

Abundance

The most abundant birds observed on the rock platforms were Silver Gulls. Their numbers doubled from a maximum of 313 during winter observations to 605 during the summer observations (**Table 2**). In contrast, Crested Terns, the second most abundant bird species, decreased considerably in abundance from a maximum of 232 during the winter observations to 51 during summer observations for this study. This trend is not so evident in **Table 2** which does not compare summer and winter counts during the same year. Sooty Oystercatchers were the third most numerous of the consistently present rock-platform frequenting birds with a maximum of 26 recorded (see later discussion on Sooty Oystercatchers regarding seasonal abundance). The number of summer-migrating terns falls to zero during winter whereas during winter, migrating White-fronted Terns appear. Nine Ruddy Turnstones were recorded during summer observations in January 2006, but only one was observed over-wintering during July 2005 (historically up to two have been recorded over-wintering). All other rock-platform frequenting birds, when present, numbered less than ten of each species. Only one Eastern Reef Egret, and no more than three White-faced Herons, were seen on the entire rock platforms at any one time. Two Eastern Reef Egrets have recently been observed (R. McDonald pers. comm. 2007).

Table 1. Bird diversity and maximum number of birds recorded during six survey days (July 2005 & January 2006).

Species	**Newcastle Rock Platform**	**Shepherds Hill Rock Platform**	**Merewether Rock Platform**
Little Pied Cormorant	2	1	
Little Black Cormorant	4	1	
Great Cormorant	1 (4 *)	(5 *)	(5 *)
Australian Pelican	8		
White-faced Heron	1	1	2
Eastern Reef Egret			1
Ruddy Turnstone	9		
Sooty Oystercatcher	16 **	14	6
Silver Gull	231	52	349
Crested Tern	231		28
White-fronted Tern	5		
Total No. of Species	**10**	**5**	**5**

* In vicinity of rock platform, on power poles, potentially rock-platform frequenting.
** 26 recorded later during March 2006.

Table 2. Seasonal bird[1] diversity and abundance on Newcastle rock platforms (maximum number from 1972 to present).

Species	**Summer** **(Sept-Apr) Maximum No.**	**Winter** **(May-Aug) Maximum No.**	**Status**	**Protection**
Australian Pelican	6	8	Resident	
Little Pied Cormorant	2	2	Resident	
Pied Cormorant	Recorded	Recorded	Resident	
Little Black Cormorant	4	3	Resident	
Great Cormorant	1 (12 on poles)	(9 on poles)	Resident	
White-faced Heron	3	1	Common resident	
Eastern Reef Egret	1	1	Rare	
Grey-tailed Tattler	1	0	Summer migratory wader	JAMBA/CAMBA[3]
Ruddy Turnstone	>50	2 (7 Stony Point)	Uncommon summer migratory wader	JAMBA/CAMBA
Red-necked Stint	1-5 (21 on Big Ben Rock, Nobbys Reef)	0	Summer migratory wader	JAMBA/CAMBA
Sooty Oystercatcher	26	22	Resident	Vulnerable - TSC Act[4]
Pacific Gull	0	1[2]	Accidental visitor	
Kelp Gull	1	0	Accidental visitor	
Silver Gull	605	313	Common resident	
Caspian Tern	>30	0	Resident	CAMBA
Crested Tern	>200	232	Common resident	JAMBA
White-fronted Tern	0	>17	Uncommon winter migrant	
Common Tern	>250	0	Summer migrant	JAMBA/CAMBA
Little Tern	16	0	Summer migrant	Endangered - TSC Act
White-winged Black Tern	1[2]	0	Summer migrant	JAMBA/CAMBA

[1] Rock-platform frequenting birds only, [2] Flying, [3] Japan-Australia Migratory Birds Agreement/ China-Australia Migratory Birds Agreement, [4] NSW Threatened Species Conservation Act 1995.

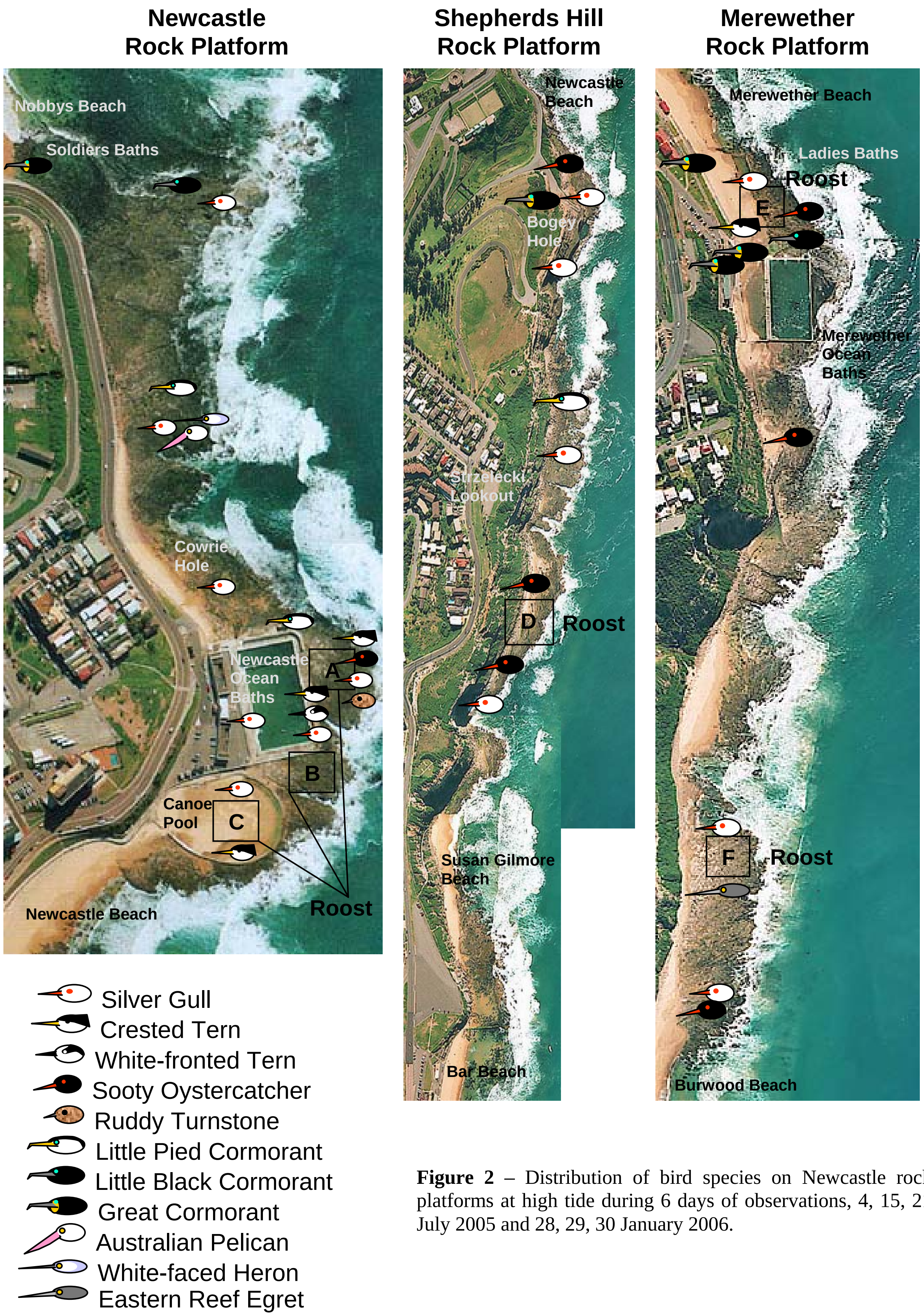
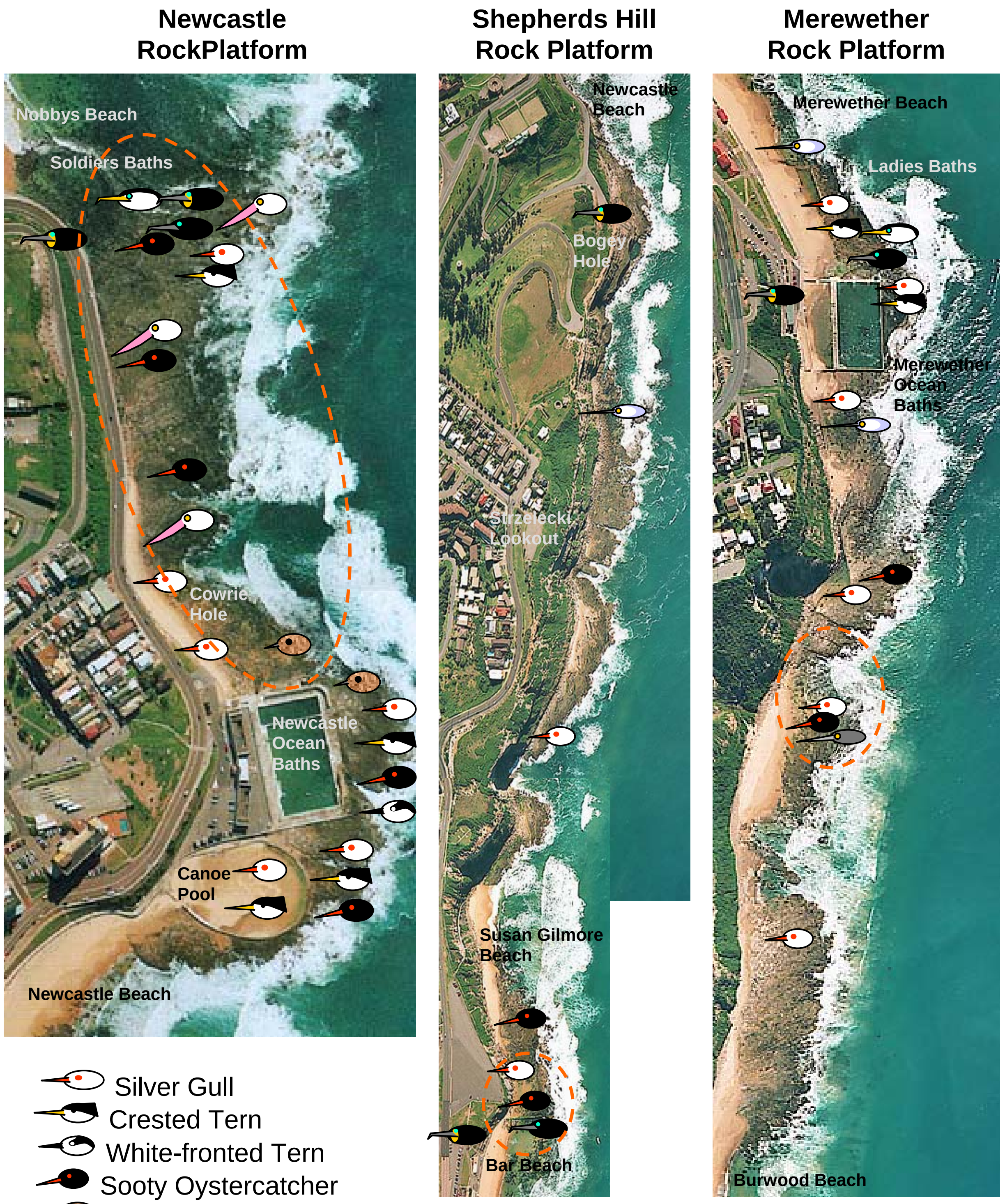


Figure 2 – Distribution of bird species on Newcastle rock platforms at high tide during 6 days of observations, 4, 15, 21 July 2005 and 28, 29, 30 January 2006.



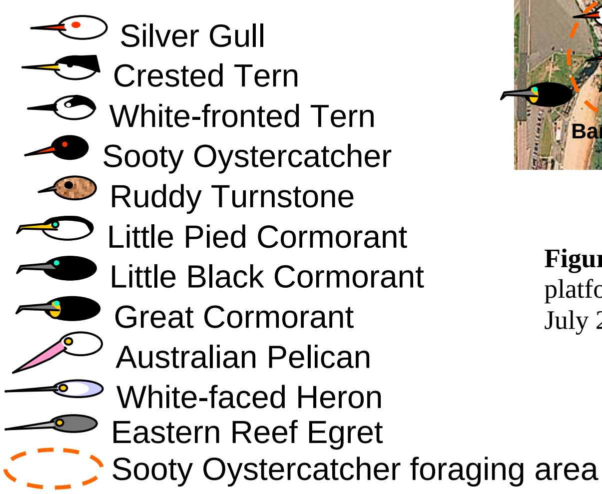


Figure 3 – Distribution of bird species on Newcastle rock platforms at low tide during 6 days of observations, 4, 15, 21 July 2005 and 28, 29, 30 January 2006.

Status of Rock-Platform Frequenting Birds

The following discussion is based on six days of observations for this study, personal observations and historical data from 1972 to present (Herbert 2006).

Australian Pelican *(Pelecanus conspicillatus)*

Although a common resident in the Hunter Region, only eight Australian Pelicans were recorded on the rock platforms, and then only on the Newcastle Rock Platform. There are limited foraging opportunities on the rock platforms for large numbers of these birds. During calm conditions, pelicans have been observed swimming and foraging along the seaward edge of the Newcastle Rock Platform. However, their main interest appears to be scraps discarded by fishermen (**Figure 4)**. The closest breeding areas are located at Pelican Island in Wallis Lake and in Brisbane Water.

Caspian Tern *(Sterna caspia)*

Caspian Terns are regarded as residents in the Hunter Region. They were recorded only once during the study roosting on the Merewether Rock Platform. As many as 30 were observed in 2001. Other sightings were from Nobbys Beach, not the rock platforms. There are no breeding records for the Hunter Region.

Silver Gull *(Larus novaehollandiae)* and Crested Tern *(Sterna bergii)*

Silver Gulls and Crested Terns are common residents (**Figures 5** & **6**). This is reflected by their presence in large numbers on the rock platforms (as many as 605 gulls and 231 terns). They are not known to breed along the rock platforms, but do so in large numbers on Moon Island off the entrance to Lake Macquarie, and on Sandy Island, at the drop-off into Lake Macquarie. Moon Island supports as many as 1000 nesting pairs of Silver Gulls and 500 pairs of Crested Terns (Alan Morris pers. comm.).

Common Tern *(Sterna hirundo)* and Little Tern *(Sterna albifrons)*

More than 250 Common Terns and up to 16 Little Terns have been recorded as summer migrants to the rock platforms. They often roost at Newcastle Ocean Baths at Roost A (**Figures 2** & **7**). Common Terns breed outside Australia, but Little Terns breed locally at Forster and The Entrance, to the north and south of Newcastle respectively. Both breeding sites need active conservation management and intervention to maintain their viability. Little Terns have also bred historically in the Hunter Estuary, at Dark Point and the Big Gibber north of Hawks Nest, and at Red Head south of Newcastle. The most likely local area for future potential breeding may be the rehabilitated Stockton Sandspit. Little Terns are listed as endangered under the NSW Threatened Species Conservation Act, 1995.

Kelp Gull *(Larus dominicanus)* and Pacific Gull *(Larus pacificus)*

Single Kelp Gulls have been reported twice on the Newcastle Rock Platform and a single Pacific Gull, flying past, has been reported. These should be regarded as rare, accidental visitors.

White-winged Black Tern *(Chlidonias leucopterus)*

White-winged Black Terns are summer migrants. There is only one record of a bird on the rock platform, at Newcastle Ocean Baths, although as many as 30 have been observed flying around Newcastle Harbour. They should be regarded as accidental to the rock platform, being more likely to be observed flying over the harbour or roosting on navigation buoys and on boulders around the harbour foreshore. White-winged Black Terns normally breed in the northern hemisphere.

White-fronted Tern *(Sterna striata)*

White-fronted Terns are uncommon winter migrants (**Figure 8**). Most White-fronted Terns breed in New Zealand and migrate to southeastern Australia in winter. In the past, more than 17 have been observed roosting at Newcastle Ocean Baths, 20 on Stockton Breakwater and 40 on Stockton Beach.

Sooty Oystercatcher *(Haematopus fuliginosus)*

Sooty Oystercatchers (**Figure 9**) are regarded as uncommon non-breeding residents in the Newcastle area and are listed as vulnerable under the NSW Threatened Species Conservation Act, 1995. Twenty-six were observed on the rock platforms during 2006 (in March, after the January field work for this study). A maximum of eight Sooty Oystercatchers was recorded during the 1990s. However, from a low point of one in

Figure 4. Pelicans waiting for scraps discarded by fishermen on the Newcastle Rock Platform.

Figure 5. Silver Gulls.

Figure 6. Crested Terns.

Figure 7. Roost A on the seaward side of Newcastle Ocean Baths.

Figure 8. White-fronted Terns.

Figure 9. Sooty Oystercatcher feeding on a limpet.

Figure 10. Ruddy Turnstone.

Figure 11. Great Cormorant roosting on a light pole.

the year 2000 the number reported increased each year to a maximum of 26 in 2006 (**Figure 12**). Hopefully this indicates a real increase in breeding success in the region rather than simply an increase in the rate of observations. Field observations suggest that this population may have a home range extending southwards towards Lake Macquarie.

Each year numbers decline from July to October before gradually increasing to maximum numbers from January to June. Although this trend, shown on **Figure 13**, is supported by only a small amount of data, it is also evident for Boat Harbour (Kurnell), Long Reef (Narrabeen) and the Central Coast.

Sometimes the total resident population of Sooty Oystercatchers can be observed foraging and roosting on the Newcastle Rock Platform. At other times they can be dispersed along the entire length of the rock platforms, including Shepherds Hill and Merewether Rock Platforms. At low tide they also forage along the Hunter River shoreline at Stony Point, on oyster-banks off Stockton Sandspit, on the Kooragang Dykes and on Big Ben Rock, Nobbys Reef (**Figure 1**). At high tide they roost mainly on the Newcastle Rock Platform, at the most important roost immediately seaward of Newcastle Ocean Baths (Roost A), but also on Shepherds Hill Rock Platform (Roost D) and Merewether Rock Platform, Kooragang Dykes and Stony Point.

Sooty Oystercatchers generally breed on offshore islands or secluded headlands. However, offshore islands are absent from the Newcastle area. The nearest probable breeding site is Moon Island, off Lake Macquarie, where only one pair is reported to breed. Sooty Oystercatchers can, rarely, breed on sufficiently secluded mainland headlands, but it is extremely unlikely that any of the shoreline between Nobbys Head and Burwood Beach would provide suitable conditions. A population of as many as 23 Sooty Oystercatchers has been recorded on the Central Coast (A. Morris pers. comm.). It is not known if this is an entirely separate population to the Newcastle/Lake Macquarie population, or if an interchange of individuals takes place. Again only one island is located off the Central Coast, Bird Island, which is known to support one breeding pair at any one time. Three islands off Port Stephens are about twice the distance from Newcastle as Moon Island and are separated by the continuous beach of Newcastle Bight that would provide no intervening foraging opportunities for Sooty Oystercatchers. Although interchange with the Port Stephens population is possible, it is more likely that the resident Port Stephens population of 18 Sooty Oystercatchers (Stuart 2004) would have priority use of these offshore islands. A breeding pair on each of the three islands has been reported (Alan Morris pers. comm.). Broughton Island, even further north, supports at least two breeding pairs (pers. obs.). Apart from Moon Island it is unknown where Newcastle Sooty Oystercatchers, that depart in spring, might breed.

Sooty Oystercatchers appear to favour the lower, more frequently inundated parts of the rock platforms for foraging (**Figure 3**). However, they favour the higher parts of the rock platforms for roosting, which accounts for the high numbers of oystercatchers that have been observed around the Newcastle Ocean Bath, at Roosts A and B, and on the Shepherds Hill Rock Platform immediately north of Susan Gilmore Beach, at Roost D (**Figure 2**).

Grey-tailed Tattler *(Heteroscelus brevipes)* and Red-necked Stint *(Calidris ruficollis)*

Grey-tailed Tattlers and Red-necked Stints are summer migrants and both breed in the northern hemisphere. One tattler and one to five stints have been recorded only a few times on the rock platforms. However, because tattlers are cryptic and stints are both small and cryptic, they may have been under-reported, especially for the less observed Shepherds Hill Rock Platform and the southern part of the Merewether Rock Platform. As many as 21 Red-necked Stints have been observed on Big Ben Rock, an outcrop of rocks exposed at low tide off Nobbys Head. These shorebirds are protected under the Bonn Convention and international agreements with the governments of Japan (JAMBA) and China (CAMBA).

Ruddy Turnstone *(Arenaria interpres)*

Ruddy Turnstones are uncommon summer migrants that breed in the northern hemisphere (**Figure 10**). In some years, as many as seven turnstones have been recorded over-wintering on the Newcastle Rock Platform. Turnstones are regularly recorded during summer with rarely as many as 40 to 50 Ruddy Turnstones observed on the Newcastle Rock Platform and more than 20 observed on the adjacent Newcastle and Nobbys Beaches. The relatively large number of more than 50 turnstones, reported at Newcastle Ocean Baths in April 1994, were probably on passage to their northern hemisphere breeding grounds as

March/April is the usual departure period for migratory waders from the Hunter Estuary. This emphasizes the importance of Newcastle Ocean Baths roost as a stopover for the smaller migratory waders traveling northwards in autumn and perhaps southwards in spring. Ruddy Turnstones are protected under the Bonn Convention and international agreements with the governments of Japan (JAMBA) and China (CAMBA).

Cormorants

Little Pied Cormorant *(Phalacrocorax melanoleucos)*, Little Black Cormorant (*Phalacrocorax sulcirostris)* and Great Cormorant (*Phalacrocorax carbo)* are common residents. They have been reported on the rock platforms in maximum numbers of only 2, 4 and 12 respectively. They breed away from the coast in a number of the Lower Hunter Region wetlands. They use rock platforms as temporary roosts to dry their feathers and rest between offshore fishing dives. Great Cormorants were mostly observed roosting on power poles and light poles immediately above and behind the rock platforms and beaches (**Figure 11**). During the surveys, only one Great Cormorant was observed to roost directly on the rock platform. Pied Cormorants (*Phalacrocorax varius)* are regarded as usual residents in the Hunter Region. Between 6 and 20 Pied Cormorants have been recorded, mainly on surrounding beaches rather than on the rock platforms. Like other cormorants they nest in wetlands inland from the coastline.

Eastern Reef Egret *(Egretta sacra)*

One, and sometimes two, dark-phase Eastern Reef Egrets have been observed on the rock platforms. They are regarded as rare in southeastern Australia and are not known to breed in the Newcastle area, but have been reported breeding on Moon Island, off Lake Macquarie (A. Morris pers. comm.).

White-faced Heron *(Egretta novaehollandiae)*

White-faced Herons are common residents in the Hunter Region, but only single birds are recorded on the rock platforms. A maximum of three birds have been observed foraging at any one time along the entire length of the rock platforms. They nest away from the immediate coast.

Nankeen Kestrel *(Falco cenchroides)*

Nankeen Kestrels are usual residents in the Hunter Region and, although not strictly a rock-platform frequenting bird, are the only birds that have been noted to breed in the vicinity of the rock platform, specifically on cliffs immediately above the Shepherds Hill Rock Platform. T. Clarke (pers. comm. 2005) observed a pair of Nankeen Kestrels nesting on cliffs between Bar Beach and Susan Gilmore Beach. Evidence for roosting and a possible nest site was also identified during this study along the Shepherds Hill Rock Platform, about 200m north of Susan Gilmore Beach. As this is within half a kilometre of the previously observed nesting location, it indicates a degree of site faithfulness.

White-bellied Sea-Eagle *(Haliaeetus leucogaster)*

Although White-bellied Sea-Eagles are not specifically rock-platform dependant birds they do overfly the shoreline searching for fish and predating on birds that use the rock platforms. One, and probably two, Sooty Oystercatchers have been taken by sea eagles recently (Judi Thomas pers. comm. 2007).

Habitat Use

Most birds encountered on the Newcastle rock platforms use them for roosting. There are, in fact, few species that actually rely predominantly on the rock platforms for food. The Sooty Oystercatcher is the main foraging species present all year round whereas the migratory Ruddy Turnstones forage only during summer (occasionally one or two birds over-winter). Other foraging species, such as Eastern Reef Egret and White-faced Heron, were usually recorded as single birds. Although large numbers of Silver Gulls were recorded, only a few foraged specifically on the rock platform. Australian Pelicans did not directly forage on the rock platform, but instead waited on scraps from fishermen and, on calm days, swam off the rocks (**Figure 4**).

The most significant and regularly used roost site is located on the Newcastle Rock Platform on the seaward side of Newcastle Ocean Baths, at Roost A (**Figures 2** & **7**). In addition to hundreds of Silver Gulls and Crested Terns, small numbers of Sooty Oystercatchers, Ruddy Turnstones, Little Terns, Common Terns and White-fronted Terns also roost there. Additional roosting areas are located between Newcastle Ocean Baths and Canoe Pool (Roost B) and in Canoe Pool (Roost C, gulls and terns only) (**Figure 2**). Other regularly used roost sites for gulls and terns are located on the Merewether Rock Platform between

Merewether Ocean Baths and Ladies Baths (Roost E), and immediately north of Burwood Beach (Roost F, **Figure 2**). Another significant roost site, for Sooty Oystercatchers only, is located on the Shepherds Hill Rock Platform, between Strzelecki Lookout and Susan Gilmore Beach (Roost D, **Figure 2**), where as many as 14 Sooty Oystercatchers have been observed.

During surveys for this study, the most consistently utilized low-tide foraging area for all birds, particularly Sooty Oystercatchers, was located on the Newcastle Rock Platform between the Cowrie Hole and Soldiers Baths (**Figure 3**). In addition, previous observations and observations during this study indicate that Ruddy Turnstones forage consistently along the seaward edge of the rock platform adjacent to the Newcastle Ocean Baths. During this study, specific areas of the Shepherds Hill and Merewether Rock Platforms were observed as important low-tide foraging areas, but only for Sooty Oystercatchers (**Figure 3**).

Historical Bird Diversity and Abundance

Eighteen species of rock-platform frequenting birds have been recorded on the rock platforms since records began in 1972 (**Table 2**). Note that numbers included are derived from the maximum number for each species from a combination of historical and recent data. Although listed, White-winged Black Terns and a Pacific Gull are not considered in the assessment of rock platform bird diversity as they were observed flying over, not on, the rock platform. A maximum of 18 species that may be present during summer reduces to a maximum of 12 species during winter after most migratory birds have departed. Silver Gulls (605) and Crested Terns (232) are the most abundant species on the rock platforms. However, because they are common birds they have not been counted systematically in the past. Therefore, the maximum numbers, shown in **Table 2**, were recorded only recently during the six days of observations for this study. As many as 17 White-fronted Terns have been recorded during winter, but not at all in summer. Historically, more than 250 Common Terns and more than 30 Caspian Terns have been observed during summer, but their occurrence is sporadic.

Only two non-breeding Ruddy Turnstones have been recorded to over-winter on the rock platforms, however seven have been observed near Stony Point, immediately inside the entrance to Newcastle Harbour. More than 50 have been observed on the rock platforms during summer. Low numbers of infrequently recorded and cryptic migratory waders observed on the Newcastle Rock Platform, such as Red-necked Stints and Grey-tailed Tattlers, might be more commonly recorded if the rock platforms were monitored more regularly.

A combination of historical and recent observations indicate that Sooty Oystercatchers are present in maximum numbers from mid-summer to early winter, decreasing to a minimum during spring before increasing again (**Figure 12**). Although a maximum of 16 Sooty Oystercatchers was recorded during the six days of observations, as many as 26 Sooty Oystercatchers were recorded later, during March 2006 (J. Thomas pers. comm.). Sooty Oystercatchers appear to be increasing in numbers since historical records began (**Figure 13**).

DISCUSSION

In addition to seasonal influences it is evident that weather affects the diversity and abundance of birds using the rock platforms. Both diversity and abundance were considerably lower following a period of strong winds when heavy seas were sweeping over the platforms. Diversity and abundance were also influenced by birds moving to adjacent habitats. Some Sooty Oystercatchers moved off the rock platforms into the Hunter Estuary to roost on the Kooragang Dykes at high tide and, at low tide, a few foraged on oyster-banks off Stockton Sandspit, north of Stockton Bridge and along the Hunter River foreshore at Stony Point (**Figure 1**). In addition, eight Sooty Oystercatchers were observed flying to Big Ben Rock, emergent rocks off Nobbys Head (part of Nobbys Reef), where it is quite likely they would forage as well as roost. Ruddy Turnstones have also been observed roosting on the Kooragang Dykes, the Hunter River shoreline off Stockton, at Stony Point and on Big Ben Rock (**Figure 1**).

It is evident that each year the numbers of Sooty Oystercatchers decline from July to October before gradually increasing to maximum numbers from January to June (**Figure 13**). This trend may indicate that mature breeding birds leave the rock platforms about August/September to breed on offshore islands (e.g. Moon Island, etc.). After breeding they return during mid-summer with their fledged offspring to join immature or non-breeding

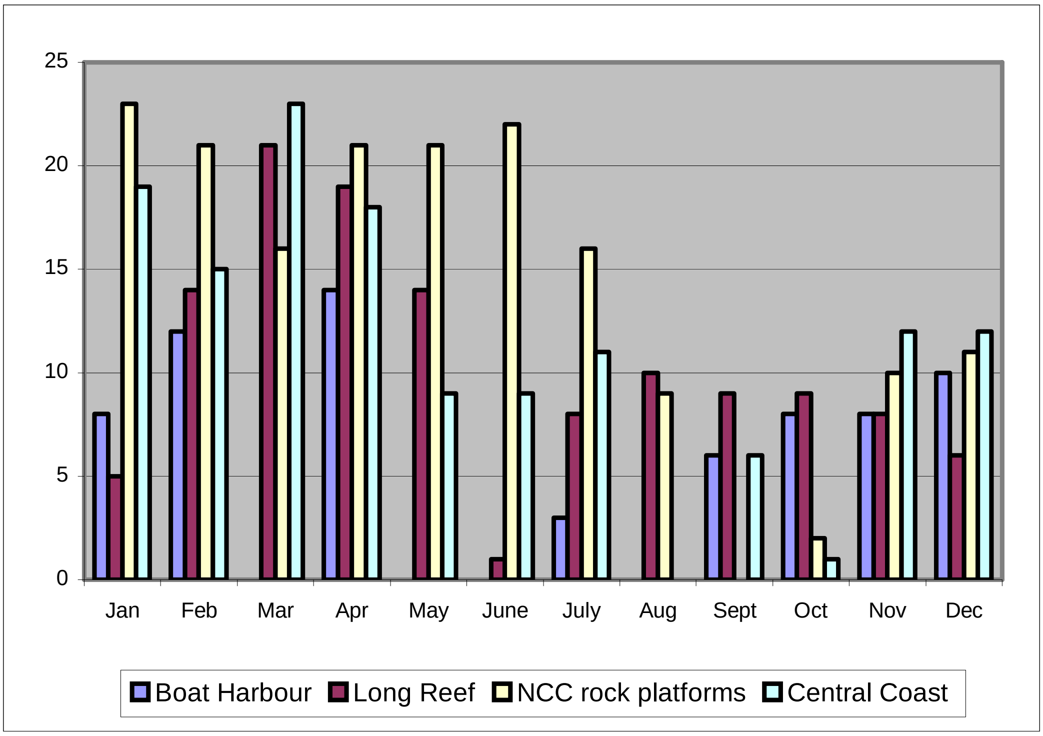


Figure 12. Similar trends of abundance variation throughout the year are shown by maximum monthly counts of Sooty Oystercatchers from Boat Harbour (Kurnell, 1995-2003, B. Speechley pers. comm.), Long Reef (Narrabeen, 1995-1998, P. Straw pers. comm.), Newcastle rock platforms (NCC rock platforms, 1985-2005, HBOC data) and the Central Coast (1995-2003, A. Morris pers. comm.).

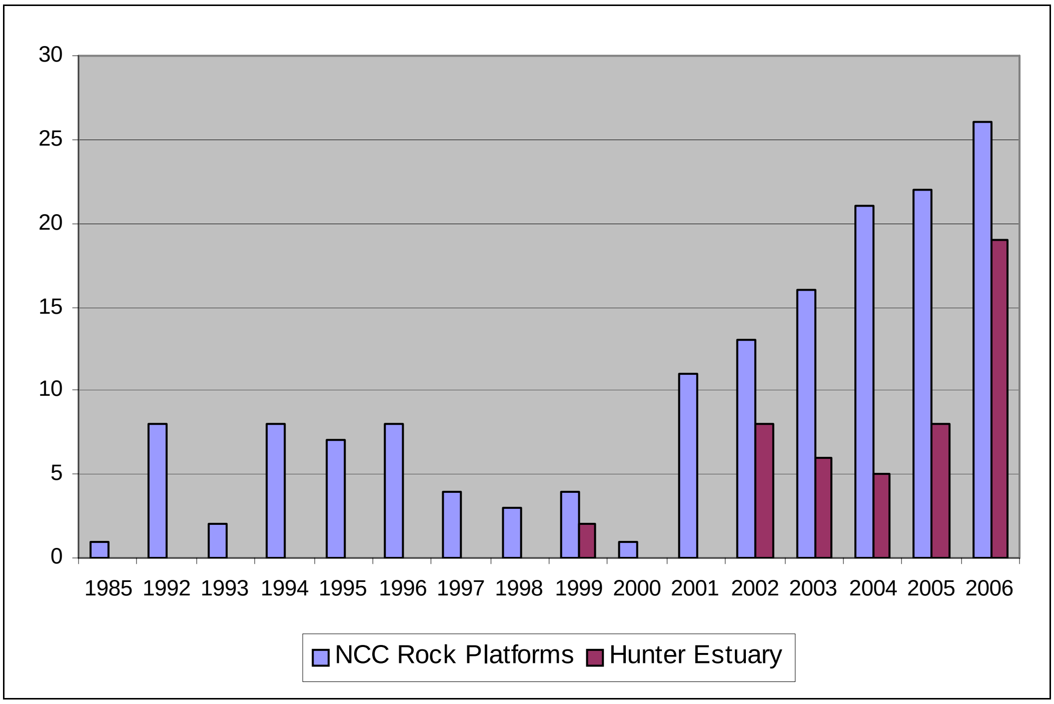


Figure 13. A comparison of maximum yearly counts since 1985 indicates that Sooty Oystercatchers appear to be increasing in numbers on the Newcastle rock platforms (NCC Rock Platforms) and in the Hunter Estuary (monitoring commenced 1999).

adults that have remained on the mainland rock platforms. Similar trends have also been observed in Victoria where numbers increase from April to peak in July/August, and also in Tasmania where birds move to wintering mainland sites between March and September (Marchant and Higgins 1993). It is apparent that similar movements occur much earlier at Newcastle's warmer latitude.

Differences Between Rock Platforms

There appear to be noticeable differences in the diversity and abundance of birds using different parts of the rock platforms (**Figure 4** and **Table 1**). The Newcastle Rock Platform supported about double the diversity of birds and a greater abundance of each species than Shepherds Hill or Merewether Rock Platforms. Shepherds Hill Rock Platform, although the most extensive, the most inaccessible and, therefore, the least disturbed of the three rock platforms, supported the least diversity and numbers of birds. This apparent paradox may be explained by both geographical and geological factors as discussed below.

Favourable geographical and geological features contribute to the higher diversity and abundance of birds using the Newcastle Rock Platform when compared to the more southern rock platforms. The proximity of the Newcastle Rock Platform to the Hunter Estuary enables many birds to move easily between estuarine and coastal habitats during tidal changes. The adjacent estuary also provides a convenient refuge from coastal heavy weather. The Newcastle Rock Platform is a low-lying peninsular backed by a relatively low-level hinterland. Roosting birds, therefore, have a relatively clear line-of-sight to their surroundings, allowing early detection of approaching aerial predators such as White-bellied Sea-Eagles and Peregrine Falcons. In addition the Newcastle Rock Platform, north of the Cowrie Hole, is composed of thin-bedded, fine-grained sandstone that dips gently seawards (**Figure 14**). This provides an expansive, low-lying, frequently inundated, seawards-sloping rock platform with a complex indented shoreface that supports a diverse and abundant invertebrate community, an ideal foraging habitat for rock-platform dependant birds such as Sooty Oystercatchers. This is supported by a study that concluded that the Newcastle Rock Platform had the highest diversity and abundance of marine shoreface invertebrates when compared with the other rock platforms (Gladstone 2006).

A number of negative features may account for the lack of avian diversity and abundance on the Shepherds Hill Rock Platform and most of the Merewether Rock Platform. Both rock platforms are more distant from the Hunter Estuary than the Newcastle Rock Platform and both are backed by high, vertical cliffs that impede a clear line-of-sight to approaching aerial predators. In addition, they have extensive stretches of elevated rock platform that presents a blocky, vertically jointed sandstone edge to the sea with a narrow intertidal habitat that supports fewer invertebrate biota than the Newcastle Rock Platform (**Figure 15**).

Figure 14. The Newcastle Rock Platform, between Cowrie Hole and Soldiers Baths, has a gently seaward-sloping rock platform with a gradational shoreface. The abundance and diversity of invertebrate fauna supported by this shoreface provides abundant foraging opportunities for Sooty Oystercatchers.

Figure 15. Shepherds Hill Rock Platform, below Strzelecki Lookout, showing an elevated rock platform with an abrupt, vertically jointed shoreface. The paucity of accessible invertebrate fauna here provides limited foraging opportunities for Sooty Oystercatchers.

Threatening Processes and Disturbances

People walking quietly past, rather than through, roosting birds generally produced very little direct disturbance. However, pairs and groups of people traversing the main roosting area on the seaward side of the Newcastle Ocean Baths, Roost A, repeatedly put birds to flight. The main problem is boisterous behaviour when both children and adults unthinkingly, and sometimes deliberately, walk or run straight through roosting or foraging birds instead of recognizing them and skirting around them.

Surfboard riders not only surf off Newcastle beaches but also catch waves offshore from rock platforms. To launch their boards, they often traverse the rock platform itself. A well-used launching spot exists on the Newcastle Rock Platform on the seaward side of Newcastle Ocean Baths. They pass within a few metres of Roost A, the most significant roost site along the entire Newcastle coast, often putting the birds to flight. This represents a recurring disturbance that is dependant on the level of boisterousness and the number of surfers at any one time. It is particularly a problem during school holidays and the warmer months when surfing activity increases. Repeated disturbances such as this render the area difficult for birds to roost or forage with any continuity.

When several rock fishermen occupied a length of the rock platform shoreline simultaneously, oystercatchers were often displaced and departed the area. However, in other areas oystercatchers roosted and foraged within 20m of individual fishermen who were quietly fishing or not moving directly towards the birds. In contrast, pelicans deliberately waited close to rock fishermen in the hope of obtaining fish scraps (**Figure 4**).

Off-the-leash dogs were observed on all the rock platforms and have also been observed chasing birds. All these areas were sign-posted as banning dogs.

Only one instance of disturbance by a natural predator was observed during the field study when a White-bellied Sea-Eagle flew high over the Newcastle Rock Platform. However, a sea-eagle has recently been observed capturing Sooty Oystercatchers (Judi Thomas pers. comm. 2007).

During periods of high spring tides or a combination of high tides and heavy wave action most of the rock platforms are inundated and may become untenable for any birds to roost or forage. During these periods many birds fly up the Hunter Estuary to roost at locations such as the Kooragang Dykes and Stony Point.

Because rock platforms in the Sydney region are in close proximity to a large human population they are being denuded of invertebrate biota by the removal of shellfish, crabs and sea urchins for human consumption, regardless of bag limits. This biota is vital for the survival of foraging rock platform species such as Sooty Oystercatchers, but is not vital for the survival of humans in this area and at this time in Australia. This activity is really a cultural phenomenon generally restricted to a few ethnic groups. The author is not aware of similar problems in the Newcastle area. However, if this does occur, or is allowed to happen, it would be of serious concern for the survival of rock-platform foraging birds.

Management Options and Recommendations

Newcastle's rock platforms are heavily used by humans for recreation. This is especially so for the Newcastle Rock Platform; for parts of the Shepherds Hill Rock Platform, between Bar Beach and Susan Gilmore Beach; and the Merewether Rock Platform, north of Merewether Ocean Baths. However, despite the high level of human use, these areas support a significant diversity of species and abundance of birds.

Consideration should be given to providing protection for the vulnerable Roosts A and B (**Figure 2**) on the seaward side of Newcastle Ocean Baths to prevent repeated disturbance by people walking or running through the roosting birds. Facilities to allow viewing without disturbing the birds could also be considered. At the very least it is recommended that interpretive information signs be erected at that location. These roost sites offer a spectacular display of biodiversity that is of significant educational and aesthetic value. It is a well-known birdwatching site not only for local birdwatchers but also for birdwatchers from Sydney and interstate. The lack of information signs about birds at the Newcastle Rock Platform is in stark contrast to Cairns City, which has constructed an extensive esplanade boardwalk, supported by a plethora of interpretive signs, to direct tourists to view bird life along the shoreline mudflats. This feature attracts thousands of Australian and international tourists each year. During the compilation of this report the author had the opportunity to visit the Cairns Esplanade during July. Dozens of people were using the esplanade but, at that time of the year, there were less than a hundred birds of about half a dozen species. In comparison the Newcastle Rock Platform, visible from Shortland Esplanade and the Ocean Baths, often had many hundreds of birds totaling as many as 10 species. Displays of biodiversity and abundance such as this, in addition to the recently rehabilitated Stockton Sandspit, are spectacular, but unrealized, avian assets for ecotourism that are virtually ignored in the Hunter Region.

There is a need to educate surfers, who cross rock platforms to launch into the surf, to avoid running through roosting and foraging birds, and to skirt around them without disturbing them, particularly at the Newcastle Ocean Baths. Suitable signs should guide surfers along the edge of the rock platform behind the baths seating area so that they do not need to access the rock platform directly from the baths.

Fishermen should be educated to regard oystercatchers as they would fellow fishermen, by respecting their space, by not approaching within 25m and by walking around, not through, roosting and foraging birds. Fishermen could be recruited by informing them of the birds' vulnerable status and encouraging them to adopt the birds as a symbol of the health of the rock platform. They may adopt a sense of protection and ownership of the birds' welfare, and even discourage other people from disturbing them. Sooty Oystercatchers could be promoted as a readily recognized symbol of the health of the rock platforms.

Consideration should be given to banning the collection of shellfish, crabs and sea urchins etc. from the entire area of the Newcastle Rock Platform and from the favoured foraging areas of the Sooty Oystercatchers on the Shepherds Hill and Merewether Rock Platforms (**Figure 3**).

Even though there are adequate signs banning dogs from entry onto beaches, evidence of dogs on some beaches and rock platforms was noted. This indicates that more policing of the regulations banning dogs should be undertaken and that signs specifically banning dogs from the rock platforms are needed.

It is recommended that an education/information campaign be instigated so that the public can more fully understand the ecology of the rock platform environment, including both invertebrate and avian biota. This could be achieved through published articles, guided rock platform walks and interpretive signage in appropriate locations.

CONCLUSIONS

Because of its favourable geology, geography and invertebrate fauna the Newcastle Rock Platform has about twice the avian biodiversity of the Shepherds Hill and Merewether Rock Platforms. The Newcastle Rock Platform also hosts the greatest abundance of birds and is the location of the most significant regularly used roost on all rock platforms in the Newcastle City area. Because of the dynamic conditions on the coastal rock platforms no birds nest there. However, the Nankeen Kestrel is known to nest on cliffs immediately above the Shepherds Hill Rock Platform.

Of the 18 bird species regarded as rock platform frequenters only three species depend heavily on the rock platforms for their survival: Eastern Reef Egret, Ruddy Turnstone and Sooty Oystercatcher. Other birds, such as cormorants, gulls and terns, mostly use the rock platforms as a secure roost to rest after foraging offshore or landward. Of the hundreds of Silver Gulls present on the rock platforms only a small proportion actually forage there. Sporadic summer migrants such as Grey-tailed Tattler and Red-necked Stint probably both roost and forage when present, but were not observed during this study. The variable number and sporadic sightings of White-faced Herons indicate that the rock platforms are not their sole foraging area.

The most vulnerable and regular rock-platform dependant bird is the resident Sooty Oystercatcher, an iconic indicator of the ecological health of the area. If numbers are really increasing, as records appear to show, the few prime foraging areas in the vicinity of Newcastle become increasingly important for their survival. As harvesting of rock platform fauna for human consumption or bait is a direct threat to their existence, it has been recommended that the collection of shellfish, crabs and sea-urchins, etc., be prohibited from the entire Newcastle Rock Platform and from other prime foraging areas for Sooty Oystercatchers on the Shepherds Hill and Merewether Rock Platforms (Gladstone & Herbert 2006).

It is gratifying that Newcastle City Council is already acting on some of the recommendations presented to them by Gladstone and Herbert (2006) and reiterated above. Information signs are presently being designed for installation at selected entry points to the rock platforms.

Meaningful decisions concerning the management of birds cannot be made without reliable data. This report, summarized from Herbert (2006a & b), has attempted to pull together historical information and generate new information. However, the total of six days of winter and summer observations provided only just enough data for tentative conclusions. On the other hand, it was surprising how much useful data was generated in such a short time, providing interesting numerical and qualitative information regarding use of the rock platforms, particularly for the resident shorebird, the Sooty Oystercatcher. Historical records for individual species have been sporadic and, except for HBOC observations, abundances have rarely been recorded. It is obvious, especially for the Shepherds Hill and Merewether Rock Platforms, that birds frequenting those rock platforms have been under-reported. Ongoing management decisions should be based on regular surveys and counts of birds using the rock platforms, in association with monitoring of threats and disturbances at various times of the year.

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Surveys of waterbirds in Port Stephens, 2004-2006

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The population of migratory and resident shorebirds in Port Stephens in New South Wales has been surveyed in three successive summers, in surveys carried out using boats at high tide. All the other waterbirds present were also counted in the surveys. Over 2004-2006, the counts of migratory shorebirds have ranged from 689 to 2,053 birds, representing 19 species, and the other waterbird numbers have ranged from 749 to 2,417 birds representing 28 species. Two species, Eastern Curlew and Pied Oystercatcher, have been present in numbers representing 1% or more of their total world population. More than 4% of the Australian population of Whimbrel have been present, and around 0.5% of the Australian populations of Bar-tailed Godwit and Sooty Oystercatcher. The survey results, coupled with historical records, show that Port Stephens is an important habitat for several species of migratory and breeding resident shorebirds and has been for more than 20 years.

INTRODUCTION

Port Stephens in New South Wales (see **Figure 1**) is a popular tourist and recreational area located approximately 200km north of Sydney. The south-eastern part of Port Stephens has undergone substantial development especially over the past 20 years or so and the north-eastern area has also seen considerable growth in holiday and retirement housing. Boating, swimming and other water-based activities are very popular particularly during weekends and school holidays. The utilisation of Port Stephens by migratory and resident shorebirds is well known albeit not very systematically studied or documented. A review of the available historic information (Stuart 2004, 2005) highlighted some noteworthy records from the 1980s and 1990s, such as counts of up to 400 Eastern Curlew in summer and up to 150 Double-banded Plover in winter at an area now included in the Worimi Nature Reserve (see **Figure 1** for location), and at least 235 Grey-tailed Tattler around the shoreline of Pindimar Bay in summer. Smith (1991) described Port Stephens as the most important site in NSW for Whimbrel and one of the two most important sites in the state for Eastern Curlew. He noted that both these species and the Pacific Golden Plover had been recorded in Port Stephens in numbers above 1% of their national population. On this basis, Smith nominated Port Stephens as a Priority 2 site for shorebird habitat protection in NSW – one of only 5 such sites in NSW (and with the only nominated Priority 1 site for protection being the Hunter estuary some 50km to the south of Port Stephens).

Since the mid 1980s there had been no systematic surveying of Port Stephens for shorebirds, apart from monthly high tide visits to the Worimi Nature Reserve since September 2000 (Stuart 2004). To redress this and establish a current understanding of the relative importance of Port Stephens, high tide surveys were undertaken in the summers of 2004-2006.

METHODS

Two of the surveys were carried out in February, before migratory shorebirds can be expected to have started their return journey to their breeding grounds. The 2005 survey was delayed until mid March due to a combination of weather and logistics difficulties. All three surveys have been carried out by boat, with counting done from the boats using binoculars. Four to six boats have been used each time, allowing several sub-areas of Port Stephens to be surveyed simultaneously (see **Figure 1** for the sub-area routes). Between 10 and 14 experienced observers have participated in each survey, with 2-4 observers per vessel (plus a dedicated skipper). Port Stephens is often subject to strong north-easterly sea breezes, particularly in the afternoon, so days with early high tides were chosen to have more opportunity to take advantage of the morning calm. In the 2006 survey, the boats were supplemented by kayaks to obtain much closer approach to the shallow waters of Winda Woppa point - consequently some small shorebirds roosting further back from the water's edge were able to be detected that had been out of sight from further offshore.

The south-east portion of Port Stephens was not included in the area of the surveys, principally because on Sundays in summer, when the surveys have been conducted, this part of Port Stephens is full of people and previous reconnaissance had indicated no shorebirds to be present. The general area surveyed is indicated in **Figure 1**. In general, the methodology has been the same each time. However in March 2005 a combination of strong winds and a mechanical problem with one boat prevented the full area being surveyed - in particular, area B (indicated in **Figure 1**) was not surveyed except for Fame Cove, and parts of area C also were not covered.

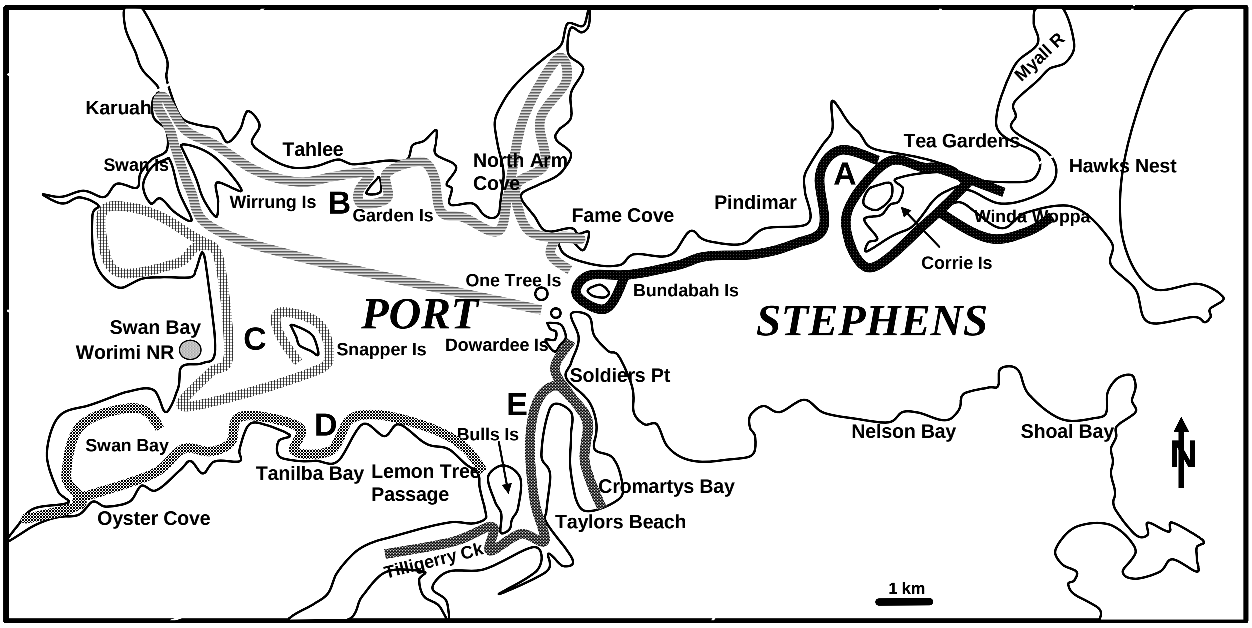

Figure 1. Areas of Port Stephens targeted for surveying.

Table 1. Shorebirds recorded at Port Stephens 2004 – 2006.

Species	February 8 2004	March 12 2005	February 26 2006
Black-tailed Godwit *Limosa limosa*	51	0	0
Bar-tailed Godwit *Limosa lapponica*	888	268	515
Whimbrel *Numenius phaeopus*	218	248	424
Eastern Curlew *Numenius madagascariensis*	649	80	303
Common Greenshank *Tringa nebularia*	0	8	15
Terek Sandpiper *Xenus cinereus*	6	0	4
Common Sandpiper *Actitis hypoleucos*	1	0	1
Grey-tailed Tattler *Heteroscelus brevipes*	44	9	32
Ruddy Turnstone *Arenaria interpres*	8	20	9
Red-necked Stint *Calidris ruficollis*	20	2	6
Sharp-tailed Sandpiper *Calidris acuminata*	0	0	40
Beach Stone-curlew *Esacus neglectus*	0	0	1
Pied Oystercatcher *Haematopus longirostris*	112	30	77
Sooty Oystercatcher *Haematopus fuliginosus*	18	5	9
Pacific Golden Plover *Pluvialis fulva*	0	0	38
Grey Plover *Pluvialis squatarola*	0	0	1
Red-capped Plover *Charadrius ruficapillus*	0	0	26
Lesser Sand Plover *Charadrius mongolus*	5	4	15
Masked Lapwing *Vanellus miles*	33	15	11
TOTAL	**2,053**	**689**	**1,527**

Table 2. Other waterbirds recorded in Port Stephens 2004 – 2006.

Species	February 8 2004	March 12 2005	February 26 2006
Black Swan *Cygnus atratus*	1056	208	200
Australian Wood Duck *Chenonetta jubata*	0	0	30
Pacific Black Duck *Anas superciliosa*	3	0	8
Chestnut Teal *Anas castanea*	7	8	10
Little Penguin *Eudyptula minor*	0	4	0
Darter *Anhinga melanogaster*	0	0	1
Little Pied Cormorant *Phalacrocorax melanoleucos*	46	44	112
Pied Cormorant *Phalacrocorax varius*	458	47	402
Little Black Cormorant *Phalacrocorax sulcirostris*	27	2	13
Great Cormorant *Phalacrocorax carbo*	31	7	38
Australian Pelican *Pelecanus conspicillatus*	162	40	175
White-faced Heron *Egretta novaehollandiae*	8	27+	27
Little Egret *Egretta garzetta*	1	0	0
White-necked Heron *Ardea pacifica*	1	0	0
Great Egret *Ardea alba*	4	4	9
Intermediate Egret *Ardea intermedia*	1	0	2
Striated Heron *Butorides striatus*	4	0	1
Nankeen Night Heron *Nycticorax caledonicus*	2	0	0
Australian White Ibis *Threskiornis molucca*	30	31	64
Straw-necked Ibis *Threskiornis spinicollis*	0	3	1
Royal Spoonbill *Platalea regia*	4	0	0
Arctic Jaeger *Stercorarius parasiticus*	5	0	0
Silver Gull *Larus novaehollandiae*	377	170	287
Gull-billed Tern *Sterna nilotica*	1	0	0
Caspian Tern *Sterna caspia*	7	5	0
Crested Tern *Sterna bergii*	178	149	146
Common Tern *Sterna hirundo*	2	0	9
Little Tern *Sterna albifrons*	2	0	3
TOTAL	**2,417**	**749**	**1,538**

RESULTS

Shorebirds

Nineteen shorebird species were recorded at least once in the 3 years of surveying, including 14 migratory species. Table 1 summarises the species found each year, including the numbers of birds that were present. Ten species were present every year: Bar-tailed Godwit, Whimbrel, Eastern Curlew, Grey-tailed Tattler, Ruddy Turnstone, Red-necked Stint, Pied Oystercatcher, Sooty Oystercatcher, Lesser Sand Plover and Masked Lapwing.

Other Waterbirds

28 waterbird species were recorded at least once in the 3 years of surveying, and the results are summarised in Table 2. Twelve species were present every year: Black Swan, Chestnut Teal, Little Pied Cormorant, Pied Cormorant, Little Black Cormorant, Great Cormorant, Australian Pelican, White-faced Heron, Great Egret, Australian White Ibis, Silver Gull, Crested Tern. The Little Tern, which is classified as Endangered under the NSW Threatened Species Act, was recorded in small numbers in two of the surveys.

Important Roosting Areas

Because the surveys have been made at high tide, the shorebird species have been roosting at various locations around Port Stephens. So too have many of the other waterbirds, including the cormorants and terns that have been sitting on emergent posts. The main roosting locations for the 2004 survey have been described previously (Stuart 2004, 2005a) and will not be discussed again in detail here. What has become clear from the 3 years of surveying is that some locations consistently service large numbers of shorebirds and sometimes other waterbirds. These more significant roosting locations are: Winda Woppa point, Corrie Island, Swan Bay (near Worimi NR), Oyster Cove village and Tilligerry Creek.

DISCUSSION

Far fewer birds were recorded in 2005 than in the other two years. Although area B was not able to be surveyed in 2005, the extent to which that gap contributed to the lower count is uncertain, since in both 2004 and 2006, area B had the least birds of the five areas surveyed (for example, in 2004 it had around 7% of the total shorebirds). Much of its shoreline is rocky or else fringed with trees and is not habitat where shorebirds and waterbirds typically would be expected to roost. Other explanations for the low 2005 count have been considered. Although the survey was conducted relatively late in the season, the low numbers of shorebirds in 2005 are not obviously linked with a mass departure of birds to the northern breeding grounds, nor to the Hunter estuary, since analysis of data in the 2005 Hunter Region Bird Report shows that shorebird numbers in the Hunter estuary were fairly stable over the February and March surveys, and that the counts at Worimi Nature Reserve actually increased somewhat in March compared to February (Stuart 2006). The counts for 2005 of all other waterbirds (which are non-migratory) were similarly reduced compared to the 2004 and 2006 surveys. Thus there was a general large decrease in the numbers both of shorebirds and other waterbirds. Possibly, the foraging and/or roosting conditions in Port Stephens were sufficiently different in the 2004/05 summer compared with the two other summers such that the number of birds that Port Stephens could support became significantly different.

The 2004 and 2006 results compare well with shorebird numbers counted by Hunter Bird Observers Club members in 1982. In the 1982 land-based survey of the main known roosting sites (not including Corrie Island) a total of 1750 shorebirds were recorded (Stuart 2004). This shows that Port Stephens has been an important habitat for migratory as well as Australian resident shorebirds for more than 20 years, and adds weight to the theory that numbers in 2005 were low due to poor conditions for feeding or roosting.

The data for four shorebird species in particular merit discussion, as the surveys (plus the available prior records) suggest Port Stephens is an important area for them. The particular species are: Whimbrel, Bar-tailed Godwit, Eastern Curlew and Pied Oystercatcher.

Port Stephens is more important for Whimbrel than the Hunter estuary, where the peak count in the past 7 years of monthly surveying is of 185 birds but with numbers more typically being below 100 birds (Hunter Region Bird Reports 1999-2005). The three successive years of counts of several hundred birds in Port Stephens presented in this paper are consistent with a record of 260 birds in Port Stephens in 1982 (Smith 1991). The 2006 record of 424 Whimbrel represents around 4% of the Australian migrating population (sub-species *variegatus*) and more than 50% of the previously estimated NSW population of 700 birds (Watkins 1993).

The counts of many hundreds of Bar-tailed Godwit in all three surveys confirm that this species is a common and abundant shorebird of Port Stephens. The numbers are consistent with the count of 600+ birds by Hunter Bird Observers Club in a partial survey of Port Stephens for the Australasian Wader Studies Group in 1982 (Stuart 2004). The 2004 count of 888 birds represents >0.5% of the total population of the sub-species *baueri* that visits Australia each summer (Delany & Scott 2002).

The count of 649 Eastern Curlew in 2004 represents 1.7% of the total world population for this species, and is consistent with past records of 700-960 birds in Port Stephens (Stuart 2004, 2005a). Port Stephens continues to be an internationally significant location for Eastern Curlew, particularly in the context of its declining world population (Smith 1991). However, the much lower counts for the species in 2005 and 2006 are cause for concern. An ongoing monitoring program will be essential.

The 2004 count of 112 Pied Oystercatcher is a notable increase from the previous maximum count of 63 birds for Port Stephens (Smith 1991), and the 2006 count of 77 birds confirms the importance of the area in modern times. The count in 2004 of 112 birds corresponds to just on 1% of the total world population of the species (Delany & Scott 2002), and to around 40% of the estimated NSW population (Watkins 1993).

Five shorebirds that are classified as Vulnerable under the NSW Threatened Species Act were recorded in at least one of the surveys: Black-tailed Godwit, Terek Sandpiper, Pied Oystercatcher, Sooty Oystercatcher and Lesser Sand Plover. Also, a single Beach Stone-curlew was present (on Corrie Island) in 2006 - this species is classified as Endangered in NSW. The 2004 and 2006 counts for Sooty Oystercatcher exceed all previous known counts (Stuart 2004) and the 18 birds recorded in the 2004 survey represent around 0.5% of the total population of the southern Australian sub-species *(Haematopus fuliginosus fuliginosus).*

The counts for Grey-tailed Tattler in the surveys may be under-estimates. Some historic records are of greater counts and with one record of at least 235 birds (Pegler 1980). The latter birds were observed to fly to mangrove areas around Pindimar Bay to roost - close access to those areas is difficult by boat and birds might have been overlooked. In December 2004, the author made a survey by foot of the western side of Pindimar Bay and 75+ birds were present (Stuart 2005b).

The counts of 400+ Pied Cormorant in the 2004 and 2006 surveys are notable for the Hunter Region, since there are few other records of more than 20 birds ever reported. The counts of Black Swan, Little Pied Cormorant, Australian Pelican, Silver Gull and Crested Tern are also notable for the Region, on at least some of surveys. However, it must be taken into consideration that the above counts derive from what is by far the largest area survey in the Region done in an integrated manner. The counts probably reflect the nature of the undertaking as much as the number of birds.

CONCLUSIONS

Port Stephens is an important habitat for several species of migratory and breeding resident shorebirds, and has been for more than 20 years. A total of 2,053 shorebirds were recorded there in February 2004 and 1,527 birds in February 2006; these counts are comparable to one of 1,750 birds from a partial survey of the area in 1982. Port Stephens is a significant habitat for Eastern Curlew and Pied Oystercatcher (1-2% of the total world populations of both species present there in February 2004) and Whimbrel (2-4% of the Australian population) and an important habitat for both Bar-tailed Godwit and Sooty Oystercatcher (0.5% of the Australian population of both species present in 2004).

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Bird population of a cattle property near Paterson, NSW – an eleven year study.

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During an eleven year study between 1996 and 2007 involving surveys at three monthly intervals, 126 species of birds were recorded on a cattle property near Paterson in the Lower Hunter Region of New South Wales. The results demonstrate how a cattle property with about 15% remnant vegetation provides an important contribution to sustaining the diversity of bird populations.

A constant effort survey approach was used which involved estimating numbers of species, using the methods developed for the Birds Australia "Birds on Farms" project. Preliminary analysis of the results suggests that a number of species had declined when results for the first and second halves of the study were compared. Decline was most obvious for waterbirds and is attributed to abnormally low rainfall during the latter years of the study. The estimation of numbers of birds supported and strengthened conclusions drawn from variations in the frequency species were recorded based on presence and absence.

Explanations of the reasons for changes in population indicated by this study inevitably vary between species and involve environmental factors at the local, regional and national scale. Consequently this investigation has value both as an independent investigation and as part of a collaborative Birds Australia nationwide project.

INTRODUCTION

This study commenced as part of the "Birds on Farms" project run by Birds Australia. It was continued during the "New Atlas of Australian Birds" and the "Ongoing Atlas" projects which used compatible survey techniques. Bird surveys were conducted on a property at Butterwick (32º 39´ S 151º 38´ E) near Paterson in the NSW Hunter Valley between July 1996 and January 2007. The property which is run for cattle is on the edge of the Butterwick flood plain. Approximately 15 percent of the area surveyed is vegetated, primarily along the edges of Green Wattle Creek which flows through the property.

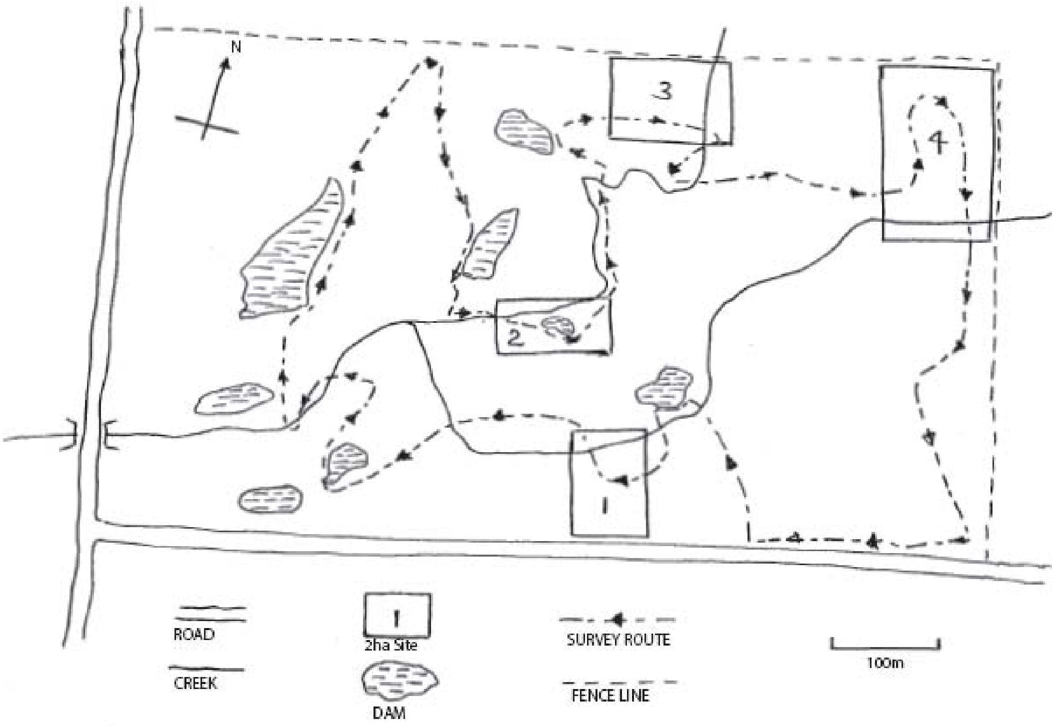
The intention of this paper is to demonstrate the importance of farms with remnant vegetation to the conservation of bird populations. The study also provides baseline data against which future population trends can be gauged. Discussion of changes during the present study is limited to examples where trends are obvious. A more detailed evaluation will be the subject of a subsequent paper as will variations in the sub-populations of different habitats sampled at the 2ha sites.

METHODS

Surveys were conducted unaccompanied at approximately three monthly intervals as close as practical to the 15th day of January, April, July, and October. All surveys were conducted within 21 days of the target date. Surveys took between three and four hours to complete, following the same route and adopting a constant survey effort approach to facilitate the comparison of results. Four sites each approximately 2ha in size and with different vegetation structure were surveyed for twenty minutes (**Figure 1**).

Birds were identified visually and by call and the number of birds present was recorded. Surveys commenced between one and two hours after sunrise targeting the period of maximum bird activity. Separate records were kept for each of the four 2ha sites as well as for the total survey.

Fig.1. Survey Route and 2ha Sites



The study involved 44 surveys at approximately 3 monthly intervals. The eleven autumn surveys were conducted over a ten year span with two surveys in 2003 following abnormally low numbers during the first count. Both data sets have been included in the following analysis. Comparison of these two counts demonstrates the extent to which variation can occur between counts, which at least in part reflects the dynamic nature of the bird populations. For example the first count involved 125 birds and 36 species compared with 202 birds and 34 species in the latter survey.

In the following sections species have been classified according to the frequency and season in which they were recorded. The tabulated data includes a "change factor" which is the ratio of the number of surveys a species was recorded in the first half (i.e. the first 22 surveys) compared to second half (i.e. the second 22 surveys) of the study. Change factor values greater than 1 suggest the possibility that a species may have decreased during the study. For instance a change factor of 1.2 indicates that a species was recorded 20% more frequently in the first half of the study. Conversely a change factor of 0.8 indicates that a species has decreased being present 20% less frequently in the second half of the study.

Habitat Overview

A vegetation survey, with emphasis on the 2ha sites was made with the assistance of members of the Australian Plant Society, Maitland Branch.

Green Wattle Creek is a key feature of the property as much of the remnant vegetation is along or adjacent to its edges. However there are also a number of copses of trees, typically between one and two ha in size, providing shelter belts for the cattle. There is little under-storey vegetation other than along the creek edges. In addition to the creek system there are several dams, at least three of which always contain water. The creek flows intermittently but there are always some holes with water, often in the most densely vegetated areas. Along the creek edges the vegetation has a rainforest flavour. Several mature *Callistemon salignus* are an important food resource when in flower. Extensive marshy areas and even ephemeral areas of flooded pasture form after periods of heavy rain. However during drought conditions these areas dry out completely.

Site 1 is a stand of trees dominated by *Angophora floribunda* and several species of eucalypt. Most of the trees are at least 20m in height but only three are mature enough to have nest holes. This site includes the creek on one side and borders an extensive area of woodland on the other side, from which it is separated by the unsealed and lightly used road. *Melaleuca nodosa* and *Melaleuca linariifolia* occur along the creek and together with some small shrubs along the road side provide cover for small bird species. There are a number of fallen limbs on the ground below the mature trees.

Site 2 is bounded by a heavily vegetated length of creek. The surrounding area is subject to intermittent flooding resulting in the formation of an ephemeral water pool surrounded by mature *Melaleuca stypheloides*. There is also an area of tussocks, and a patch of blackberry. Most of the vegetation is between 3 and 6m high and there are few large mature trees.

Site 3 is another copse of trees, typically taller than 15m and dominated by *Angophora floribunda* and *Eucalyptus paniculata*. An arm of Green Wattle Creek forms one edge for approximately 50m. There is very little under-storey vegetation other than that associated with the creek where there are small patches of blackberry. Unlike the other sites this copse of trees is isolated from extensive areas of woodland.

At site 4 a copse of trees, again typically taller than 15m, is dominated by two species of eucalypt, one an unidentified ironbark and *Corymbia maculata*. At one end a belt of a *Melaleuca* species borders an open paddock. Green Wattle Creek provides the opposite boundary. On another side within the property there is an extensive area of scrub in which several large eucalypts emerge above the canopy of a dense stand of approximately 4m high *Melaleucas*. The remaining boundary of site 4 is an extensive area of woodland outside the property which has not been grazed during the last eight years and, unlike site 4, has extensive under-storey vegetation.

The other major vegetation on the survey route is an extensive stand of *Casuarina glauca*, about 15m high, growing along a 100m section of the creek and an isolated stand of *Melaleuca nodosa.* During the study, other than the impact of grazing, there was no modification of vegetation on the property other than the establishment of one additional dam. On adjacent properties there was some clearing of trees but it did not substantially change the vegetation corridors linking the study area to areas of nearby woodland.

Factors Impacting on the Survey Data

The primary purpose of the surveys was to determine the presence and absence of species both at the four 2ha sites and for the total survey. However, in addition, an estimate was made of the number of each species present. The four sites are separated by several hundred metres and there is typically an interval of at least 20 minutes between making each 2ha count. While this minimises the probability of the same birds being sampled at two sites it does not completely eliminate the possibility of this occurring, particularly outside the breeding season when woodland birds often form mobile mixed foraging flocks and where large birds are present.

In addition to conducting surveys early, where possible days were selected with favourable weather conditions, namely without wind and rain. These considerations were particularly important as many species were identified by call. During the early stages of these studies the observer’s call identification skills and intuitive knowledge of where to expect individual species increased making surveys in the later years of the study more comprehensiveIn the case of larger species like the waterbirds frequenting open areas the numbers provide an accurate measure of abundance and there is no bias associated with observer experience. For the smaller woodland birds particularly species of thornbill and pardalote size foraging in the crowns of tall trees the numbers are only an indication and indicate minimum numbers present, particularly where records are based on call.

RESULTS

Summary Statistics

The results are summarised in **Table 1** which provides a comparison of species and individual bird numbers between seasons. A total of 126 species were recorded during the surveys, with a further 5 species recorded at other times. The greatest number of species was recorded in summer 94 and spring 90 with 62 species recorded in a single summer survey. However the average species diversity and abundance was highest in spring with 54.0 species and 290.5 birds/survey. Diversity was appreciably lower in autumn and winter with averages of 37.0 and 41.9/survey respectively, reflecting the absence of summer visitors. Abundance was lowest in autumn with an average 196.8 birds/survey. The corresponding winter numbers were surprisingly high at 270.8.

Table 1. Summary of Survey Statistics

	All Visits	**Summer**	**Autumn**	**Winter**	**Spring**
Species Recorded	126	94	80	82	90
Average/survey	45.3	48.4	37.0	41.9	54.0
Maximum	62	55	42	49	62
Minimum	34	39	34	34	41
Number of Birds	10665	2325	2165	2979	3196
Average/survey	249.1	238.1	196.8	270.8	290.5
Maximum	410	294	295	345	410
Minimum	125	186	125	239	234
Birds counted 2ha surveys	6846 (64%)	1580 (68%)	1461 (67%)	1817 (61%)	1988 (62%)

The time taken to conduct the four 20minute 2ha counts was approximately 40% of the total duration of the surveys. The importance of these 2ha plots, which were selected because of their habitat potential, is emphasised by the occurrence of 64% of the birds counted in these areas. A detailed analysis of these sub-counts is outside the scope of this paper.

Species Regularly Recorded Throughout the Year

The 19 species falling into this category as listed in **Table 2** are best described as very common on the property and many are resident. Indeed seven species were seen on every survey. Inclusion in this category is based on the species being recorded in 80% of the surveys. The change factor suggests that some of these species had decreased during the study and that none had increased. The indicated decline in all three species of waterbirds, Australian Wood Duck, Pacific Black Duck and Purple Swamphen is attributed to the drought conditions prevalent towards the end of the study.

The species listed in **Table 2** are a diverse mix reflecting three significant habitat types. The waterbirds frequent the dams and marshy areas, the parrots and Magpie-lark favour the open grazed areas and the passerines are found in the remnant vegetation along the creek. Superb Fairy-wrens and Yellow Thornbills were the most abundant species, while the less numerous and more elusive Brown Thornbill was a feature of the creek side vegetation.

Yellow-faced Honeyeaters were occasionally present in large numbers with a maximum count of 80. Fluctuations in numbers reflect both the presence of birds during migration and favourable feeding conditions along the creek provided by flowering vegetation. The Red-browed Finch also forms large flocks with a maximum count of 60.

Species Regularly Recorded in either Summer or Winter

The cut-off for inclusion in **Table 3** was that a species was recorded at least 4 times during either summer or winter and at least five times more frequently in summer than winter or vice-versa.

Of the 17 species listed in **Table 3** twelve occurred in summer and were absent in winter. The Sacred Kingfisher and Rufous Whistler were recorded on every summer count and represent the classical summer migrant which winters in northern latitudes. More surprising inclusions in this category were the Nankeen Night Heron and Royal Spoonbill which were flushed from remnant water pools along the creek in summer. Both these species and the Mistletoebird, which is also included in **Table 3** as a summer visitor, are recorded in NSW throughout the year (Barrett *et al.* 2003). Hence the occurrence of these species in summer is attributed to local movement in

Table 2. Species observed regularly in all seasons (present on at least 36 or 80% of surveys).

Common Name	Scientific Name	Average Number Present [1]	Maximum Number Present	Number of Surveys Present	Change Ratio [2]
Australian Wood Duck	*Chenonetta jubata*	8.5	26	38	1.2
Pacific Black Duck	*Anas superciliosa*	5.3	20	40	1.2
Purple Swamphen	*Porphyrio porphyrio*	5.6	16	42	1.1
Galah	*Cacatua roseicapilla*	4.6	24	36	1.0
Eastern Rosella	*Platycercus eximius*	15.8	44	44	1.0
Laughing Kookaburra	*Dacelo novaeguineae*	4.2	8	43	1.1
Superb Fairy-wren	*Malurus cyaneus*	27.6	60	44	1.0
White-browed Scrubwren	*Sericornis frontalis*	3.1	8	39	1.1
Brown Thornbill	*Acanthiza pusilla*	5.3	14.0	44	1.0
Yellow Thornbill	*Acanthiza nana*	19.8	40.0	44	1.0
Noisy Miner	*Manorina melanocephala*	12.5	34.0	43	1.1
Yellow-faced Honeyeater	*Lichenostomus chrysops*	16.7	88.0	41	1.0
Magpie-lark	*Grallina cyanoleuca*	3.4	12.0	44	1.0
Grey Fantail	*Rhipidura fuliginosa*	8.3	18.0	44	1.0
Willie Wagtail	*Rhipidura leucophrys*	2.5	6.0	37	0.9
Grey Butcherbird	*Cracticus torquatus*	3.2	7.0	43	1.0
Australian Magpie	*Gymnorhina tibicen*	8.4	22.0	44	1.0
Australian Raven	*Corvus coronoides*	3.5	16.0	43	1.1
Red-browed Finch	*Neochmia temporalis*	13.6	46.0	41	1.1

[1] Average number seen on surveys when present
[2] Ratio of number of surveys in which species recorded during first half of study (1996-2000) are compared to the second half (2001-2007).

response to favourable seasonal conditions in the study area.

The Rose Robin is an altitudinal migrant breeding in the ranges and moving to coastal locations in winter. It was recorded in seven of the eleven winter surveys and presumably the same male bird was present annually in one of the 2ha survey sites.

The exceptionally high change ratio of 7 for the Mistletoebird and 2.5 for the Rose Robin may suggest a possible local decline in these species. The Mistletoebird is highly nomadic and changes in its presence would be expected to relate to the flowering of mistletoe.

Two honeyeaters (Noisy Friarbird and Red Wattlebird) were predominantly recorded in winter as opposed to summer, the former species exclusively so. Again this is interpreted as a consequence of local movement as both species occur throughout the year in the Hunter region (Barrett *et al.* 2003).

The occasional presence of Cattle Egrets and an Olive-backed Oriole in winter is consistent with their known tendency to breed in the area and partially disperse outside the breeding season.

The Black-faced Monarch and Rufous Fantail, summer migrants to the Hunter region (Stuart 2006), were absent in summer, but recorded on passage particularly in spring.

The change ratio of 0.3 for Latham's Snipe is fascinating as it suggests an increase at a time when other wetland species like the Purple Swamphen, Australian Wood Duck and Masked Lapwing appeared to decline. An explanation is that the muddy margins of the dams provide a drought refuge for this species when optimal habitat like the adjacent Butterwick flood plain dries out.

Table 3. Frequently Observed Summer and Winter Visitors
(Species recorded on at least 4 surveys (summer or winter) and at least 5 times more frequently in summer than winter or vice-versa).

Common Name	**Scientific Name**	**Average Number Present [1]**	**Maximum Number Present**	**Number of Surveys Present**	**Number of Summer Records**	**Number of Winter Records**	**Change Ratio [2]**
Cattle Egret	*Ardea ibis*	5.2	18.0	19	10	2	1.1
Nankeen Night Heron	*Nycticorax caledonicus*	1.4	3.0	9	6	0	0.8
Royal Spoonbill	*Platalea regia*	1.3	2.0	10	4	0	1.0
Latham's Snipe	*Gallinago hardwickii*	1.5	3.0	10	7	0	0.3
Common Koel	*Eudynamis scolopacea*	1.0	1.0	8	6	0	1.0
Channel-billed Cuckoo	*Scythrops novaehollandiae*	1.3	3.0	16	8	0	1.3
Sacred Kingfisher	*Todiramphus sancta*	4.6	10.0	22	11	0	1.0
Dollarbird	*Eurystomus orientalis*	3.3	9.0	21	10	0	1.1
White-throated Gerygone	*Gerygone olivacea*	5.0	14.0	23	10	0	0.9
Red Wattlebird	*Anthochaera carunculata*	2.2	8.0	25	1	8	0.7
Noisy Friarbird	*Philemon corniculatus*	5.0	12.0	9	0	5	0.5
Rose Robin	*Petroica rosea*	2.1	6.0	7	0	7	2.5
Rufous Whistler	*Pachycephala rufiventris*	5.1	12.0	28	11	0	0.9
Leaden Flycatcher	*Myiagra rubecula*	1.7	3.0	11	5	0	0.8
Cicadabird	*Coracina tenuirostris*	1.4	2.0	5	5	0	0.7
Olive-backed Oriole	*Oriolus sagittatus*	1.6	3.0	16	7	1	0.6
Mistletoebird	*Dicaeum hirundinaceum*	1.3	2.0	8	6	0	7.0

[1]Average number seen on surveys when the species was recorded.
[2]Ratio of number of surveys in which species recorded during first half of study (1996-2000) compared with second half (2001-2007).

Species Often Recorded

The 39 species in this category (**Table 4**) were recorded during between 20% and 80% of the surveys. Again a broad range of species are involved, many of which are normally vocal and conspicuous (e.g. White-winged Chough) suggesting that they are only intermittently present in the study area.

The change factor indicates that five of the six species of water bird had declined, particularly the Masked Lapwing. In contrast the Straw-necked Ibis was recorded more frequently in the second half of the study. Its increased occurrence probably reflects the extremely difficult inland conditions associated with the drought.

Red-rumped Parrots were not recorded in the first half of the study but were present in small numbers on 41% of the surveys in the second half, usually in the vicinity of a dam established during the study near a house. The house and associated cattle holding pens were also the focal point for the two invasive species, the Common Starling and the Common Myna which occurred in small numbers. They were absent from the rest of the property.

Evidence for decline in the passerine species listed in **Table 4** is strongest for the Speckled Warbler, Grey-crowned Babbler, Pied Butcherbird and Welcome Swallow. Both the Speckled Warbler and the Grey-crowned Babbler are listed as vulnerable species in NSW (Stuart 2006). The Speckled Warbler was primarily sighted near the 2ha survey site 4 adjacent to extensive woodland where this species has also declined following an increase in sub-storey vegetation following the cessation of light grazing, which is known to be beneficial to Speckled Warblers (Barrett *et al*. 2002). The features of site 4 which favour this species are the presence of fallen debris and a lack of extensive under-storey vegetation. The Butterwick area is an acknowledged stronghold of the Grey-crowned Babbler which was often present in substantial numbers with 24 recorded on one occasion. The decline in the Pied Butcherbird is in contrast to the Grey Butcherbird which was present on 98% of the surveys.

Species which showed the most marked increase in presence during the second half of the study included Bar-shouldered Dove, Striated Pardalote, Lewin's Honeyeater, Eastern Spinebill and Varied Sittella.

Table 4. Species often observed and present in all seasons
(recorded on between 9 (20%) and 35 (80%) of the 44 surveys).

Common Name	Scientific Name	Average Number Present [1]	Maximum Number Present	Number of Surveys Present	Change Ratio [2]
Grey Teal	*Anas gracilis*	2.2	4	12	1.4
Chestnut Teal	*Anas castanea*	2.6	8	13	1.2
Little Pied Cormorant	*Phalocrocorax melanoleucos*	1.2	2	17	1.8
White-faced Heron	*Egretta novaehollandiae*	2.1	5	26	1.6
Straw-necked Ibis	*Threskiornis spinicollis*	5.4	24	11	0.8
Masked Lapwing	*Vanellus miles*	2.8	7	31	2.1
Crested Pigeon	*Ocyphaps lophotes*	3.9	24	32	1.1
Bar-shouldered Dove	*Geopelia humeralis*	1.7	3	18	0.4
Long-billed Corella	*Cacatua tenuirostris*	5.8	40	13	1.6
Sulphur-crested Cockatoo	*Cacatua galerita*	1.8	8	13	2.3
Little Lorikeet	*Glossopsitta pusilla*	6.6	20	9	0.8
Australian King-Parrot	*Alisterus scapularis*	2.7	11	14	1.0
Red-rumped Parrot	*Psephotus haematonotus*	2.9	6	9	0.0
Fan-tailed Cuckoo	*Cacomantis flabelliformis*	1.1	2	9	0.8
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*	1.6	5	11	1.2
White-throated Treecreeper	*Cormobates leucophaea*	1.5	4	29	0.8
Spotted Pardalote	*Pardalotus punctatus*	5.2	17	34	0.9
Striated Pardalote	*Pardalotus striatus*	2.6	6	27	0.6
Speckled Warbler	*Chthonicola sagittata*	1.9	5	10	2.3
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	7.1	25	17	1.1
Striated Thornbill	*Acanthiza lineata*	8.8	25	29	0.8
Lewin's Honeyeater	*Meliphaga lewinii*	2.3	5	25	0.5
Eastern Spinebill	*Acanthorhynchus tenuirotris*	2.7	11	19	0.6
Scarlet Honeyeater	*Myzomela sanguinolenta*	7.9	23	18	0.8
Jacky Winter	*Microeca fascinans*	2.5	6	20	0.7
Eastern Yellow Robin	*Eopsaltria australis*	2.5	8	35	0.8
Grey-crowned Babbler	*Pomatostomus temporalis*	5.2	24	29	1.4
Varied Sittella	*Daphoenositta chrysoptera*	7.2	18	14	0.4
Golden Whistler	*Pachycephala pectoralis*	2.9	10	31	1.2
Grey Shrike-thrush	*Colluricincla harmonica*	1.5	3	21	1.3
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	3	6	31	0.8
Pied Butcherbird	*Cracticus nigrogularis*	1.9	4	35	1.5
Pied Currawong	*Strepera graculina*	1.9	8	13	0.9
White-winged Chough	*Corcorax melanorhamphos*	11.2	36	15	1.5
Satin Bowerbird	*Ptilonorhynchus violaceus*	2.5	16	15	1.1
Welcome Swallow	*Hirundo neoxena*	3.2	12	21	2.0
Silvereye	*Zosterops lateralis*	10	32	22	1.2
Common Starling	*Sturnus vulgaris*	3.1	12	24	1.0
Common Mynah	*Acridotheres tristis*	2.4	6	17	0.9

[1]Average number seen on surveys when species recorded.
[2]Ratio of number of surveys in which species recorded during first half of study (1996-2000) compared with second half (2001-2007).

Table 5. Species seen infrequently and classed as either uncommon or rare
(species recorded on less than 8 or 20% of the 44 surveys).

Common Name	**Scientific Name**	**Average Number Recorded** [1]	**Maximum Number Recorded**	**Number of Surveys Recorded**	**Change Ratio** [2]
Brown Quail	*Coturnix ypsilophora*	3.0	3	1	0.0
Australasian Grebe	*Tachybaptus novaehollandiae*	1.0	1	1	0.0
Little Black Cormorant	*Phalocrocorax sulcirostris*	1.2	2	5	0.7
Great Cormorant	*Phalocrocorax carbo*	1.0	1	1	0.0
Australian Pelican	*Pelecanus conspicillatus*	1.0	1	1	NR
White-necked Heron	*Ardea pacifica*	1.5	2	2	1.0
Great Egret	*Ardea alba*	1.0	1	1	0.3
Australian White Ibis	*Threskiornis molucca*	1.0	1	2	1.0
Pacific Baza	*Aviceda subcristata*	1.0	1	1	NR
Black-shouldered Kite	*Elanus axillaris*	1.0	1	3	2.0
Whistling Kite	*Haliastur sphenurus*	1.0	1	5	NR
Brown Goshawk	*Accipter fasciatus*	1.3	2	4	0.3
Grey Goshawk	*Accipter novaehollandiae*	1.0	1	2	1.0
Collared Sparrowhawk	*Accipter cirrhocephalus*	1.3	2	3	0.5
Wedge-tailed Eagle	*Aquila audax*	1.5	4	8	1.7
Brown Falcon	*Falco berigora*	1.0	1	3	0.5
Australian Hobby	*Falco longipennis*	1.0	1	1	0.0
Nankeen Kestrel	*Falco cenchroides*	1.0	1	1	0.0
Baillon's Crake	*Porzana pusilla*	1.0	1	1	0.0
Dusky Moorhen	*Gallinula tenebrosa*	1.0	1	4	NR
Spotted Turtle-Dove	*Streptopelia chinensis*	1.0	1	3	2.0
Wonga Pigeon	*Leucosarcia melanoleuca*	1.0	1	1	NR
Topknot Pigeon	*Lopholaimus antarcticus*	3.5	6	2	NR
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	3.0	3	2	NR
Little Corella	*Cacatua sanguinea*	3.8	9	4	0.3
Rainbow Lorikeet	*Trichoglossus haematodus*	3.0	6	6	0.0
Musk Lorikeet	*Glossopsitta concinna*	3.0	3	1	NR
Pallid Cuckoo	*Cuculus pallidus*	1.0	1	6	1.0
Brush Cuckoo	*Cacomantis variolosus*	1.0	1	1	0.0
Pheasant Coucal	*Centropus phasianinus*	1.0	1	1	NR
Southern Boobook	*Ninox novaeseelandiae*	2.8	5	4	1.0
Australian Owlet-nightjar	*Aegotheles cristatus*	1.0	1	1	0.0
White-throated Needletail	*Hirundapus caudacutus*	26.0	50	2	1.0
Variegated Fairy-wren	*Malurus lamberti*	3.1	5	7	2.5
Brown Gerygone	*Gerygone mouki*	1.7	2	3	2.0
Buff-rumped Thornbill	*Acanthiza reguloides*	2.7	3	3	NR
Striped Honeyeater	*Plectorhyncha lanceolata*	1.0	1	1	0.0
Blue-faced Honeyeater	*Entomyzon cyanotis*	2.3	8	8	1.0
Brown-headed Honeyeater	*Melithreptus brevirostris*	4.3	8	7	0.8
White-naped Honeyeater	*Melithreptus lunatus*	3.2	5	5	0.3
Eastern Whipbird	*Psophodes olivaceus*	1.0	1	3	0.0
Black-faced Monarch	*Monarcha melanopsis*	1.2	2	5	0.7
Spectacled Monarch	*Monarcha trivirgatus*	1.0	1	1	NR
Restless Flycatcher	*Myiagra inquieta*	1.0	1	1	0.0
Rufous Fantail	*Rhipidura rufifrons*	1.2	2	6	1.0
White-bellied Cuckoo-shrike	*Coracina papuensis*	1.0	1	4	0.3
White-winged Triller	*Lalage sueurii*	1.0	1	1	NR
Double-barred Finch	*Taeniopygia bichenovii*	17.7	50	3	0.5
Tree Martin	*Hirundo nigricans*	3.2	2	8	7.0
Fairy Martin	*Hirundo ariel*	2.7	6	3	NR
Rufous Songlark	*Cinclorhamphus mathewsi*	1.0	1	1	0.0

[1]Average number seen on surveys when recorded.
[2]Ratio of number of surveys seen in first half of study (1996-2000) compared with the second half (2001-2007).
A value of zero indicates the species was not recorded in the first half of the study while NR indicates the species was not recorded in the second half.

Species Recorded Occasionally

The 51 species listed in **Table 5** occurred occasionally being recorded in less than 20% of the surveys. The change ratio in **Table 5** should be interpreted with caution because of the small number of sightings.

Ten species of raptors were recorded, all in the occasional category, the Wedge-tailed Eagle and the Whistling Kite being the species most frequently recorded.

The Dusky Moorhen was surprisingly scarce, only being recorded on four surveys. Presumably the dams are too small to support this species permanently.

One of three occurrences of the Double-barred Finch involved approximately 50 birds, an unusually large number for a species which has become increasingly scarce in the Butterwick area during the last decade.
All three records of the Fairy Martin were in the first half of the study with the last records in 1999. At that time two colonies were nesting in culverts under roads within approximately 1km of the study area. Both these breeding colonies became extinct about the time records ceased in the study area.

The Australian Owlet-nightjar was not recorded until the final survey when one was flushed from a 1.5 m high hollow stump at site 4.

The record of the Spectacled Flycatcher occurred during the spring migration when a single bird was resident for several days on the creek indicating the importance of the remnant vegetation to migrant birds on passage. Spectacled Flycatchers are seldom recorded in the Lower Hunter.

The summer record of Baillon's Crake was made on a dam which had reed covered fringes and muddy margins. This species, possibly the same bird, subsequently occurred on a similar dam in the author's garden approximately 1km from the study area.

A further five species were recorded outside the surveys. Single Yellow-billed Spoonbill *Platalea flavipes* and Crimson Rosella *Platycercus elegans* were seen on several occasions. An eleventh raptor species, the White-bellied Sea-Eagle *Haliaeetus leucogaster* was also recorded on one occasion. Historical records include a flock of White-browed Woodswallow *Artamus superciliosus* in the spring of 1994 (Stuart 1995) and a Black-necked Stork *Ephippiorhynchus asiaticus* seen by the owners of the property. In addition a large rail, almost certainly a Buff-banded Rail *Gallirallus philippensis*, was seen flying over a marshy area during a survey but this is an unconfirmed record.

Examples of Population Change

In the previous discussion the ratio of the frequency of presence of species in the first 22 surveys compared with the following 22 surveys was used as an indication of population change. A number of possible instances of change have been highlighted in the previous sections. In most instances the evidence involves small samples and merely provides the focus for further investigation.

Where a species is resident and the species is always recorded the change ratio based on frequency of presence is always 1 and hence of no use as an indicator of population change. However, in such cases the comparison of the abundance of a species based on the average number of birds seen on a survey is a more helpful indicator. In **Table 6** the change ratio based on average numbers is compared for a few species selected to provide examples of population change.

As indicated previously a number of waterbirds were less frequently observed during the second half of the study. Examination of **Table 6** shows that in each instance, except for the Grey Teal, the decrease in presence of the seven species of waterbirds coincided with a decrease in the average number of birds observed (i.e. these species were seen less frequently and in lower numbers during the second half of the study). The most dramatic change was in Australian Wood Duck numbers which were 90% higher during the first period. Variation in rainfall is an obvious cause of variation in waterbird numbers and based on annual data the second period was on average 19.6% dryer than the first half (Gillespie 2007). However it remains to be explained why some species of waterbirds, particularly the Australian Wood Duck show a much greater decline in abundance than others. A possible explanation lies in the proliferation of nearby rural subdivisions with small dams and irrigated pasture which provide superior grazing for this species under drought conditions. The Purple Swamphen is another species which grazes over an extended area adjacent to reed edged dams, where it breeds. Purple Swamphens were a breeding resident until the last seven months of the study. During the last three surveys only one bird was observed, in October, despite good rainfall one month earlier which had replenished the dams. The local movement of Purple Swamphens from the area also occurred at the author's property, 1km away, where the species was absent during January 2007 for the first time in fourteen years. Again abnormal rainfall provides a possible explanation in that the annual rainfall for the Paterson area of 618mm in 2006 was the lowest level since 1991 and 36.4% lower than the long term average for the area. In addition 161.4mm or 26.1% of the 2006 annual rainfall occurred during September while all other months recorded well below average rainfall (Gillespie 2007).

Table 6. Comparison of Change Ratios based on Presence and Abundance

Common Name	Scientific Name	Surveys Present First Half[1]	Surveys Present Second Half	Change Ratio[3] Presence	Average Number First Half[2]	Average Number Second Half	Change Ratio[4] Average Numbers
Australian Wood Duck	*Chenonetta jubata*	21	17	1.2	10.2	5.3	1.9
Pacific Black Duck	*Anas superciliosa*	22	18	1.2	5.3	4.5	1.2
Grey Teal	*Anas gracilis*	7	5	1.4	1.7	2.0	0.9
Chestnut Teal	*Anas castanea*	7	6	1.2	2.6	2.3	1.2
White-faced Heron	*Egretta novaehollandiae*	16	10	1.6	2.3	1.9	1.2
Purple Swamphen	*Porphyrio porphyrio*	22	20	1.1	5.7	4.8	1.2
Masked Lapwing	*Vanellus miles*	21	10	2.1	2.8	2.6	1.1
Superb Fairy-wren	*Malurus cyaneus*	22	22	1.0	28.2	24.6	1.1
Noisy Miner	*Manorina melanocephala*	22	21	1.0	12.6	11.2	1.1
Grey Fantail	*Rhipidura fuliginosa*	22	22	1.0	8.0	8.0	1.0
Double-barred Finch	*Taeniopygia bichenovii*	1	2	0.5	25.0	1.5	16.7
Red-browed Firetail	*Neochmia temporalis*	21	20	1.1	15.0	10.6	1.4

[1] 22 surveys were conducted in each half of the study.
[2] Average numbers reported for surveys when species present.
[3] Ratios greater than 1 indicate that a species was less frequently present in the second half of the study.
[4] Ratios greater than 1 indicate that a species was less abundant in the second half of the study.

Superb Fairy-wren and Grey Fantail, species recorded on every survey, showed little variation in abundance. Noisy Miner numbers were on average 10% higher in the first half of the study and it was absent during one survey in the latter period. The Red-browed Finch is another species which is commonly present and fairly abundant but in this case a marked decline in abundance is apparent, average values being 40% higher during the first period. The Double-barred Finch, which is occasionally recorded on the property, may be experiencing a similar decline in numbers with the only large flock occurring during the first period, but its presence is too infrequent for a firm conclusion to be drawn.

The above examples demonstrate the advantage of monitoring species numbers when assessing change in bird populations. A more detailed analysis of trends will be the subject of a subsequent paper.

CONCLUSIONS

126 species of birds were recorded during 44 surveys over an eleven year period with a further five species recorded at other times. The total of 131 species is an impressive demonstration of the important contribution working cattle properties with remnant vegetation make to sustaining bird diversity. The composition of the species list is consistent with status of species listed in the Annual Bird Reports for the Hunter Region of New South Wales (Stuart 2006). The limited extent of continuous woodland and lack of cereal crops explain the absence of the Common Bronzewing *Phaps chalcoptera* (Barrett *et al*. 2002).

Counting the numbers of birds present proved beneficial in assessing change and complemented an analysis based on the frequency of presence. While a three monthly survey interval provided useful information additional surveys, for instance monthly, would be more beneficial in view of the variation which occurred when a count was repeated. Surveys conducted in January are difficult because the birds are less active and difficult to hear when cicadas are calling. Early December would be a better time to survey the summer population when all migrants are present and conditions are cooler. Collection of breeding information was superficial because of the need to conduct surveys with a constant effort approach in order to facilitate the evaluation of population change. Hence only obvious instances of breeding behaviour were recorded.

A superficial examination of population change based on the frequency of presence suggests that a number of species were less plentiful during the second half of the study. This indication was supported by a corresponding decrease in the numbers of birds observed. The decline in the waterbirds as a group is attributed to drought conditions at the end of the study. This decline was dramatic in the case of the Australian Wood Duck and the Purple Swamphen. In contrast Latham’s Snipe was observed more frequently under drought conditions. The underlying reasons for these population changes probably involve a combination of environmental factors at local, regional and national scale. Consequently studies of this type provide important land management information both as independent investigations and as part of national Birds Australia collaborative projects.

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Ecological adaptations for Large-billed, Yellow-throated and White-browed Scrubwrens

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Large-billed Scrubwren, *Sericornis magnirostris*, White-browed Scrubwren, *S. frontalis*, and Yellow-throated Scrubwren, *S. citreogularis,* inhabit the same geographical range but do not appear to compete directly with each other. This led to the following hypotheses: firstly White-browed Scrubwrens will differ from Yellow-throated Scrubwrens in the type of vegetation they forage in; and secondly Large-billed Scrubwrens will differ from both Yellow-throated and White-browed Scrubwrens in their use of different foraging heights. Observations indicated that the foraging area of White-browed Scrubwren was significantly different to that of the Yellow-throated Scrubwren in the main type of vegetation used with White-browed using the edge vegetation along the roads (mainly exotic species) and Yellow-throated using the denser rainforest vegetation. The Large-billed Scrubwren was found to forage in a different layer of the forest (foraging mainly in the mid-storey) to that of both White-browed Scrubwrens and Yellow-throated Scrubwrens (which both forage mainly in the undergrowth). It was concluded that the three species of scrubwren have evolved different foraging adaptations to avoid competing with each other in the same geographical area.

INTRODUCTION

Three species of scrubwren in New South Wales often inhabit the same geographical range and habitat (Morcombe 2001). They are Large-billed, *Sericornis magnirostris*, White-browed, *S. frontalis*, and Yellow-throated Scrubwren, *S. citreogularis*. All are members of the Maluridae family, Order Passeriformes (Harrison 1978), and quite often inhabit areas in and around rainforest. They are not known to be difficult to observe and are generally active for most of the day (Christidis *et al*. 1988). They are active because their high metabolism requires them to feed continuously. In addition, they live in cool areas (rainforest) and do not need to reduce their activity during the hotter middle part of the day (Christidis *et al*. 1988).

Large-billed Scrubwrens are common rainforest birds, generally occurring in moist gullies in eucalypt forests (Morcombe 2001). They range throughout the east coast of Australia, along and to the east of the Great Dividing Range, up to an altitude of 1500m (Higgins & Peter 2002). Three subspecies have been described. The subspecies observed during this study, *magnirostris*, occurs from southeast Queensland, along the New South Wales coast and ranges to northeast Victoria, (Higgins & Peter 2002). Large-billed Scrubwrens tend to feed in the mid levels of the vegetation (mid-storey) and are thus completely different to other species of scrubwren in the foraging zones (Christidis *et al*. 1988). Large-billed Scrubwrens feed mainly on insects, but will occasionally take fruit (Higgins & Peter 2002).

White-browed Scrubwrens are extremely common generalists in forest habitats occurring almost anywhere there is a dense under-storey with water not far away, but they tend not to frequent the densest parts of rainforests (Morcombe 2001). They range across most of the east coast of Australia, occurring in the ranges and the low lands along the Great Dividing Range, across the south coast of Australia and on the west coast as far north as Shark Bay (Higgins & Peter 2002). Four subspecies have been described. The subspecies observed for this study, *frontalis*, occurs from northeast New South Wales to southeast South Australia (Higgins & Peter 2002). White-browed Scrubwrens tend to feed in the under-storey and, occasionally, on the ground using both introduced and native vegetation (Christidis *et al*. 1988). White-browed Scrubwrens feed mainly on insects but will occasionally take fruit (Higgins & Peter 2002).
Yellow-throated Scrubwrens are common rainforest birds, which can also inhabit wet gullies in eucalypt forests (Morcombe 2001). They range along the coast and ranges of eastern Australia

generally along and east of the Great Dividing Range (Higgins & Peter 2002). Two subspecies have been described. The subspecies observed for this study, *citreogularis*, occurs along the east coast of New South Wales to southeast Queensland (Higgins & Peter 2002). Yellow-throated Scrubwrens tend to feed on the ground in leaf litter, bare dirt or occasionally in low shrubs, generally preferring native vegetation (Christidis *et al*. 1988). Yellow-throated Scrubwrens feed mainly on insects but will occasionally take fruit (Higgins & Peter 2002).

For these three species to have evolved in the same area niche partitioning probably occurred to reduce competition with each other (Joseph & Moritz 1993). The aim of this report is to investigate adaptive differences in their foraging locations regarding the vegetation types and structures in which they forage. This led to the following two hypotheses: the White-browed Scrubwren will differ from the Yellow-throated Scrubwren in the type of vegetation it forages in; the Large-billed Scrubwren will differ from both Yellow-throated and White-browed Scrubwrens in their use of different foraging heights.

METHODS

To determine which behaviours to use in testing the two hypotheses an ethogram of the three species behaviours was conducted (**Table 1**), and to determine the appropriate time frame for the hypotheses tested a time budget was produced (**Table 2**). A plant field guide (Robinson 1994) was used to distinguish the difference between rainforest and non-rainforest vegetation and a plant expert (Chris MacLean pers. comm.) assisted in the field. Non-rainforest vegetation was observed only in disturbed areas along roads and on edges of rainforest that were mainly composed of non-native vegetation.

To test the two hypotheses three distinct locations were chosen with enough distance between them to ensure that, although all three species of scrubwren occurred in close proximity, they were separate populations. All locations were along the upper Allyn River, Barrington Tops. One location was along Peach Tree Walk on the eastern side of the river, another was through the gate at the northern end of the road on the west side of the river at White Rock Campsite and a third location was south from the gate along the road on the west side of the river. At each site four individual birds of each species of scrubwren were observed for a continuous five minutes and all foraging behaviour was recorded.

To avoid disturbance silence was maintained at all times and binoculars were used for observation. At the time of observation, autumn 2006, the birds were active most of the day but particularly because of the overcast weather conditions, as this means it does not get too hot for the birds so they stay active. This allowed observations to be carried out between 9 and 11am on three consecutive days, 24th-26th March 2006, observing on only one day at each of the three sites. Individual birds were observed for five minutes recording (presence, percent time per foraging behaviour) behaviour at one minute intervals. Only the behaviours that involved foraging, (i.e. procuring and eating food) were recorded because they were required to compare the different foraging heights and vegetation used.

Bivariate correlation was used to compare the types/heights of vegetation foraged in by the scrubwren species. The correlation between Large-billed and Yellow-throated compared percent time spent at different foraging heights and this was the same between Large-billed and White-browed. The comparison between Yellow-throated and White-browed was in their preferred vegetation type for foraging.

RESULTS

The ethogram describes a variety of different activities (**Table 1**), which were categorized to construct the time budget (**Table 2**). A five minute observation period with one minute intervals is enough time to gather significant amount of data.

Large-billed Scrubwrens prefer to forage in the mid-storey of rainforest vegetation (**Table 3**).

Compared to the White-browed Scrubwrens that tend to forage in understorey and low shrubs of non-rainforest vegetation (**Table 3**), Yellow-throated Scrubwrens prefer to forage on the ground or in the understorey of rainforest vegetation (**Table 3**). Differences in the three species' foraging areas are shown in **Figure 1**.

There was a difference between the types of vegetation used for foraging between Yellow-throated and White-browed Scrubwrens. Yellow-throated Scrubwrens tend to use typical rainforest vegetation compared to the more disturbed, non-rainforest vegetation preferred by White-browed Scrubwrens. This result was supported by the strong negative correlation of the percent time spent in the type of vegetation used for foraging by these two species (**Table 4**).

Results show that Large-billed Scrubwrens usually forage in the mid-storey of rainforest, occasionally using low shrubs (**Table 3**). This was shown to be significantly different from the other two scrubwrens that prefer to use low shrubs, under-storey and the ground for foraging. This result was supported by strong negative correlations of percent time spent at different foraging heights (**Table 4**).

Table 1. Ethogram for three species of scrubwrens and their different behaviours.

Behavioural category	Behavioural definition and description
Preening	Sitting either on the ground or in vegetation cleaning feathers.
Roosting	Sitting inactive either on the ground or in vegetation.
Flying	Moving through the air with wings beating.
Feeding	Sitting on the ground or in vegetation consuming food collected while foraging.
Foraging on ground	Searching for food on the ground i.e. in leaf litter or in mud.
Foraging in understorey in rainforest vegetation	Searching for food in low understorey less than 50cm in height, in rainforest.
Foraging in understorey in non-rainforest vegetation	Searching for food in low understorey less than 50cm in height, in non-rainforest.
Foraging in low shrub in rainforest vegetation	Searching for food in low shrub and vines greater than 50cm in height to 2m in height, in rainforest.
Foraging in low shrub in non-rainforest vegetation	Searching for food in low shrub and vines greater than 50cm in height to 2m in height, in non-rainforest.
Foraging in mid-storey	Searching for food in mid-storey greater than 2m in height and less than 10m in height.

Table 2. Time budget for each scrubwren over a 20 minute period.

Category	Large-billed Scrubwren	White-browed Scrubwren	Yellow-throated Scrubwren
No. of 5 minute observation periods	4	4	4
No. of individuals observed	4	4	4
Total minutes of observation	20	20	20
Percent time preening	6.7	0	0
Percent time roosting	9.2	6.7	5.8
Percent time flying	7.5	3.3	0
Percent time feeding	12.5	15.0	13.3
Percent time foraging on ground	0	10	32.5
Percent time foraging in understorey in rainforest vegetation	0	5.8	37.5
Percent time foraging in understorey in non-rainforest vegetation	0	40	0
Percent time foraging in low shrub in rainforest vegetation	0	0	10.8
Percent time foraging in low shrub in non-rainforest vegetation	2.5	19.2	0
Percent time foraging in mid-storey	61.7	0	0

Table 3. Percentage of time spent foraging by each scrubwren.

Category	**Large-billed Scrubwren**	**White-browed Scrubwren**	**Yellow-throated Scrubwren**
No. of 5 minute observation periods	12	12	12
No. of individuals observed	15	15	15
Total minutes of observation	60	60	60
Percent time foraging on ground	0	14.5	46.7
Percent time foraging in understorey in rainforest vegetation	0	10.8	34.4
Percent time foraging in understorey in non-rainforest vegetation	0	38.6	7.8
Percent time foraging in low shrub in rainforest vegetation	4.8	1.2	11.1
Percent time foraging in low shrub in non-rainforest vegetation	0	34.9	0
Percent time foraging in mid-storey	95.2	0	0

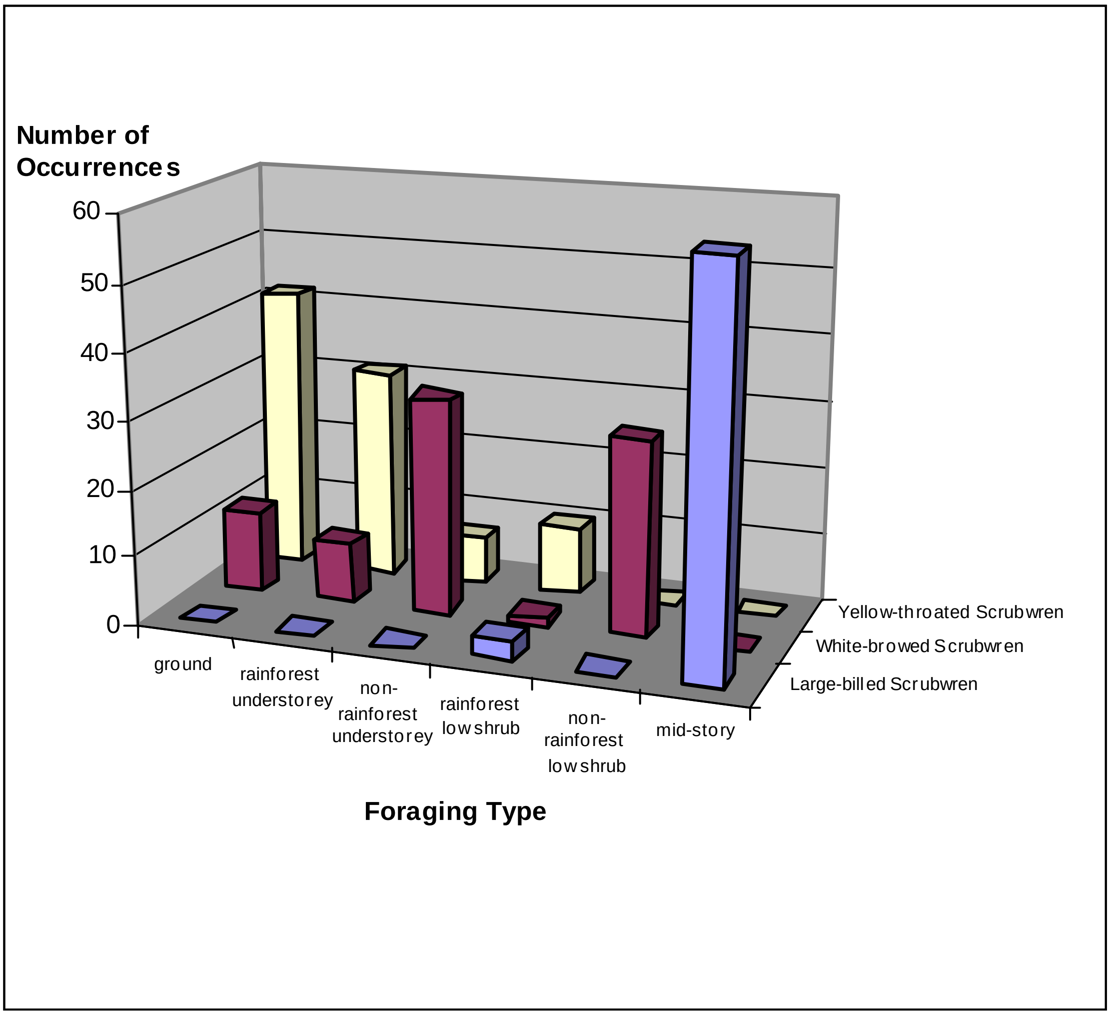

Figure 1. Number of times a different foraging area was used by Large-billed, White-browed and Yellow-throated Scrubwrens.

Table 4. Correlation between % time at foraging height for Large-billed and White-browed and for Large-billed and Yellow-throated. For White-browed and Yellow-throated the correlation is between % time in rainforest and non-rainforest vegetation. Two degrees of freedom was used.

Species 1	**Species 2**	**Correlation**
Large-billed Scrubwren	White-browed Scrubwren	-0.7573
Large-billed Scrubwren	Yellow-throated Scrubwren	-0.7519
White-browed Scrubwren	Yellow-throated Scrubwren	-0.6187

DISCUSSION

White-browed Scrubwrens were observed to forage in non-rainforest vegetation whereas Yellow-throated Scrubwrens showed a tendency to forage in rainforest vegetation and on the ground below. The first hypothesis, that White-browed Scrubwrens will differ from Yellow-throated Scrubwrens in the type of vegetation they forage in, was supported. It would be interesting to see more detail about the floristics of the different vegetation types, so that if this study is repeated in other parts of the species' range (see below), comparisons can be made regarding regional habitat preferences.

Large-billed Scrubwrens were observed to forage in the mid-storey of rainforest vegetation which is significantly different behaviour to both White-browed and Yellow-throated Scrubwrens which both forage in the under-storey or on the ground. These results supported the second hypothesis, that Large-billed Scrubwrens differ from both Yellow-throated and White-browed Scrubwrens in their use of different foraging heights.

These results suggest that Yellow-throated, Large-billed and White-browed Scrubwrens could have co-evolved without the necessity of geographical separation (Higgins & Peter 2002). The three species may have been in direct competition for food if the Large-billed Scrubwren had not adapted to feeding higher in the vegetation (Christidis *et al*. 1988), and if the White-browed Scrubwren had not adapted to feeding in habitats with dense ground cover adjacent to, but not within, rainforest (Joseph & Moritz 1993). Yellow-throated Scrubwrens exist in the rainforest by foraging in low vegetation and on the ground, without direct competition from the other scrubwrens (Joseph & Moritz 1993).

Observations for this project were carried out in the non-breeding season and, the birds were not very vocal. Therefore, the birds were often difficult to locate. All three days spent in the field were overcast, which allowed the birds to be active in the middle of the day, but they were quiet early in the morning. Because bird behaviour may change during different seasons and thus change the results (Joseph & Moritz 1993), data collection should be repeated in winter, spring and summer. This project also should be expanded to cover a wider geographic range where the three scrubwren species co-occur, to test whether the results can be generalized to other parts of the species' shared range (Christidis *et al*. 1988). Data could also be collected in similar habitats, but in locations where the species don't all co-occur. Niche expansion may then be demonstrated in one or more of the species (Christidis *et al*. 1988).

CONCLUSIONS

Observations indicate that Large-billed Scrubwrens are rainforest mid-storey specialists, White-browed Scrubwrens are non-rainforest ground and under-storey specialists and Yellow-throated Scrubwrens are rainforest ground and under-storey specialists (**Figure 1**). Thus, although the three species of scrubwrens occupy similar geographic areas they mostly forage at different heights within the same vegetation type or forage at similar heights but in different vegetation types, thereby avoiding direct competition for food resources.

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Mangrove proliferation and saltmarsh loss in the Hunter Estuary

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The Hunter Estuary is in a state of ecological crisis. The diverse mosaic of vegetation communities that previously existed in the estuary is rapidly degrading into a mangrove monoculture with a consequent loss of biodiversity. It is concluded that deepening the harbour and harbour channels by dredging, has led to a considerable increase in the tidal range in the estuary. This is considered the main mechanism responsible for the rapid landwards incursion of mangroves into, and displacing, the saltmarsh community. In order to restore the balance between mangrove and saltmarsh communities, it is proposed that existing floodgates be managed adaptively to manipulate tidal inundation. In addition, in areas where critical shorebird habitat is under threat of mangrove encroachment, flow-control structures should be constructed to manage tidal flow into the remaining uncontrolled tidal creeks, downstream of Hexham Bridge.

INTRODUCTION

Mangrove proliferation and the concomitant loss of the saltmarsh community is a phenomenon recognized throughout southeast Australia. This trend is more pronounced in developed estuaries (Saintilan & Rogers 2002). Therefore, it should be no surprise that the Hunter Estuary, the most developed estuary on the New South Wales coast, is experiencing serious ecological changes (**Figure 1**). The process is now so rapid that the estuary is in danger of becoming a monoculture of mangroves within a few years, with all the resulting problems related to loss of biodiversity.

Since the 1950s mangroves have increased in area from about 1300ha to about 1700ha, despite the loss of 240ha to industrial and urban development. At the same time, the original saltmarsh area of 2133ha, was reduced by 67% (1428ha) by 1994 (Williams *et al.* 2000). Since then, this trend has continued and, in some areas, perhaps at a more rapid rate (personal observations). Saltmarsh is now listed as an endangered community. This trend together with the previous loss of saltmarsh and mangroves from the extensive Hexham Swamp and Tomago Wetlands, by the closure of floodgates during the 1970s, has put tremendous pressure on the ecological integrity of the Hunter Estuary that increasingly resembles a canal system. Many people see changes in the estuary as a natural progression. However, the Hunter Estuary, originally a shallow estuarine delta, is being transformed into a deep-water industrial harbour that is now the largest coal-exporting port in the Southern Hemisphere. Myriads of estuarine islands, separated by winding tidal creeks, have been amalgamated into one super-island, Kooragang Island. As a result more than half of the original estuarine shoreline has been lost. Most of the flanking intertidal floodbasins have been closed off by floodgates that have never been opened since installation. The prawn and fish industry has suffered and migratory shorebirds visiting the estuary have declined in numbers from more than 10,000 during the 1970s to about 3,500 as their habitat has degraded. The Hunter Estuary is no longer a pristine wilderness that can be left to “natural processes”. Natural processes have been overwhelmed by “progress”. The estuary is man-modified and must now be managed by man to achieve positive outcomes for the biodiversity that remains.

A number of authors have suggested various reasons for the changes, but have generally concluded that that there is no *single* explanation for *all* estuaries in southeastern Australia. Without a definite explanation there has been no attempt to suggest alternatives for controlling the changes, if indeed that is possible or even desirable. The purpose of this discussion is to briefly review suggested reasons for mangrove proliferation and saltmarsh loss and to discuss the most likely mechanism for these changes as it relates to the Hunter Estuary. Remediation measures are also suggested.

DISCUSSION

Mangrove and saltmarsh communities occur in a restricted, narrow, vertical zone determined by local tidal variations above and below mean sea-level. In the Hunter Estuary this vertical zone measures less than two metres at the mouth and decreases rapidly upstream. Mangrove and saltmarsh communities flourish in sedimentary environments undergoing active deposition. These environments are essentially flat with very low gradients between areas of extremely low relief. Therefore, even slight changes to tidal amplitude and/or relative sea-level have a large effect on the horizontal distribution of these environments.

The following discussion reviews various mechanisms proposed to explain the proliferation of mangrove and the simultaneous loss of saltmarsh as they relate to the Hunter Estuary and compares them with the views expressed here that tidal range increase is the main causal mechanism for the ecological problems now manifest in the estuary.

Several possible mechanisms for mangrove incursion into former saltmarsh habitat have been discussed in the past:

- Precipitation;
- Agricultural practices;
- Sedimentation and nutrients;
- Subsidence;
- Global sea-level change and
- Altered tidal regime.

These points are used for the following discussion concerning the Hunter Estuary.

Precipitation

In southeast Australia average annual precipitation has increased since 1945 (Pittock 1988, in Saintilan & Williams 1999). It was suggested that hypersaline conditions within saltmarsh soil could be diluted sufficiently to allow mangrove colonization. In an area of mangrove expansion in the Hunter Estuary, Buckney (1987) noted a loss of vigour following an *El Nino* drought period in 1982, leading him to believe that increased rainfall may have contributed to initial mangrove expansion. If this is so then there should be a noticeable decline in the health of mangroves that have developed since then in relation to the present prolonged drought that is now regarded as the most severe in the last 100 years. Contrary to this expectation mangroves are vigorously expanding their range at what appears to be an increasing rate (personal observations). In addition, a large area of saltmarsh on Area E, Ash Island (western part of Kooragang Island, **Figure 1**), suffered no mangrove incursions during this period. However, during the late 1990s mangroves did rapidly encroach and displace saltmarsh within only a few years, but only after creek culverts were removed allowing increased tidal flushing. This effectively decreased the hypersalinity of the saltmarsh soil, as additional rainfall was predicted to do. But over the very short period of only a few years, the reduced salinity was much more likely to have been the direct result of opening the area up to full local tidal amplitude (especially as this ongoing process was taking place during a prolonged drought).

It is considered that increased rainfall has had no significant effect on mangrove proliferation and saltmarsh loss in the Hunter Estuary.

Agricultural Practices

It has been suggested that mangroves may have recolonised areas previously cleared of mangroves in the past in Moreton Bay (Morton 1994). This may well be the case for parts of Ash Island that were cleared for dairy farming in the late 1800s. It has also been observed in those areas that grazing cattle prevented mangrove propagules from establishing into mature plants. Continuous cattle grazing would then keep these areas free of mangroves. On the other hand, withdrawal of cattle from areas on Ash Island, particularly Area E and Milhams Pond, has seen the sudden proliferation of mangroves over wide areas of saltmarsh that previously never supported mangroves. Thus, it is considered that grazing by cattle has merely served to delay the spread of mangroves until recently, in contrast to areas where mangrove proliferation has been occurring for the past 30 years or more in areas that have never been grazed (e.g. Kooragang Nature Reserve).

In the past mangrove branches have been utilized to construct racks for oyster farming and may also have been used as fuel for burning shells for lime manufacture. The extent of these activities has not been investigated here, but they were probably more commonly carried out in the North Arm of the Hunter River from Fern Bay to Sandy Island where oyster leases are still present and where dredging of oyster banks for shells was practiced.

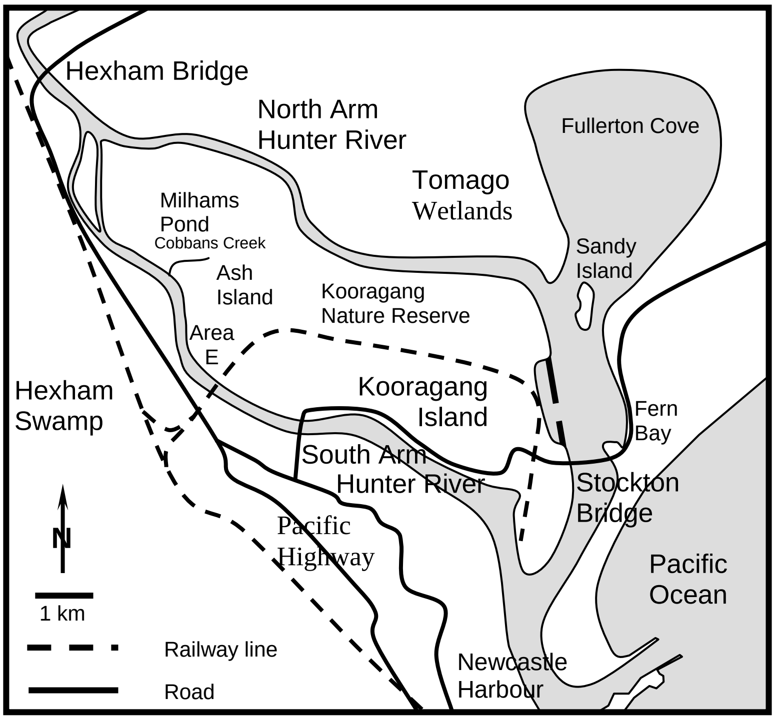

Figure 1. In the lower part of the Hunter Estuary a maze of former estuarine islands has been amalgamated into one super-island called Kooragang Island. Dredging has converted the shallow estuarine delta into a deep-water port by deepening the seaward end of the South Arm, Newcastle Harbour and the entrance channel.

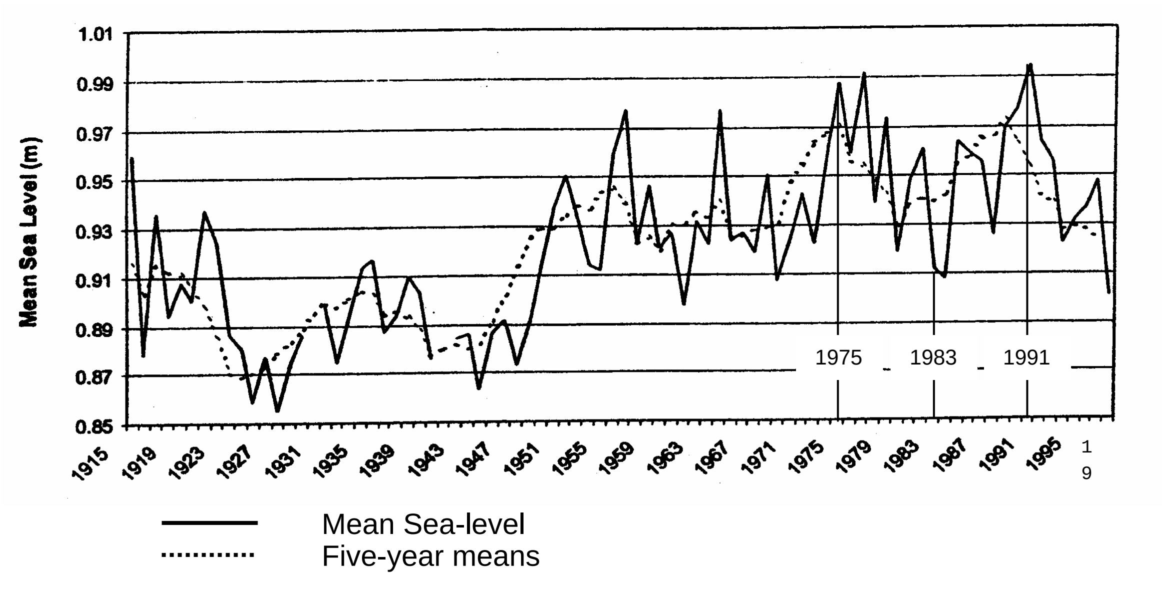

Figure 2. Sea-level trends at Fort Denison, 1915-1998 (modified from Saintilan & Wilton 2000). The five-year means sea-level curve, if smoothed even more, appears to be a sinusoidal curve with a periodicity of about 80 years.

Other areas where mangrove destruction probably took place in the lower part of the estuary are now covered by industrial development or housing.

It is evident that agricultural practices, where cattle grazing is continuing, have *prevented* mangrove expansion. The sudden expansion of mangroves in areas of saltmarsh where cattle have been removed merely indicates that grazing has delayed the ongoing proliferation of mangroves compared to areas never grazed. In fact these areas have probably experienced an accelerated growth of mangroves that has tended to catch up with the steadier proliferation of mangroves elsewhere.

Sedimentation and nutrients

Saintilan & Williams (1999) suggested that fresh nutrient-rich sediment promotes the establishment of mangrove propagules in the upper intertidal environment. This is certainly a possibility for the Hunter Estuary, which has a largely cleared, agriculturally developed catchment. However, most of the clearing and subsequent sediment mobilization would have taken place in the late 1800s and early 1900s, not during the later part of the 1900s when the most significant mangrove proliferation commenced. In addition, it would be expected that mangrove proliferation should have been rapid following the 1955 floods with the accompanying sedimentation. But, it was not until the 1970s that mangroves were noticeably increasing their range. While it is possible that sedimentation and nutrients would assist the spread of mangroves the mismatch in timing is not convincing for this to be a major cause. In addition, Saintilan (2003) suggested that nutrient addition may only contribute by increasing luxuriance of the mangrove seedlings and does not contribute to mangrove establishment.

Subsidence

In an active depositional estuary subsidence is usually offset by vertical aggradation (sediment deposition). If the rate of sedimentation exceeds the subsidence rate the estuarine delta advances seawards. If the rate of sedimentation is lower than the subsidence rate the estuarine delta retreats as it is increasingly inundated. In the latter case, net subsidence of the estuarine surface has the effect of a relative sea-level rise and may therefore contribute to mangrove transgression (landward encroachment). Conversely, if the estuarine surface increases in elevation mangroves should retreat.

Rogers *et al.* (2006) found that on Kooragang Island the rate of sediment accretion was about twice the rate of subsidence caused by sediment compaction in areas of mangroves, and mixed mangroves and saltmarsh, resulting in a net increase in surface elevation. In saltmarsh, increased surface elevation mostly resulted from sediment accretion and was little affected by subsidence caused by compaction.

These findings indicate that surface elevation had increased and that mangroves should not, therefore, find conditions suitable for proliferation. Indeed they should be in retreat in that area. The area studied was described as an area of "… minimal mangrove expansion …" which is not surprising. In order to provide a clearer picture of the role of subsidence and sediment accretion in relation to mangrove expansion in the Hunter Estuary it is necessary to sample areas of rapid mangrove expansion, not areas of minimal expansion. In fact, other areas studied by Rogers *et al.* (2006) in estuaries with rapid mangrove encroachment into saltmarsh had sediment accretion rates that did not translate to a net increase in surface elevation (equivalent to a relative sea-level fall).

In view of the above discussion, the role of subsidence contributing to mangrove proliferation is not supported in the Hunter Estuary. However, the few locations studied may not be representative of areas of rapid mangrove proliferation.

Global sea-level change

Saintilan & Williams (1999) noted that eustatic (global) sea-level rose during the last century and that small increments in sea-level translate … *"into substantial alterations in the frequency of [tidal] inundation over wide areas, and this may be one factor contributing to mangrove incursion upon saltmarsh".*

From Fort Denison sea-level data, Saintilan & Wilton (2001) suggested that mean sea level had been 4cm higher for the period 1950-2000 than for the first half of the century (**Figure 2**). Saintilan & Williams (1999) implied that eustatic (global) sea-level rose by about 5cm during the 1900s and Saintilan & Rogers (2002) stated that it had risen by 7cm. MHL (2004) states that there has been 4.5cm rise in sea-level since the 1950s. However, whatever the real sea-level rise has been, the full rise would be experienced only at the mouth of the Hunter Estuary and would decrease progressively upstream to perhaps only a couple of centimetres between Stockton and Hexham Bridges.

It is interesting to note that the sea-level curve in **Figure 2**, if smoothed even more than the dotted five-year means, is actually a sinusoidal curve with a periodicity of about 80 years, virtually coincident with the period chosen for the chart from 1915 to 1998. This observation has several implications in attempting to relate global sea-level to mangrove proliferation. Although, according to the chart, five-year-mean sea-level was 4cm higher during the late 1900s, the five-year-mean sea-level in 1998 was only about 1cm higher than it was in 1915. Furthermore, the *mean* sea-level was, in fact, about 6cm lower in 1998 than it was in 1915! Also sea-level during the latter 1900s was, for most of the time, less than the sea-level in 1915. In addition, if the sinusoidal curve is projected back in time, to before 1915, it implies that sea-level during the latter part of the 1800s was similar to the elevated levels during the late 1900s. However, there is no evidence to suggest that mangroves were proliferating during the late 1800s in response to the implied higher sea-levels as inferred from the sea-level chart. Also, the considerable 9cm-fall in sea-level during the 1990s (1991 to1998) has not been reflected in a decreased rate in the proliferation of mangroves. On the contrary, this has been a period where even casual observations have noted the continuing very rapid rate of mangrove expansion. However, Buckney (1987) showed that on Kooragang Island there was actually a decrease in the expansion of mangroves from 1975 to 1982. Williams *et al*. (2000), when comparing their longer-term data with Buckney's, suggested two possible explanations for a discrepancy between their results; either "one or other of the analyses is wrong, or the dynamics of mangrove change need to [be] mapped at less than 10 year intervals". In support of the latter statement, this short term reversal in the prevailing trend of mangrove proliferation could be explained by a period of falling sea-level that took place between 1975 and 1983 (**Figure 2**). Thus, it appears that global sea-level does have some influence on the distribution of mangrove and saltmarsh communities but the amount of rise and fall does not appear to be enough to explain the overall magnitude of the ecological changes observed. Saintilan & Wilton (2001) found that this was the case in Currambene Creek, Jervis Bay, where the 30cm vertical increase in the range of mangroves was much greater than the small amount of global sea-level rise could account for. However, Saintilan & Rogers (2002) indicated that "the consistency of the trend between estuaries … suggests at least some component of saltmarsh loss is related to sea-level trends".

Saintilan & Wilton (2001) noted that in Jervis Bay saltmarsh overlies strata with mangrove remains dated to about 2000 years before present, implying that the vegetation succession from mangroves to saltmarsh has been stable for the last 2000 years. Therefore, it is only recently that we have seen the reverse situation where mangroves have been replacing and overlying saltmarsh. It appears from the above discussion that global sea-level has been oscillating with a periodicity of about 80 years and that the magnitude of this oscillation has not had an overall controlling influence on mangrove expansion. Another process with greater influence on the ecology of the estuary must be implicated.

Altered tidal regime

Morton (1994) attributes the landward incursion of mangroves with altered tidal range (presumably an increase) in Moreton Bay. This concept is supported by Saintilan & Williams (1999) who noted that the construction of tidal barrages and modification of entrance conditions could be contributing factors that altered (presumably increased) the tidal range significantly, promoting the landward colonization of mangroves, as discussed by Druery & Curedale (1979) for the Tweed and Brunswick Rivers.

During the last 50 years, the solstice tidal range in the Hunter Estuary increased by 100mm at Stockton Bridge and by as much as 250mm at Hexham Bridge (Umwelt 2002). Smaller tidal range increases were noted for spring, mean and neap tidal cycles.

"These recorded increases in tidal range indicate that a greater volume of water now passes through the entrance channel on each tidal cycle with estimates indicating approximately a 5% increase in tidal exchange volume.

Analysis of channel cross-sectional information … indicates that since 1950 the controlling cross-sectional area of the entrance channel has *increased [by dredging] from approximately 3400m^2 in the 1950s to approximately 5780m^2 in 2000 with a corresponding increase in depth from approximately 10 metres to approximately 17 metres. This equates to approximately a 1.7 times increase in entrance channel cross-sectional area."* (Umwelt 2002).

Thus, Umwelt (2002) suggested that harbour dredging has been the major cause of tidal range increase in the estuary. A study by Manly Hydraulics Laboratory (MHL 2002) on Hunter Estuary processes also concluded that tidal range had increased in the estuary and suggested three possible mechanisms: dredging and deepening of channels; construction of levees; and construction of floodgates [the latter two mechanisms confining the tidal prism to the main channels instead of allowing the tide to dissipate into flanking estuarine wetlands].

Thus, channel, river mouth and harbour deepening by dredging has substantially increased tidal inflow into the estuary, resulting in a greater tidal prism penetrating upstream and directly contributing to tidal range increases in the upstream reaches of the estuary. Increased tidal amplitude has caused a considerable increase in *relative* sea-level in the Hunter Estuary, which is well in excess of *global* sea-level rise.

The boundary between saltmarsh and mangroves is related to small differences in elevation and soil salinity. An increase in tidal range increases the rate of tidal inundation that can, in turn, reduce the hypersalinity of the saltmarsh environment allowing mangroves to invade. It is suggested that the relatively huge increase in tidal range recorded between Stockton Bridge and Hexham Bridge is the most significant factor leading to mangrove proliferation and saltmarsh loss. In support of this conclusion, the timing of the rapid mangrove expansion correlates with the most significant period of dredging that took place in the early 1980s. Williams *et al.* (2000) also suggested that increased tidal range caused by harbour dredging is one of the main factors related to mangrove expansion and specifically identified tidal range increase as the reason for rapid mangrove expansion following culvert collapse at the mouth of Cobbans Creek.

Contributing factors for tidal range increase

Although it is considered that harbour and channel deepening is the main process for increasing the tidal range in the Hunter Estuary there are additional estuary modifications that contribute to this effect. These modifications all tend to increase the tidal range, exacerbating the effects of dredging.

Since the 1800s about half the estuarine shoreline has been lost by the construction of rock training walls. Reclamation of saltmarsh and mangroves by infilling behind the training walls completed the transformation of these areas for industrial purposes. The straightening and smoothing of the estuary banks effectively increase the efficiency of tides moving in and out of the estuary by reducing bed friction thereby assisting the penetration of the larger tidal prism. Rising tides that would normally flow into the saltmarsh and mangrove are now prevented from dissipating into the area behind the training wall. The effect of assisting tidal inflow, but at the same time, preventing the lateral dissipation of the resulting inflow translates to vertically increased tidal range.

The removal of even greater areas of estuarine floodplain, where tidal inflow was previously dissipated, such as Hexham Swamp, Tomago Wetlands and many additional areas upstream of Hexham Bridge, have also contributed to increased tidal range. All these areas have been cut off from the estuary by the construction of flood-gates that have mostly been kept closed. As mentioned above, MHL (2002) also implicates the construction of levees and floodgates as contributing to tidal range increase.

Increasing the tidal prism entering the estuary has the effect of moving the limit of tidal influence upstream. However, in many places this is not possible because weirs have been constructed inhibiting saltwater penetration into the upper reaches of the estuary (e.g. Seaham Weir on the Williams River). Siltation and subsequent shallowing of the upper reaches of the Hunter, Williams and Paterson Rivers also inhibit upstream movement of the tidal limit. All these upstream effects contribute to tidal range increase in the downstream areas of the estuary.

All the factors discussed above effectively restrict lateral movement of tidal flow. But progressive deepening of the harbour entrance and channels forces more tidal inflow into the estuary. Thus, the estuary has experienced modifications that have progressively decreased its capacity to laterally dissipate this increased tidal inflow. The increased volume of water entering the estuary as a result of harbour and entrance deepening can no longer be accommodated laterally, therefore it can only go upwards by increasing the tidal range.

CONCLUSIONS

Although there may be several factors exacerbating the expansion of mangroves and the concomitant loss of saltmarsh in southeastern Australia, it appears that, within the Hunter Estuary, increased tidal range is the most important factor. The magnitude of the change is such that it outweighs all other factors combined. This is effectively a local relative sea-level rise that has had an enormous physical effect on the lateral distribution of ecological communities throughout the estuary.

In the past, there has been ***no*** recognition of the upstream ecological problems caused by dredging and harbour deepening. The proposed dredging of the South Arm of the Hunter River for new coal loading facilities on Kooragang Island will add to the problem of tidal range increase and accelerate the incursion of mangroves into the small amount of remaining saltmarsh. In the EIS for the proposed dredging there was no consideration of upstream effects as a consequence of channel deepening (other than the statement that tidal range ***will*** increase). Also, in a report concerning the environmental risks of dredging the North Arm, it was indicated that a tidal range increase of 50mm should be expected as far upstream as the Hexham Bridge. However, there was still very little comment regarding the drastic ***effects*** of this expected tidal range increase on the total ecology of the estuary.

It is interesting to note in the Hunter Estuary Processes Study, that although alteration to the natural flow regime is listed as a threatening process, tidal range increase is not specifically discussed (MHL 2004). However, they do suggest that the identification of processes affecting the balance between mangroves and saltmarsh requires further study. Although increased tidal range in the estuary is recognized, the study does not specifically identify it as the main mechanism for mangrove proliferation and saltmarsh loss. It is ironic that MHL's main concern is the *restriction* of tidal inundation to estuarine wetlands where floodgates have been installed, such as Hexham Swamp, rather than the main concern expressed here regarding *excessive* inundation of estuarine wetlands in areas *not* protected by flow-control structures or where mangroves have rapidly invaded saltmarsh after culvert removal (Howe 2005).

Planned and future industrial development will require additional harbour and channel deepening with further consequent tidal range increases. This will exacerbate the continuing ecological crisis. It has to be accepted that economically and politically this situation will persist. The question is, should we and can we take steps to halt, or at least ameliorate, the effects of tidal range increase. Given the impossibility of allowing environments to expand landwards "naturally", because of the limitations of surrounding development, we have to consider managing the estuary. The author fully endorses the statement by Saintilan & Rogers (2002) that "… if the expansion of mangroves at the expense of other habitats is the result of human modifications of the estuary, then the issue must be addressed within the overall framework of estuary management". In support of reinstating ecological balance to the Hunter Estuary "… data suggest that the diversity of habitat types is of more significance in supporting healthy fish stocks than mangroves alone" (Saintilan & Rogers 2002). If we decide to halt the effects of tidal range increase and to restore, or at least be able to manipulate, the balance between mangrove and saltmarsh communities there *are* measures that can be taken. "Hard engineering works have a role to play in maintaining preferred estuarine wetland habitat in areas where landward migration is constrained by topography or land use" (Howe 2005).

Weirs and culverts with flow control structures, preferably with mangrove seed exclusion facilities, can be installed at the mouth of every tidal creek in the estuary downstream of Hexham Bridge. These structures can be adaptively managed to adjust the amount of tidal inflow in order to achieve the inundation and salinity balance required for mangroves and saltmarsh development. The number of flow-control structures required should not be a daunting task as all tidal creeks in the estuary upstream of Hexham Bridge already have floodgates installed (about 200) and many others have been installed downstream (e.g. Hexham Swamp and Tomago Wetlands). There are 59 culverts in the estuary, mainly downstream of Hexham Bridge that could be modified. Floodgates are in the process of being progressively opened to reintroduce controlled tidal inundation to both Hexham Swamp and the Tomago Wetlands. The same should be considered for all tidal creeks in the estuary that have floodgates already installed. The expense of installing the existing floodgates was apparently justified for flood-control alone following the 1955 Maitland flood. It is not too much to expect that the installation of additional flow-control structures, on the remaining uncontrolled tidal creeks, in order to halt the ecological degradation of the entire estuary would be well justified. The expense would be a small proportion of the expenditure on port development that is considered the main cause for the present state of ecological imbalance in the Hunter Estuary. Flow-control structures would also be useful to manage the expected future sea-level rise that is attributable to climate change.

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Occurrence of Red-backed Fairy-wren and Southern Emu-wren at Warakeila

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INTRODUCTION

The Red-backed Fairy-wren (*Malurus melanocephalus*) is an uncommon resident species in the north of the Hunter region (Stuart 2005). Dungog (32^o 25´S 151^o 45´E) is considered to be the southern limit of its distribution in coastal NSW although at the time of European colonisation of Australia records provided by early paintings suggest that the species occurred as far south as Sydney (McAllan 2002). The Southern Emu-wren (*Stipiturus malachurus*), is an elusive species which is locally common in the Hunter region (Stuart 2005). This note places on record observations of the Red-backed Fairy-wren and Southern Emu-wren at Warakeila (32^o 15´S 151^o 31´E) and compares them with records of the more common Superb (*Malurus cyaneus*) and Variegated (*Malurus lamberti*) Fairy-wren species to demonstrate the significance of these rare sightings.

METHODS

Warakeila is a cattle property, sloping steeply upwards from the east bank of the Allyn River (altitude 190m) near Gresford. Approximately 10% of the property is vegetated, mainly along the edges of small creeks running down to the Allyn River. Between 1996 and 2007 Ann Lindsey and I made 45 surveys of the property at approximately 3 month intervals (usually in January, April, July and October). Each survey lasted about four hours, typically starting at about 7.30am. The protocols established for the Birds Australia "Birds on Farms" project were used. This involved recording all species and an estimate of their numbers. Surveys involved the same circular route which ascended along creek lines to the top of the property (**Figure 1**). In addition 20 minute surveys were made at four sites each approximately 2ha in area. These sites were selected to represent a variety of habitats including an area of creek side vegetation (site 1), woodland at the top of the property (site 2), an isolated copse of trees (site 3) and flats adjacent to the Allyn River (site 4).

OBSERVATIONS

Red-backed Fairy-wren

The Red-backed Fairy-wren was first recorded at Warakeila in April 2001 when 3 birds, including a male in eclipse plumage were seen in a dry creek bed at the top of the property. The species has been recorded during five subsequent surveys including every season with the number recorded varying from one to five. All observations have been from the vicinity of the original record or from another dry creek bed running down the property within 1km of the original location (**Figure 1**).

Southern Emu-wren

The first record of the Southern Emu-wren at Warakeila was in September 1999 when two birds were seen in an area of rank grass above a creek on the lower slopes of the property. The species has been recorded on nine subsequent surveys with three or more records in each season other than winter when it was not recorded. Numbers ranged from one to eight, the highest total being of two groups, each comprising two males and two females. These two groups were in locations more than 1km apart and separated by a ridge. Two groups of Emu-wren were also recorded in January 2007, one just above site 2 and the other at site 3, where two well developed juveniles were accompanied by at least one adult. The Emu-wren sightings, including one record from the road at the edge of the property during October 2006 (not part of a survey) were more widely distributed than those of the Red-backed Fairy-wren (**Figure 1**).

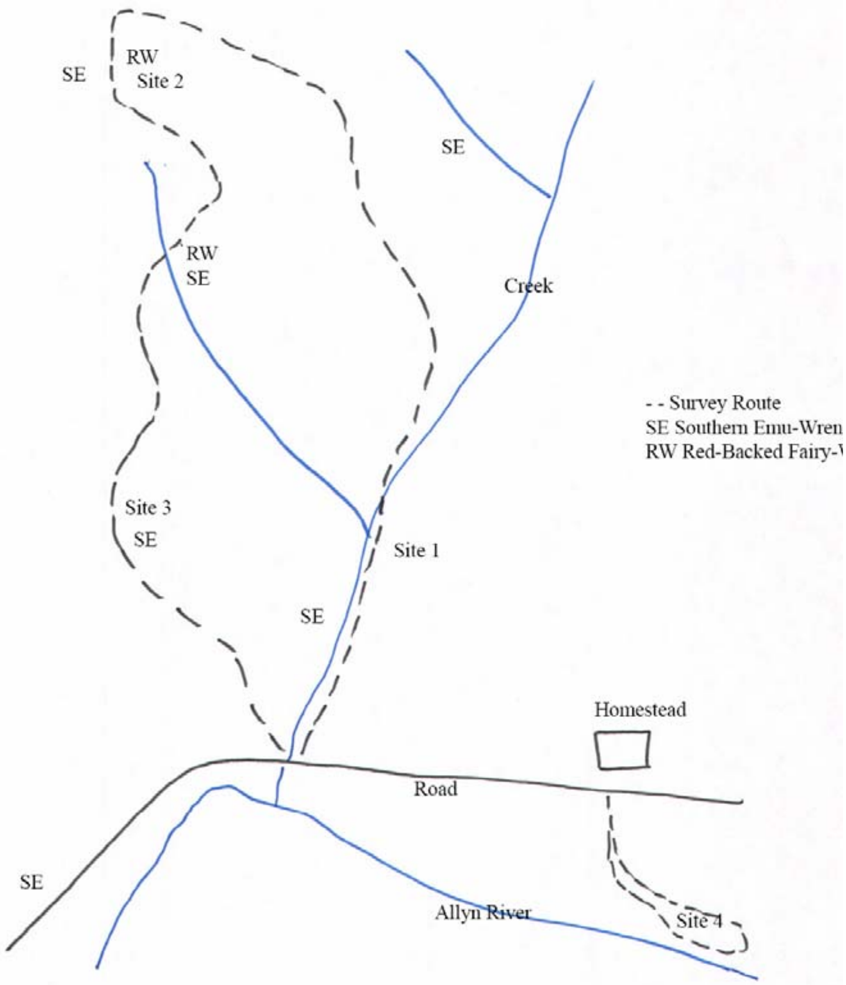

Fig.1 Warakeila - Survey Route and Locations of Key Sightings

Superb Fairy-wren

The Superb Fairy-wren was recorded on every survey and is one of the most abundant species on Warakeila being nearly 100 and 50 times more numerous than the Red-backed Fairy-wren and Southern Emu-wren respectively (**Table 1**). Numbers ranged from 20 to 70 birds with an average 40 birds/survey. Although numbers fluctuated there was no evidence of a decline in numbers over the ten year period. The species was present in all areas of the property including each of the 2ha survey sites which were selected to represent a range of habitat types as described above.

Variegated Fairy-wren

The Variegated Fairy-wren is much less numerous than the Superb Fairy-wren and has been recorded on only 35 of the 45 surveys at an average of 4 birds/survey with a maximum count of eleven. It was recorded in every season and was sparsely distributed throughout the property occurring in all the 2ha sites. However it was most frequently recorded in the vicinity of site 2 at the top of the property (**Figure 1**). There was no evidence of a decline in population over the 10 year duration of the study.

Table 1. Comparison of the number of birds recorded for four wren species.

Species	Number of surveys present (45 surveys)	Number of birds recorded all surveys
Superb Fairy-wren	45	# 1783 (94)
Variegated Fairy-wren	35	184 (10)
Red-backed Fairy-wren	6	19 (1)
Southern Emu-wren	10	32 (2)

Numbers in parentheses indicate the number of birds recorded for each species relative to
the rarest species, the Red-backed Fairy-wren

DISCUSSION

Three species of Fairy-wren (genus *Malurus*) and the Southern Emu-wren are resident on the Warakeila property. Statistics summarising the relative abundance of these species at Warakeila are shown in **Table 1**. All four species can occur together in areas of dry creek bed at the top of the property and in a separate creek bed extending down hill on the other side of an area of woodland (2ha site 2). Both the Red-backed Fairy-wren and the Southern Emu-wren seem to prefer dry creek beds in the more elevated parts of the property, particularly where patches of dense understorey such as the introduced blackberry provide cover. However the Southern Emu-wren appears to have a wider distribution than the Red-backed Fairy-wren on the property and is more likely to forage in areas of rank sedgy grass away from the creek bed cover. The other two species, the Superb and Variegated Fairy-wrens are much more broadly distributed, less dependent on the creek beds, and occur right down to the flats adjacent to the Allyn River.

The Southern Emu-wren and the Red-backed Fairy-wren were not recorded until the surveys had been in progress for 3 and 5 years respectively. While this could indicate that the species had either moved into or increased in the study area, it is more probably attributable to observer bias. Emu-wrens are elusive and difficult to detect vocally. Similarly Red-backed Fairy-wrens are difficult to separate from the other *Malurus* species apart from the male in breeding plumage. During the summer surveys the area where the Red-backed Fairy-wrens were seen was typically visited between 10.00 and 11.00 am, after the time of peak bird activity. Once it was realised that these species were present extra effort was made to detect their presence.

CONCLUSIONS

These records indicate a slight southern extension of the range of the Red-backed Fairy-wren. It is suggested that in the Hunter region both this species and the Southern Emu-wren are under-recorded in the highly degraded slopes to the east of the Great Dividing Range.

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The Status of Black Falcon in the Lower Hunter Valley

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The Black Falcon (*Falco subniger*) is considered a rare species in the Hunter Region and is usually recorded only a few times annually (Stuart 2002). Since 2002 this species has been seen more frequently in the Lower Hunter Valley. We report sightings of Black Falcons from 2002 to 2006 and describe behaviour which provides evidence of breeding near the Morpeth Wastewater Treatment Works (MWTW) 32° 44´ 06" S 151° 37´ 21" E.

The MWTW is situated on a slope above a low lying area which floods after heavy rain creating ephemeral wetlands to the west, south and east. The site is surrounded by lightly timbered agricultural land. The combination of the holding ponds and flooded grazing land provide excellent habitat for waterbirds, particularly ducks and waders. A number of raptor species are attracted to the area (Lindsey & Newman 2002).

The Black Falcon is found primarily in Eastern Australia to the west of the Great Dividing Range where it occurs in lightly timbered country near watercourses. Details of its movements are unclear but it is known to move to more coastal regions during times of drought. Natural corridors across the Great Dividing Range to the north and south of the Liverpool Range provide access to the Hunter Valley allowing its use as a drought refuge by dry country birds.

Prior to 2002, Jerrys Plains, which is approximately 80 km west of Morpeth, was the most coastal location where Black Falcons were recorded with any regularity. The first record of the falcons at Morpeth in 2002 corresponded to a drought year as indicated by the observation in the lower Hunter Valley of such species as Brown Songlark (*Cincloramphus cruralis*), Singing Bushlark (*Mirafra javanica*), Masked and White-browed Woodswallows (*Artamus personatus* and *Artamus superciliosus*) and unprecedented numbers of Sharp-tailed Sandpipers (*Calidris acuminata*), far exceeding the normal summer population of this species (Stuart 2002). Sharp-tailed Sandpipers and some other species of waders are recorded as prey for the Black Falcon (Marchant & Higgins 1993).

During the period 2002 to 2005, Black Falcons have been recorded in every month within a 20 km radius of MWTW. Our first record of the Black Falcon at the MWTW was on 16 June 2002 when two birds flew fast and low through a copse of trees near the entrance. Black Falcons were also seen in the nearby Bolwarra/Morpeth area on three occasions between 1 and 5 October 2002 (Stuart 2002). A number of sightings in an extended area of 10 km radius around Morpeth, including Largs and Tenambit, led to speculation that the birds could be breeding in the area. Additional support for this hypothesis was provided during 2004 by the observation of three Black Falcons at MWTW on 22 July and sightings of single birds on 22 June and 18 August.

Black Falcons continued to be observed from an increasingly large number of locations in the Lower Hunter including Lake Macquarie, Ash Island, Hexham Swamp, Gillieston Heights and Woodville. The frequent observation of Black Falcons at Ash Island, a habitat comprising tidal lagoons with mangroves used by waders, is interesting because the distribution of this species is primarily inland. Numerous sightings of one or two Black Falcons were made during 2003 and 2004 at Ash Island which has been surveyed monthly since 2000 by Hunter Bird Observers Club members and is frequently visited and sightings recorded at other times. The Black Falcon was first recorded there on 6 February 2003, pursuing a large flock of Sharp-tailed Sandpipers which were feeding in a shallow lagoon known as Swan Pond. It is suggested that the species did not occur regularly at Ash Island before 2003. As the falcons were first noted at MWTW and Ash Island within an eight month period it is probable that the same birds are involved. It is interesting that at both locations the falcons have been observed chasing flocks of Sharp-tailed Sandpipers, which also occur in large numbers on the Hexham Swamp when flooded paddocks provide suitable feeding habitat.

Compelling evidence of breeding was obtained at MWTW during 2005. On 24 September two Black Falcons were seen pursuing a flock of about ten feral pigeons. One pigeon became isolated and was taken by a falcon which immediately transferred the prey to its mate. This bird flew off in the direction of the MWTW entrance. An unsuccessful search was made for a nest in trees near an adjacent farm. On 10 November, three Black Falcons were observed at extremely close range flying around a clump of shrubs, three metres in height, growing on the ridge of a dyke separating a holding pond from an area of flooded paddock. Several birds in the area including Australian Magpie (*Gymnorhina tibicen)* and Magpie-lark (*Grallina cyanoleuca*) were extremely agitated. One of the three falcons flew from the end of the shrubs with prey held in its talons. This bird, which had worn tail feathers, circled back out of sight behind the shrubs and then re-emerged into view and perched on a fence post about 20m from the shrubs. After several minutes the other two falcons, both of which had much blacker plumage and no tail feather wear, flew into sight heading towards the perched bird. All three falcons then flew off towards the MWTW entrance. Subsequently a fourth Black Falcon flew from a tree in the next paddock and followed the other three birds. Inspection of the end shrub revealed an empty Magpie-lark nest with an adult Magpie-lark close by. It is thought that, obscured from our view, the bird with the worn tail feathers had predated this nest and then dropped the prey for the young.

The Black Falcon usually breeds in pairs between June and December with most records in November (Marchant & Higgins 1993 and Barrett *et al.* 2003). There is little information on the dispersal of juveniles after breeding (Marchant & Higgins 1993). In our opinion, the observations in 2005 provide evidence that Black Falcons bred successfully in the vicinity of MWTW, despite our failure to find the nest site. Published details of hunting and parental care duties suggest that the feral pigeon was taken by the male and transferred to the female to take to the nestlings. The separation of a single pigeon from a compact flock before capture is consistent with published descriptions of the hunting strategy of the Black Falcon (Debus *et al*. 2005). The subsequent observation of two birds in November with diagnostic juvenile plumage, namely, dark coloration and absence of feather wear (Marchant & Higgins 1993 and Debus 2001), suggests the nestlings had successfully fledged. The duller plumaged bird with the worn tail feathers which had been seen carrying food apparently given to the two juveniles was assumed to be the female. In this species it is the female which does most of the incubation, brooding and post-fledging duties (Marchant & Higgins 1993). Assuming that the incubation, nestling and post-fledging periods are 5, 6 and 3 weeks respectively (Debus *et al.* 2005) it is suggested that incubation commenced about the beginning of August.

Further sightings of Black Falcons were made in the vicinity of MWTW during 2006 and again there were indications of breeding activity: a single bird in January, two in June, four in October and one in November. In June the pair of Black Falcons was seen in the timbered paddocks adjacent to the dyke. They vigorously attacked a Whistling Kite (*Haliastur sphenurus*), almost forcing it to the ground and then persistently attacked a White-bellied Sea-Eagle (*Haliaeetus leucogaster*). In October the four birds were roosting on the ground and preening on the same area of the dyke where juvenile birds were seen in 2005. Plumage differences indicated that two of the 2006 birds were immature. We are uncertain whether this indicates a second successful breeding episode.

We conclude that the present status of the Black Falcon in the Lower Hunter Valley is that of rare breeding resident based on the frequent sightings since 2002 and the breeding evidence in 2005.

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Varied Sittella involved in distraction displays during June

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While conducting one of my regular surveys along Fitness's Road in the hills above Martins Creek near Paterson (32° 34´S 151° 39´E) on 14 June 2004 I encountered a flock of about eight Varied Sittellas *Daphoenositta chrysoptera*. I was standing on the road trying to call up some thornbills when the sittellas came down and hovered round me like butterflies with their wings spread displaying their broad orange wing stripe. This behaviour persisted for about a minute. I have seen this behaviour on one previous occasion several years ago on Black Rock Road approximately 1 km downhill from Fitness's Road.

I then descended about 30 metres downhill into a wooded area and again attempted to call up thornbills. To my surprise I was again surrounded by the flock of sittellas. One bird alighted within 0.5 metres of my head at eye level. I then realised that the entire flock had settled on the bare limbs of shrubs within 2 metres of me and at heights ranging from 1.5 to 3 metres from the ground. Each bird was vertically orientated with its head pointed downwards and its wings fully extended exposing the orange wing stripe to maximum advantage. Again the display persisted for at least a minute in response to "pishing" noises.

No sittellas were seen during a subsequent visit to the area on 21 June 2004.

I subsequently also observed a flock of Varied Sittella exhibiting similar behaviour near Mt Molloy in North Queensland (16° 40´S 145° 20´E) in August 2004. On this basis the behaviour appears to be normal for the species.

Distraction displays of this type have been described in conjunction with breeding activity (Higgins *et al.* 2002). However in NSW the usual breeding period of the Varied Sittella is from August to February (Higgins *et al.* 2002) with the earliest seasonal breeding records in the Hunter Region involving records of nest building on 7 August 1999 and 21 August 2000 and a bird on a nest on 13 August 2005 (Stuart 2000, 2001 and 2006). On this basis the above observation may indicate that sittellas breed during early winter under exceptional circumstances. For instance during May and the first half of June of 2004 the Hunter Region experienced unusually warm and dry conditions. Alternatively it is possible that sittellas exhibit distraction displays in response to perceived threats outside the breeding season.

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The *Whistler* – Instructions to Authors

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

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

The Publications Sub-committee requests that authors consider the appropriateness of their study to this publication. The publication is suitable for studies geographically limited to the Hunter Region and papers attempting to address data and issues of a broader nature should be directed to other journals, such as Corella, Australian Field Ornithology and Emu. Contributed papers should include analyses of the results of detailed ecological or behavioural studies or syntheses of the results of bird monitoring studies and/or comprehensive annotated species lists of important bird areas and habitats. These data would then be available for reference or further analysis in the many important issues of bird conservation in the Hunter Region. Communication of short notes on significant bird behaviour is also encouraged as a contribution to extending knowledge of bird habits and habitat requirements generally. Reviews of bird books that members have enjoyed or disliked are also being solicited to provide a guide for other readers in the region on their usefulness regionally and further afield.

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- Manuscripts can be submitted electronically; please attach your manuscript to an email as a Microsoft Word document; if submitting hardcopy by mail, please send 3 copies.
- Manuscripts should be formatted as per the instructions below; a template is available in electronic form by email or on CD-ROM.
- Up to 20 pages in length and of factual style.
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- Introduction/Background introduces the aims of and rationale for the study and cites other similar work that stimulated initiation of or is relevant for comparison with the study.
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- Results of the data analyses include description and/or analysis of data highlighting trends in the results, divided into subsections if more than one body of data is presented; use of photos, drawings, graphs and tables to illustrate these is encouraged.
- Discussion and Conclusions should indicate the significance of the results locally and regionally and reflection with national and international work is optional, as is the discussion of possible alternative conclusions and caveats with the study; suggestions for future extension of the work are encouraged.
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- References should be cited within the text of the article with the last names of the authors and the year of publication in parenthesis unless there are more than two authors, in which case the first author's last name can be used followed by '*et al.*' for the others. References should be listed at the end of the text after any Acknowledgements and before Appendices and Annotated Lists and should be formatted as per the instructions below.

Short Notes

- Up to 4 pages of descriptive or prosaic style.
- Introduce the species using english and scientific names and provide an adequate

description of the location of observations, a rationale for documenting the observations, an entertaining and cogent description of observations; relevance to similar observations should be cited with references if appropriate.

- References should be cited and listed as for contributed papers.

Book Reviews

- Approximately 2 pages of critical assessment and/or appreciation.
- Introduce topics and aims of the book as you understand them, analyse thoroughness and rigour of content (chapter by chapter or topic by topic), and conclude with comments on the effectiveness and originality of book in meeting its aims, particularly for birdwatchers in Hunter Region area if appropriate.
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Formatting Instructions

Authors are asked to format their manuscripts as follows:

1. A4 size page, portrait layout except for large tables or figures;
2. Two columns of printing per page, left and right justified, separated by 1 cm space;
3. Margins of 2 cm top, bottom, left and right;
4. Title in bold Arial font, 16 pt size, centred;
5. Authors names in Arial font, 12 pt size, centred;
6. Affiliations of authors in Arial font, 12 pt size, centred;
7. Summary to begin with paper citation, as per reference format below, one column of printing, 3cm margins left and right, Times New Roman font, 10 pt size;
8. Running header in Times New Roman font, 8 pt size: even number pages with “page number, journal name” on top line and short title to 30 characters on second line, left justified, and odd pages with “journal name, page number” on top line and authors’ last names divided by commas on second line, right justified
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11. First line of each paragraph should not be indented and one line should be left between paragraphs;
12. Typescript should be Times New Roman, 11 pt, except methods and acknowledgements which are 10 pt;
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Reference Format

Journal articles:

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