Appendix B

Shorebird Monitoring Final Report, Avifauna Research & Services, July 2007

Draft Final Report to:

URS

Botany Groundwater Cleanup Project

Bird Monitoring Program

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Avifauna
Research & Services Pty. Ltd.

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Summary

Shorebirds were monitored at Penrhyn Estuary, Botany Bay, from September 2005 until 30 June 2007 as part of a monitoring program carried out by Orica to measure any impacts caused by the removal of groundwater draining into the Bay on the environment.

All birds associated with the Estuary were monitored on a weekly basis at both high tide, when shorebirds were roosting and at low tide when shorebirds were feeding on exposed mudflats. As part of the study the health of migratory shorebirds was assessed using the birds' physical profile and an indicator. As well as a visual assessment in the field, using high-powered optics. The birds were periodically photographed using high resolution digital photography for later examination on a computer screen.

Some migratory shorebirds were late leaving on migration the last season of this study (April/ May 2007) which resulted in larger numbers of birds, such as Bar-tailed Godwit, staying longer. More birds were observed in full breeding plumage (normally acquired along the migration routes) than in previous years. However all birds appeared to be in good physical condition, with fat deposits approaching those of pre-migratory birds, and had presumably delayed their departures due to unfavourable weather conditions.

While numbers of birds fluctuated during the seasons there appears to be no evidence of any declines beyond those across other sites in Botany Bay or state or Australia-wide trends to indicate any impacts of the removal of groundwater from the area by Orica (see species acconts). In fact there were notable increases of maximum counts over the previous year of Sharp-tailed Sandpiper, Red-necked Stint and Red-capped Plover. Little Terns nested at the mouth of the estuary, successfully rearing young for the first time for many years. However this seems to have been due to their regular nesting site on the south side of the Botany Bay being unsuitable this year rather than any improvement of habitat at Penrhyn Estuary.

A move in preference of feeding habitat from the upper reaches to the outer reaches of the Estuary by Bar-tailed Godwits may be an indicator of changes to the distribution of food resources for this species.

1.0 Introduction

The Botany Groundwater Cleanup Project undertaken by Orica resulted in large volumes of groundwater being prevented from entering tidal flats in the vicinity of Penrhyn Estuary and the eastern end of Foreshore Beach. Penrhyn Estuary provides important feeding and roosting areas for a large number of waterbirds, especially migratory shorebirds that depend on the intertidal areas for foraging. Migratory species are protected under international agreements and the Environmental Protection and Biodiversity Conservation Act (EPBC Act), while some are threatened species and protected under the Threatened Species Conservation Act (TSC Act). The effected area is the last habitat remaining on the north side of the Bay for these shorebirds and is important for their long-term survival in the Sydney area.

As part of the project Orica are committed to monitoring the effects of the groundwater removal on the environment, including the fauna and flora of Penrhyn Estuary and Foreshore Beach. URS have been commissioned to undertake the relevant studies and have contracted Avifauna Research and Services Pty Ltd to undertake the study of potential impact on waterbirds, including migratory shorebirds protected under international agreements and the EPBC Act, as well as threatened species listed under the TSC Act.

The removal of groundwater from the vicinity of Penrhyn Estuary may have had an impact on invertebrates associated with the intertidal mudflats which are essential for the survival of migratory birds that feed on these animals. Changes to the groundwater flows are likely to change species composition and density of invertebrates over time and in turn have some impact on shorebirds. These changes can be measured with regular sampling of invertebrates at the study site once or twice each year. However the effect on the shorebirds may be more subtle needing an assessment of any changes to the population at the site and a measure of the health of the birds. Changes in the numbers and species composition of shorebirds at the sites can be made by counting the birds at the site during feeding and roosting on a regular basis. The health and condition of the shorebirds can either be carried out by catching the birds and measuring certain basic metabolic parameters (e.g. blood plasma triglyceride levels) to determine habitat quality (whether the birds are gaining or losing weight in the Estuary and/or using high resolution digital photography in the field to assess body mass. These techniques require a high level of expertise by the researcher and have been developed in recent years based on research in Botany Bay and other parts of the world, for example Egeler et al (2003), Williams et al (1999) and Wiersma and Piersma (1995).

Counting birds at the study site can be carried out relatively easily by a skilled observer who is able to identify all species of shorebirds and other waterbirds that are likely to occur at the site. Changes in numbers of each species at Penrhyn Estuary tend to change depending on the season as migratory species move through the area during migration. Counts should therefore be carried out at least weekly at low and high tide to measure the number shorebirds feeding at the site as well as numbers of birds roosting there. The difference in numbers will determine whether birds are moving into or out of the site during the various stages of the tide.

2.0 Methods

Shorebirds were monitored at Penrhyn Estuary from mid-September 2005 to the end of June 2007 once every week. Counts were carried out at high tide and low tide, usually on the same day except during the winter months if both tides did not occur during daylight hours. Counts at high tide were timed to enable counts of all shorebirds that were likely to be using the estuary as feeding habitat, on the assumption that shorebirds generally roost at the most convenient roost site to their foraging area. Counts were carried out at low tide to determine which parts of the estuary were used as feeding habitat and to determine whether these patterns changed over time. Low tide counts also confirmed whether all birds feeding at the estuary roosted there or moved elsewhere.

Birds were counted and identified using high quality optical 10x50 binoculars and/or 25x77 spotting scope. Data was collected in a field note book then entered onto an Excel spreadsheet for storage and analysis. The Estuary was divided into six sections and five sub-sections for the purpose of assessing which parts of the estuary were used over time. These were:

Section 1 Upper estuary
- Subsection 1a Springvale Creek
- Subsection 1b Floodvale Creek

Section 2 outer estuary
- Subsection 2a northern shore
- Subsection 2b southern shore

Section 3 Port Spit

Section 4 Port Beach

Section 5 Jetty Beach
- Subsection 5a Old Government Jetty

Section 6 Foreshore Beach

Section 6 provided a narrow strip of feeding habitat during very low spring low tides but seldom had shorebirds due to the high incidence of disturbance from people and unleashed dogs and has therefore not been included in this study.

Of the 24 species of shorebirds observed at the Estuary during the study seven species were considered key species for monitoring (see Table 1). The numbers of each of these species at the Estuary represented a major proportion of the Botany Bay populations which rely on the Estuary as feeding as well as roosting habitat.

A baseline study was not carried out prior to this project due to the fact that groundwater extraction had commenced at the beginning of the study. However data collected by the NSW Wader Study Group since 2001 includes monthly high tide counts of shorebirds at Penrhyn Estuary, as well as other sites in Botany Bay and at Boat Harbour (on the ocean side of the Kurnell Peninsula). These data were used to compare counts of shorebirds during this study through the year.

Count data was stored as Excel files and is included in the appendix A of this report.

3.0 Site descriptions

Section 1 Upper Estuary

The upper estuary at Penrhyn Estuary consists of silts deposited by Floodvale and Springvale Creeks since the formation of the estuary in the 1970s (Figure 1). The nature of this section of the estuary appeared to provide the highest density of invertebrates (despite reported high levels of industrial pollutants) judging by the numbers of birds concentrating in the area during ebbing and low tide periods. Although shorebirds foraged over the whole of this section micro-channelling in the mudflats appeared to provide a preferred habitat, especially for Bar-tailed Godwits.

Shorebirds tended to follow the receding tide to feed in invertebrates exposed, or in very shallow water, making them available to foraging birds. At low tide Bar-tailed Godwits tended to forage in shallow water at the lowest point of the upper estuary until the tide began to flow. Birds then moved back up the flats with the tide or fed in the micro-channels.

Section 1a Springvale Creek

Springvale Creek provided feeding habitat in the form of tidal mud and sand flats that stretch 50 to 100 metres upstream from the mouth of the creek.

Although a substantial area of saltmarsh provided roosting habitat in the past, the only roost site that remained during the study was a steep sand dune on the northern shore of the creek. However the sand dune was abandoned at times when the dune became too steep due to erosion by the creek. When the dune was not suitable for roosting birds move to the remaining saltmarsh between Springvale and Floodvale Creeks or to the Port Spit.

Sharp-tailed Sandpiper, Pacific Golden Plover and small numbers of Bar-tailed Godwit feed and roost at Springvale Creek as well as a single Common Sandpiper and occasional Black-fronted Dotterel.

Section 1b Floodvale Creek.

The mouth of Floodvale Creek provides a small area of mudflats frequently used by Sharp-tailed Sandpiper and small number of other shorebirds.

Section 2 Outer Estuary

During neap tides the outer estuary (the area of both sides of the estuary between the old and new boat ramps) provides little in the way of intertidal feeding habitat due to the steepness of the sandy shores. However during spring low tides larger areas of exposed sand flats and shallows provide feeding habitat for small numbers of Bar-tailed Godwits, stints and plovers.

Section 2a (the northern shores of the Outer Estuary) provides an important roost site, especially if Port Spit is disturbed by anglers or unleashed dogs, as well as marginal feeding habitat. **Section 2b** is used as a roost site, particularly during neap tides. However the narrow stretch of beach that is available during larger tides is too close to tall vegetation and is generally not used as a high tide roost.

Section 3 – Port Spit

Port Spit consists of a long sandy spit with a high density of shells of deceased bivalves. At low tide a relatively wide sandflat is exposed, however the area is subjected to shifting sands changing the profile of the site on a regular basis.

Port Spit has been the most important roost site for shorebirds and seabirds in the past and has been used by the majority of shorebirds frequenting the estuary. However erosion of the site over the past two years has reduced the area available, especially during spring high tides. Bar-tailed Godwits disturbed from this

site tend to use sub site 2a or 2b. However these sites are not ideal because the birds have to move close to vegetation spending much of their time alert to potential unseen dangers. Other shorebirds either use section 2a or at the base of the sand dune at the mouth of Springvale Creek when it is suitable.

Feeding habitat in this section is not ideal for Bar-tailed Godwits due to shifting sands which do not allow colonisation of bivalves and polychaete worms favoured by Bar-tailed Godwits. Double-banded and Red-capped Plovers were often observed foraging in the section but prey were too small to be identified.

Section 4 – Port Beach

The area defined as Port Beach in this study is the intertidal area between Brotherson Dock at Port Botany and Port Spit. It includes sand flats and large areas of stones/small rocks that appear to have been deposited at the site for some reason during the construction or maintenance of Port Botany. The rocks attract algal growth and provide habitat for invertebrates in the crevices between the stones. This section is used frequently by Red-necked Stints, Double-banded Plovers and Red-capped Plovers which forage among the stones. Few Bar-tailed Godwits were observed using this section and then usually in shallow water or on sandy patches rather than the stony terrain. One to three Grey-tailed Tattlers also forage in this section often probing under the small rocks for prey.

Section 5 - Jetty Beach

Jetty Beach provides a narrow margin of feeding habitat for shorebirds during spring low tides attracting very small numbers of shorebirds on the receding tide, usually a few more birds close to the old Government Jetty during spring low tides (up to ten birds).

Section 5a - Old Government Jetty

The remains of the Old Government Jetty provides roost sites for cormorants, gulls, pelicans and Grey-tailed Tattler. No other shorebirds use this site.

Section 6 - Foreshore Beach

Foreshore Beach provided a narrow strip of feeding habitat during very low spring low tides but seldom had shorebirds due to the high incidence of disturbance from people and unleashed dogs and has therefore not been included in this study.

Most of the shorebirds at Penrhyn Estuary forage on the intertidal mudflats in the upper estuary and follow the receding tide to feed on exposed but wet substrate or in shallow water before benthic invertebrates withdraw down into the muddy substrate. During spring low tides exposed habitat stretches along both shores of the estuary round to Brotherson Dock to the south and onto Wharf Beach to the north of the mouth of the Estuary,

Roost sites used vary depending on the height of the tide but include Port Spit, a sand spit in sub-section 2a and a sand dune at the mouth of Springvale Creek. Most species seem to prefer Port Spit as a roost site except Pacific Golden Plover that often use the sides of the dune at Springvale Creek.

Diurnal and nocturnal use of Penrhyn Estuary

Penrhyn estuary is used as foraging habitat at night as well as during the day but roosting birds abandon the site after dark to roost elsewhere until the tide recedes or until daylight. No nocturnal work has been carried out to determine where birds roost at night but it is thought that they may use flooded saltmarsh at Towra Point Nature Reserve or at Spit Island (Towra Point).

4.0 Species accounts

4.1 Bar-tailed Godwit

Since Penrhyn Estuary has been monitored as a sub-site of Botany Bay by researchers in 1992 the Bar-tailed Godwit has been recorded as the most numerous Arctic breeding migratory shorebird species at the Estuary throughout the year. It was therefore considered a key species for monitoring during this study. This species is found over much of Botany Bay and 0bservations carried out over the past 20 years (pers. obs) shows that the Bar-tailed Godwit adapts to a wider range of habitats than any of the other migratory species found in Botany Bay. The Botany Bay population as a whole has remained relatively stable over the past five years with maximum counts exceeding 400 birds, although there appears to be a slow gradual decline at Penrhyn Estuary (Figures 1a-c).

During this study numbers of Bar-tailed Godwits varied throughout the year reflecting the migratory nature of this species. Lowest numbers were during the winter months when all adults in breeding condition leave for their breeding grounds in Siberia and Alaska. Peak counts of up to 110 birds were somewhat lower than counts over the past six years but appeared to follow the trend over the six-year period.

Preferred feeding habitat during this study appeared to be the upper and outer reaches of the estuary during early part of the study, however, there appeared to be a swing in preference to the outer reaches during the latter part of the study so far (Figure 1d).

Figure 1a: Bar-tailed Godwits in Botany Bay as a whole (blue) and Penrhyn Estuary (red) (gaps = non data collected)

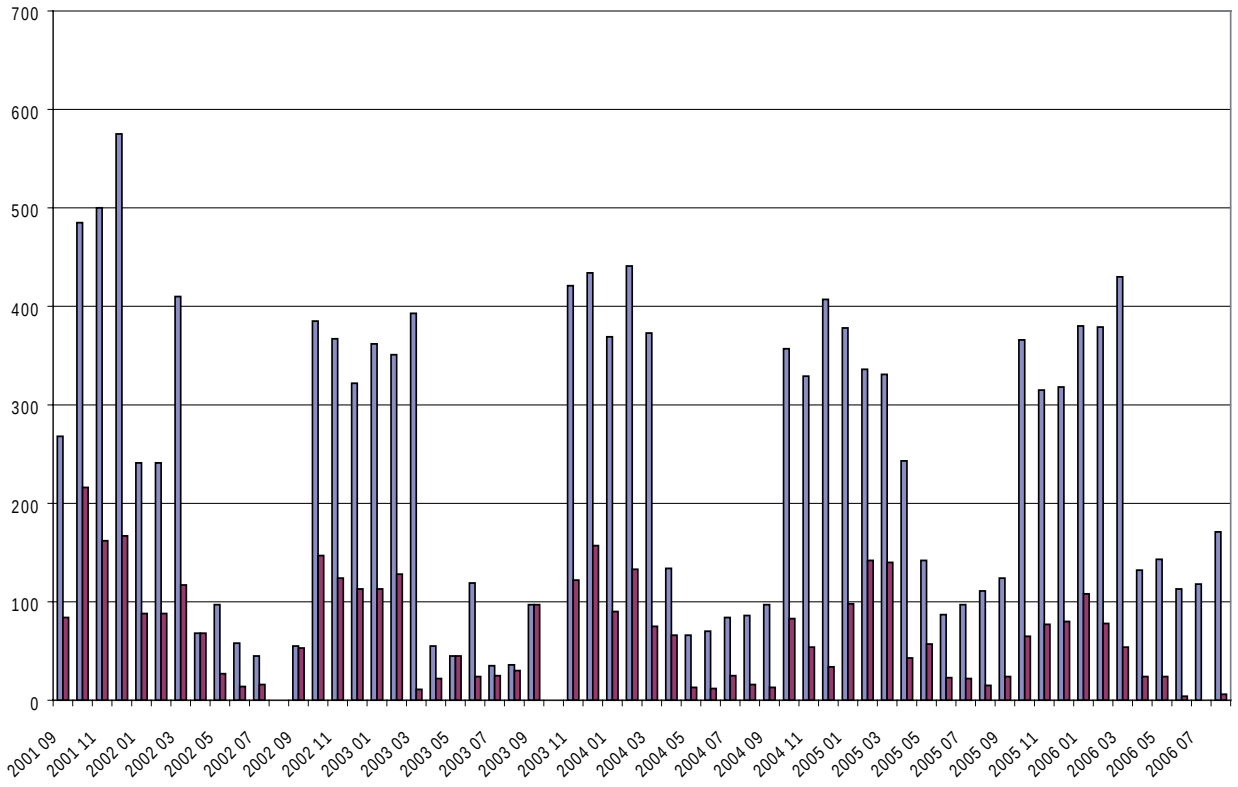


Figure 1b: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

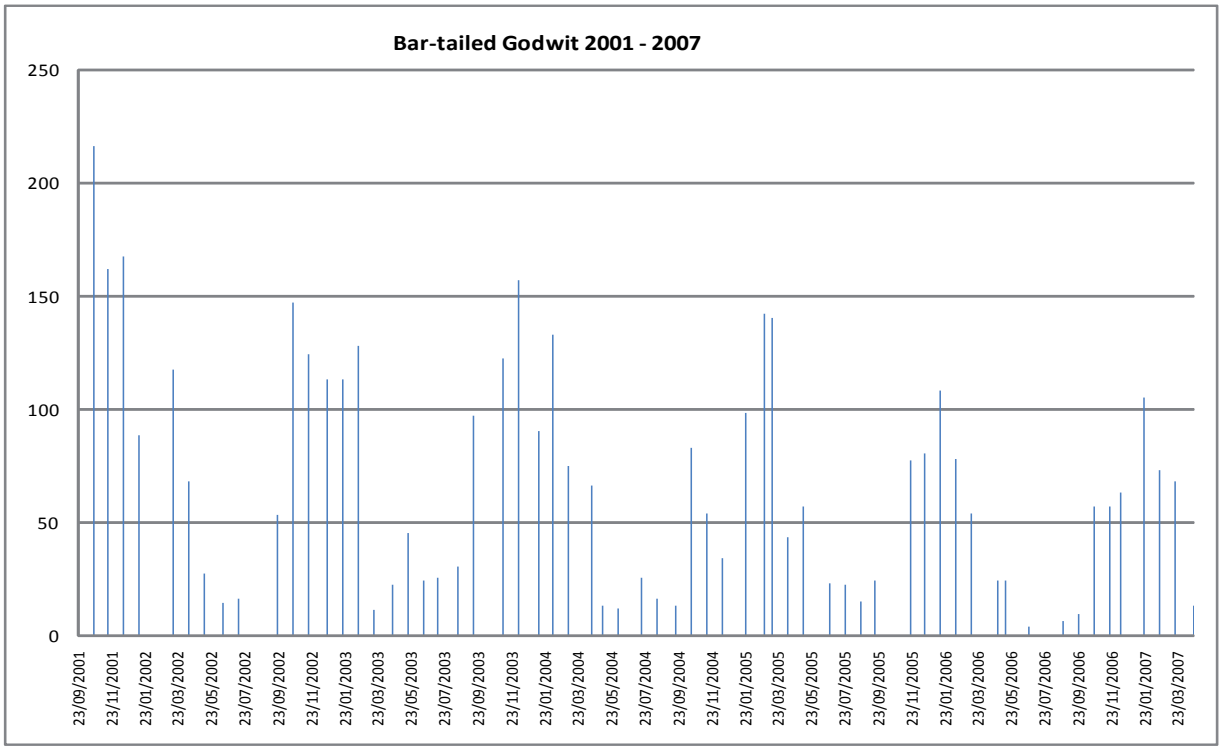


Figure 1c: Penrhyn Estuary counts during this study

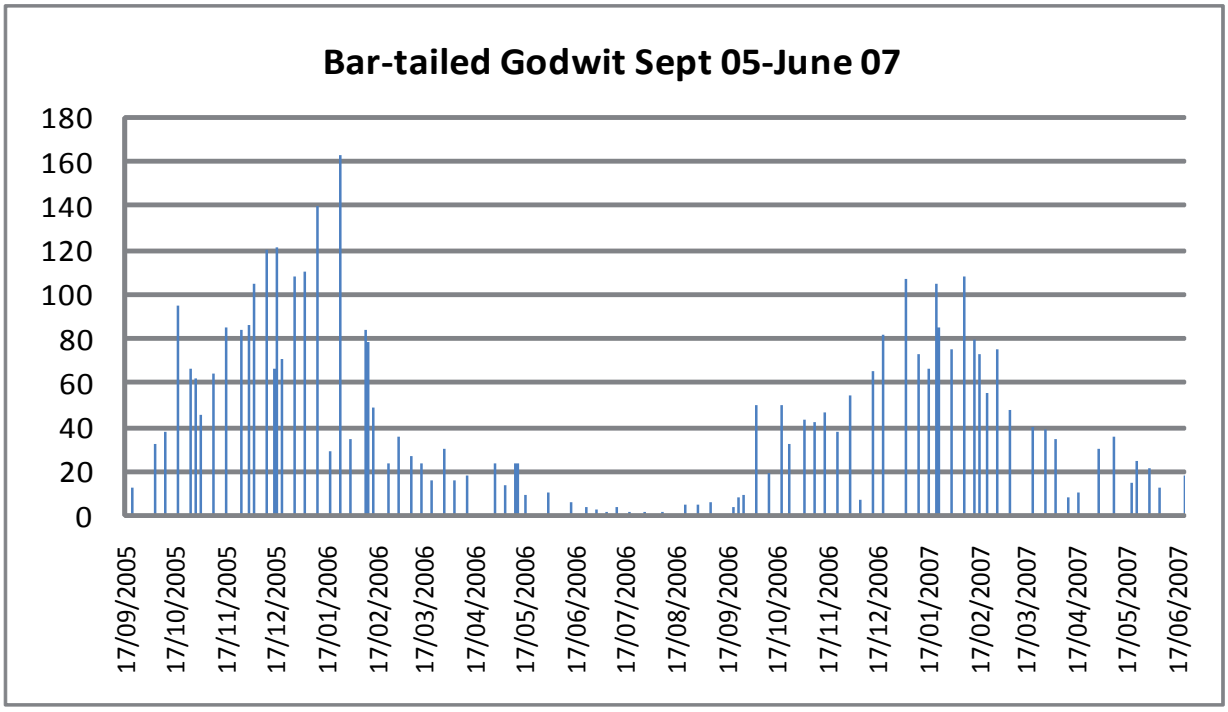
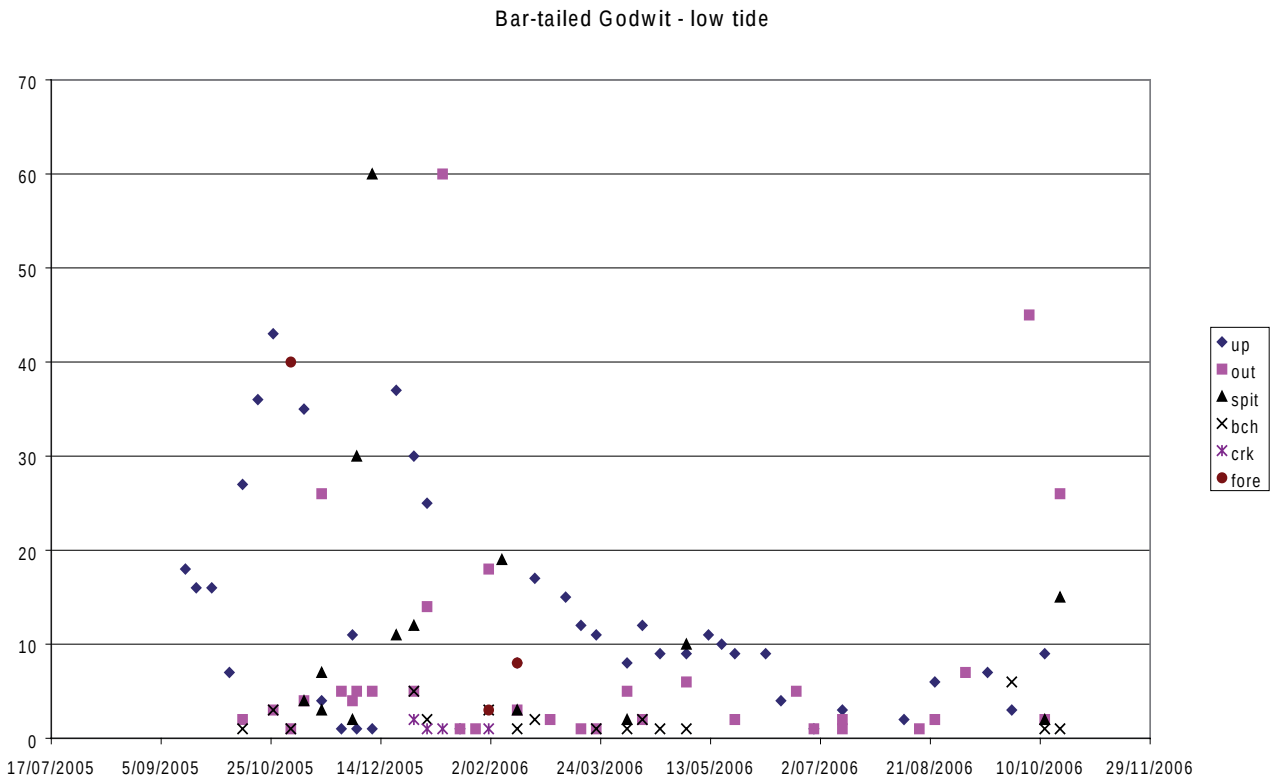


Figure 1d: Sections of Penrhyn Estuary used for foraging during this study



4.2 Red-necked Stint

The Red-necked Stint occurs at Penrhyn Estuary in Botany Bay and at Boat Harbour (on the ocean side of the Kurnell Peninsula). From banding and colour flagging records it is known that that the same birds return to the sites year after year and that there is some interchange between Penrhyn Estuary and Boat Harbour. However it has also been revealed that some birds pass through the area on their migration to Victoria, and most likely Tasmania and South Australia.

Data collected by the Australasian Wader Studies Group since 1977 indicates a decline in numbers in the Botany Bay region, although count data are sporadic, and no sub site counts are available. Counts since 2001

During this study numbers of Red-necked Stints varied throughout the year reflecting the migratory nature of this species. Lowest numbers were during the winter months when all adults in breeding condition leave for their breeding grounds in Siberia (Figure 2a). Peak counts of up to 45 birds at Penrhyn Estuary were consistent with mean counts over the past five years.

Unlike the Bar-tailed Godwit, Curlew Sandpiper and Pacific Golden Plover, which appeared to follow a downward trend at Penrhyn Estuary and in the Bay as a whole, the Red-necked Stint appeared to increase in numbers during the second year of this study.

Figure 2a: Red-necked Stint counts in Botany Bay (including Boat Harbour) (blue) and at Penrhyn Estuary between 2001 and 2006

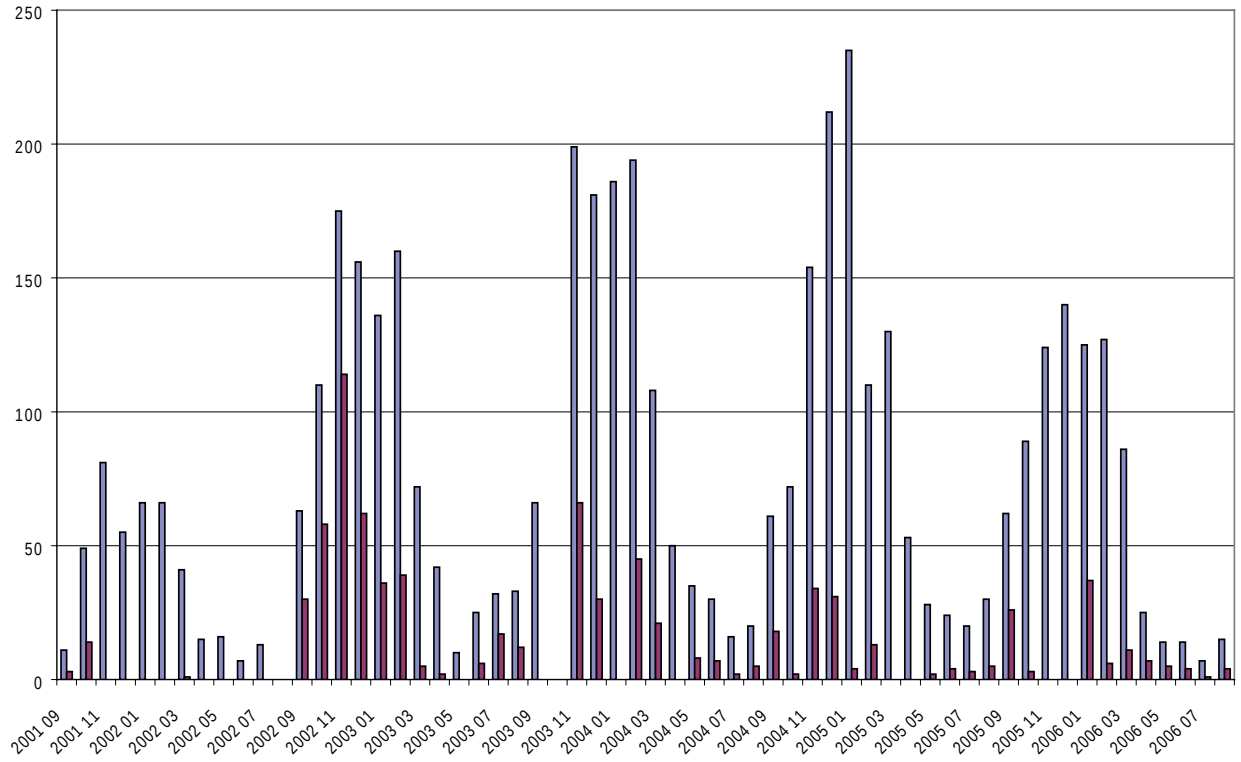


Figure 2b: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

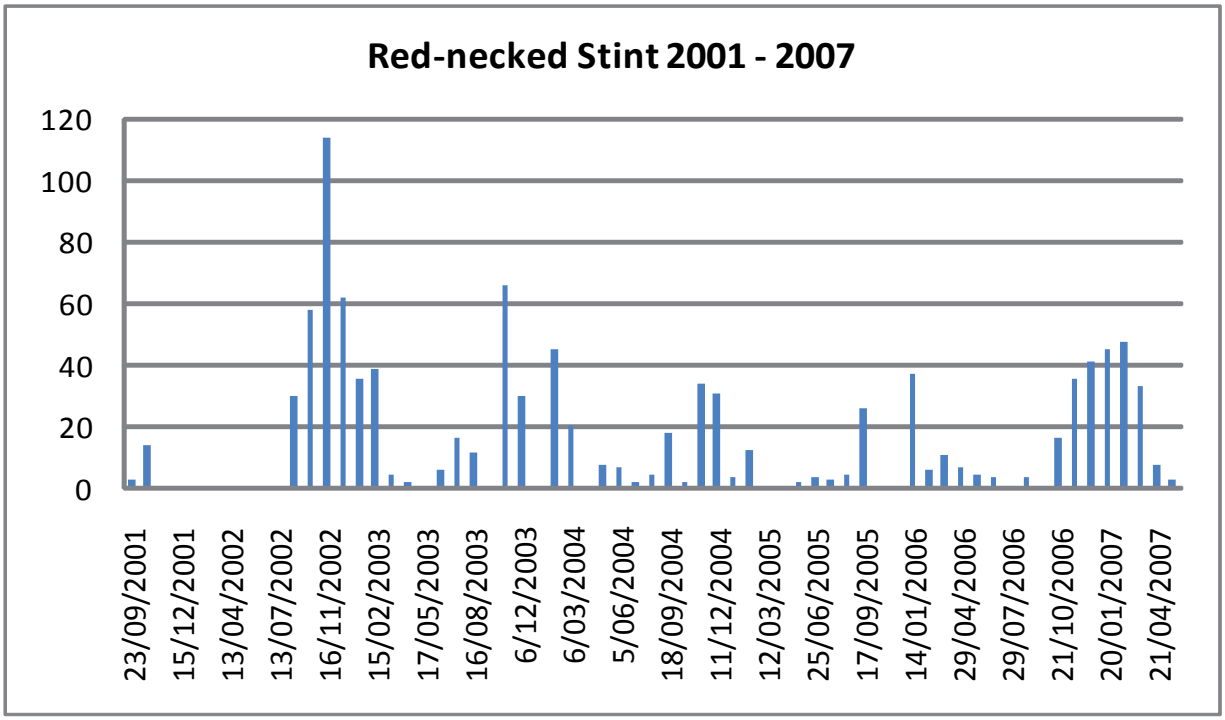
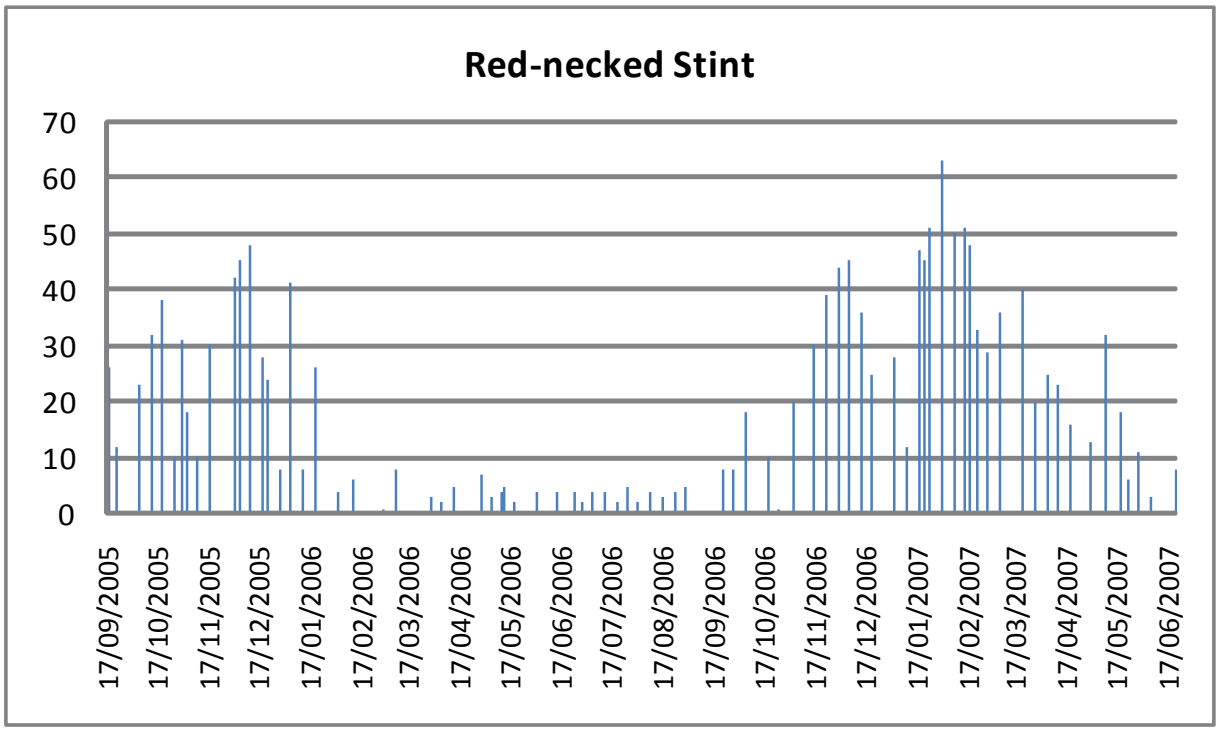


Figure 2c: Penrhyn Estuary counts during this study



4.3 Curlew Sandpiper

Most of the Curlew Sandpipers associated with Botany Bay occur at Penrhyn Estuary, as shown in Figure 3. This species has declined more than any other species in Botany Bay, however this decline is also evident throughout south east Australia for reasons not fully understood, but are considered to represent a broad population level decline (Watkins 2004). Small numbers of this species also occur in the Parramatta River estuary. The Hunter River estuary is the nearest site where, despite substantial decline in numbers during recent years, they still occur in relatively large numbers (200+).

Counts during this study revealed a similar to trend to the previous years (Figures 3, 3b and 3c). This species showed a strong preference for the upper reaches of the Estuary during the first part of the study.

Figure 3:

The majority of Curlew Sandpiper occur at Penrhyn Estuary (blue) when compared with the whole of Botany Bay, including Boat Harbour (red).

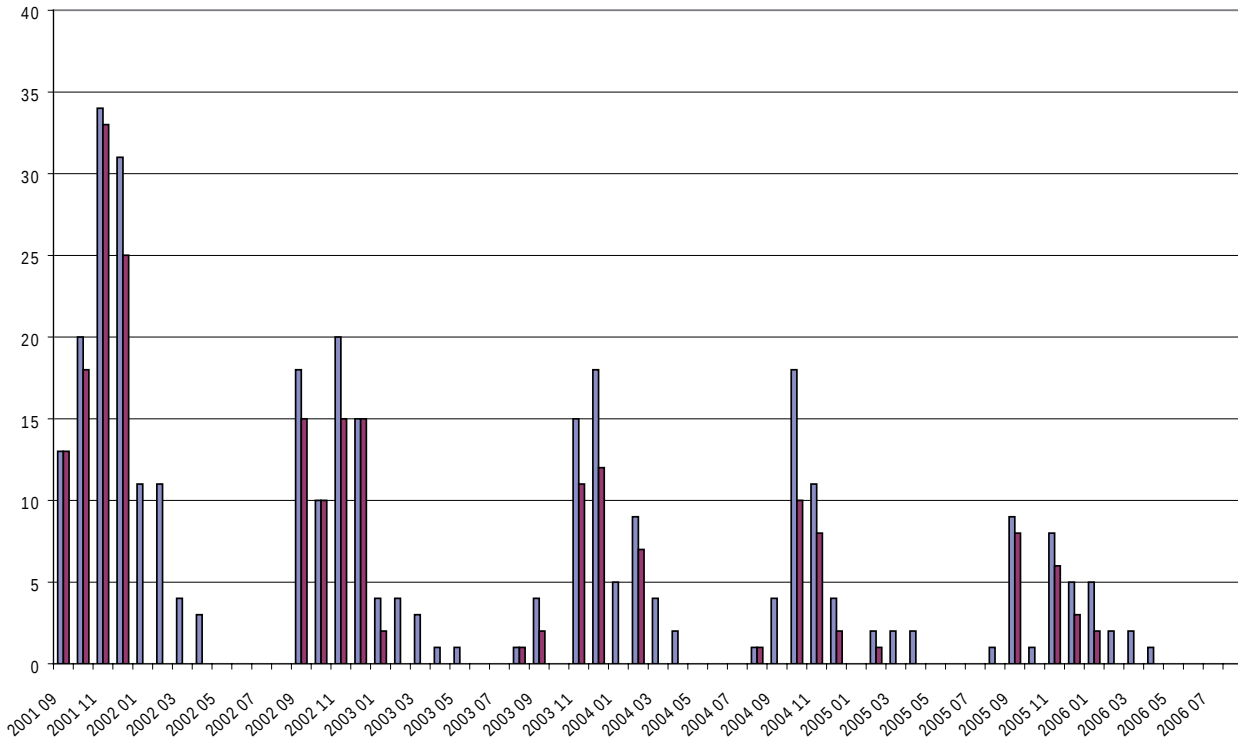


Figure 3b: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

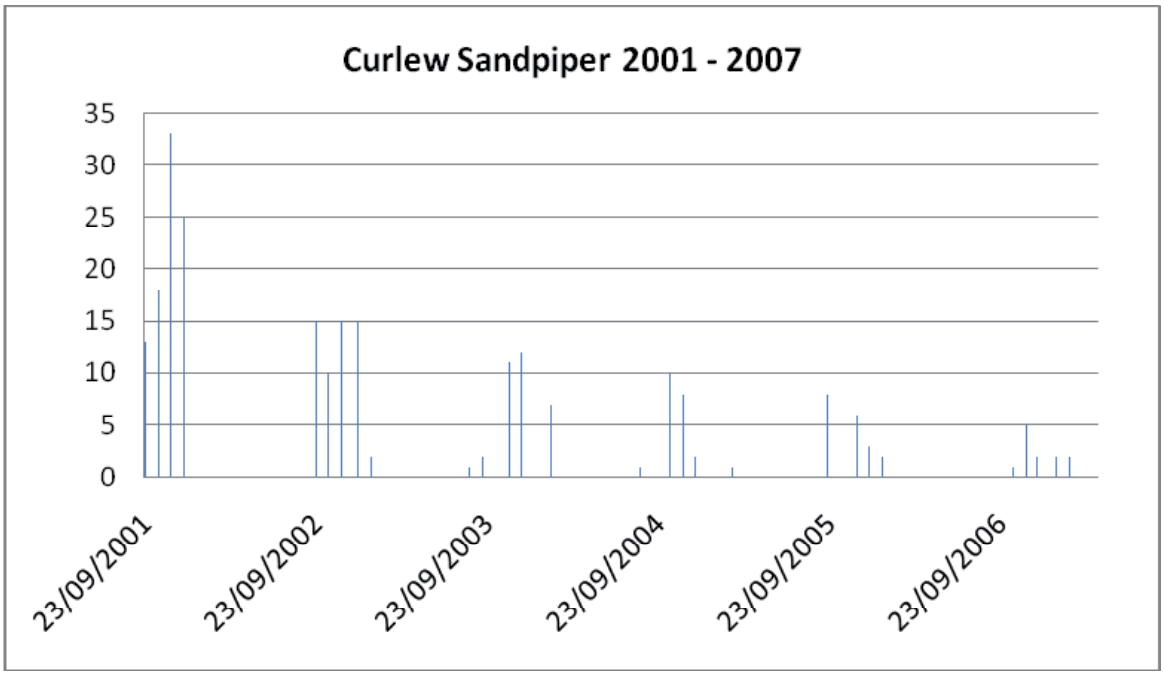
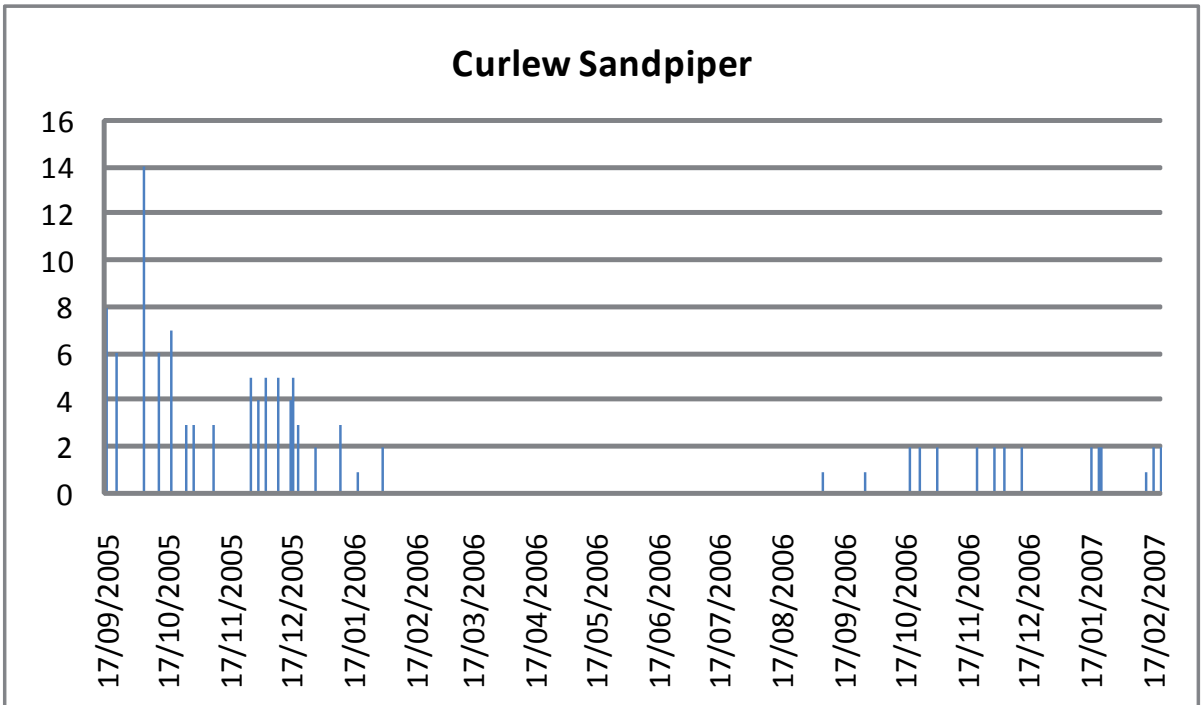


Figure 3c: Penrhyn Estuary counts during this study



4.4 Sharp-tailed Sandpiper

At Penrhyn Estuary most Sharp-tailed Sandpipers feed on the upper reaches of the Estuary and in the channel formed below the outlet of Springvale Drain, feeding on exposed mud and along the margins of saltmarsh. Numbers of Sharp-tailed Sandpiper increased in numbers during the second year of this study and were significantly higher than in previous years (Figures 4a and 4b).

This species depends on different habitat to other migratory shorebirds found at Penrhyn Estuary and may not reflect the condition of the open mudflats in the Estuary. Therefore it is not a species that provides a good indication of the effect of impacts in the estuary.

Figure 4a: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

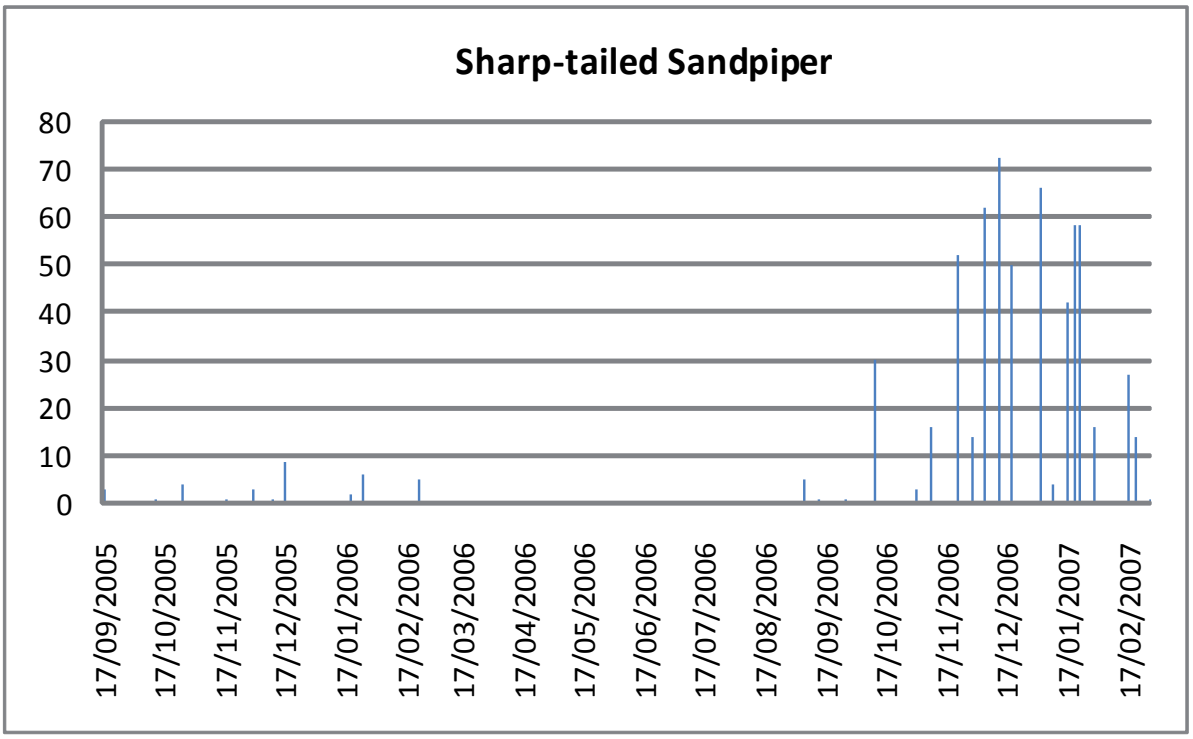
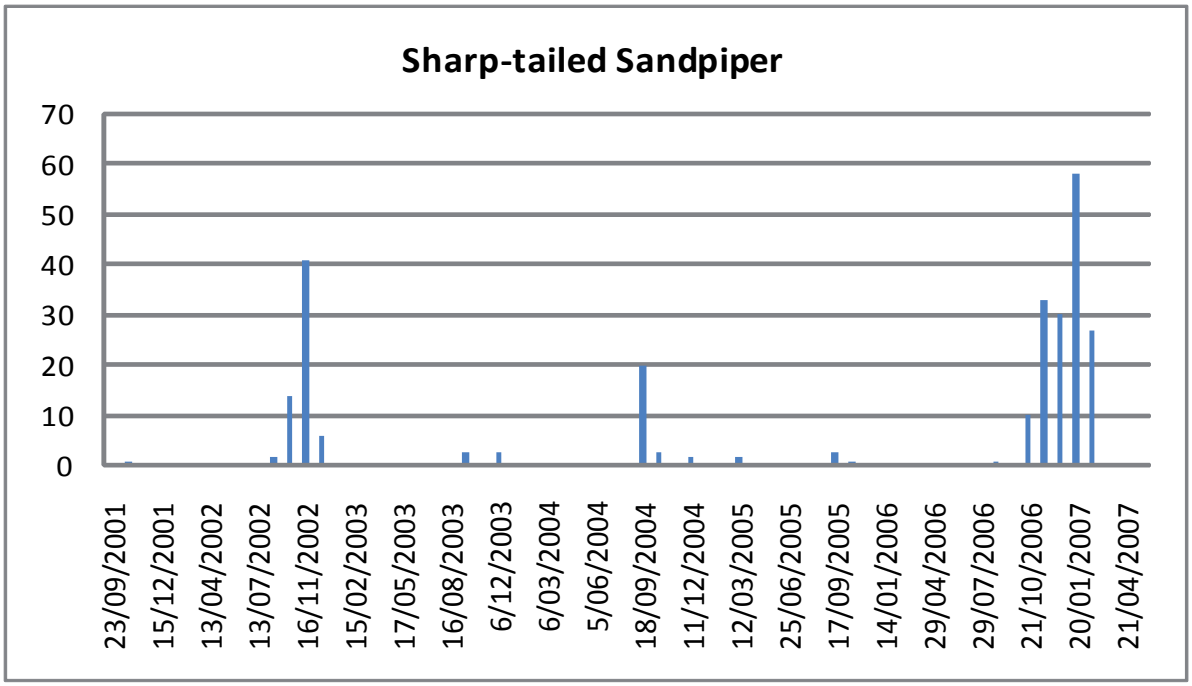


Figure 4b: Penrhyn Estuary counts during this study



4.5 Pacific Golden Plover

The Pacific Golden Plover has declined in numbers since the 1970s and 1980s when between 100 and 200 were observed in Botany Bay during the summer each year (Straw 1992) compared with counts of 25 to 30 in recent years. This species has been associated with Penrhyn Estuary since the construction of the Sydney Airport Parallel Runway resulted in the loss of the remaining habitat on the north side of the Botany Bay. This species feeds in the upper reaches of the Estuary during the day. No night time observations have been made to determine where this species feeds at night. The Pacific Golden Plovers found at Penrhyn Estuary, unlike other shorebirds, roost on the side of a very steep sand dune at the mouth of Springvale Creek or, if this site is unstable, join other shorebirds at sand spits in the Estuary.

Figure 5a: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

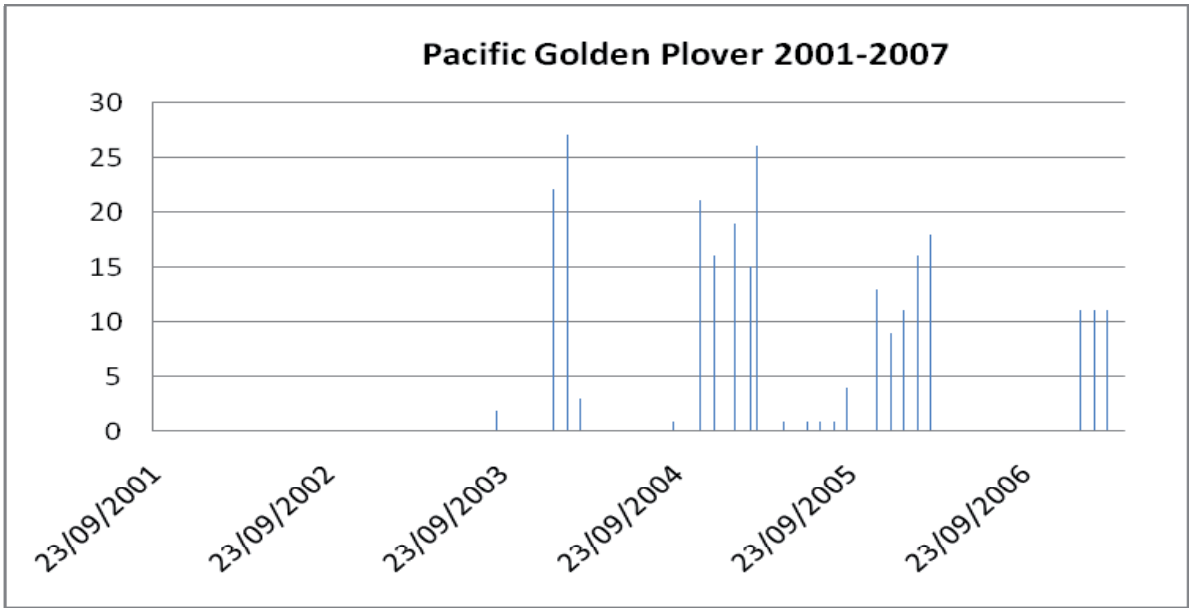
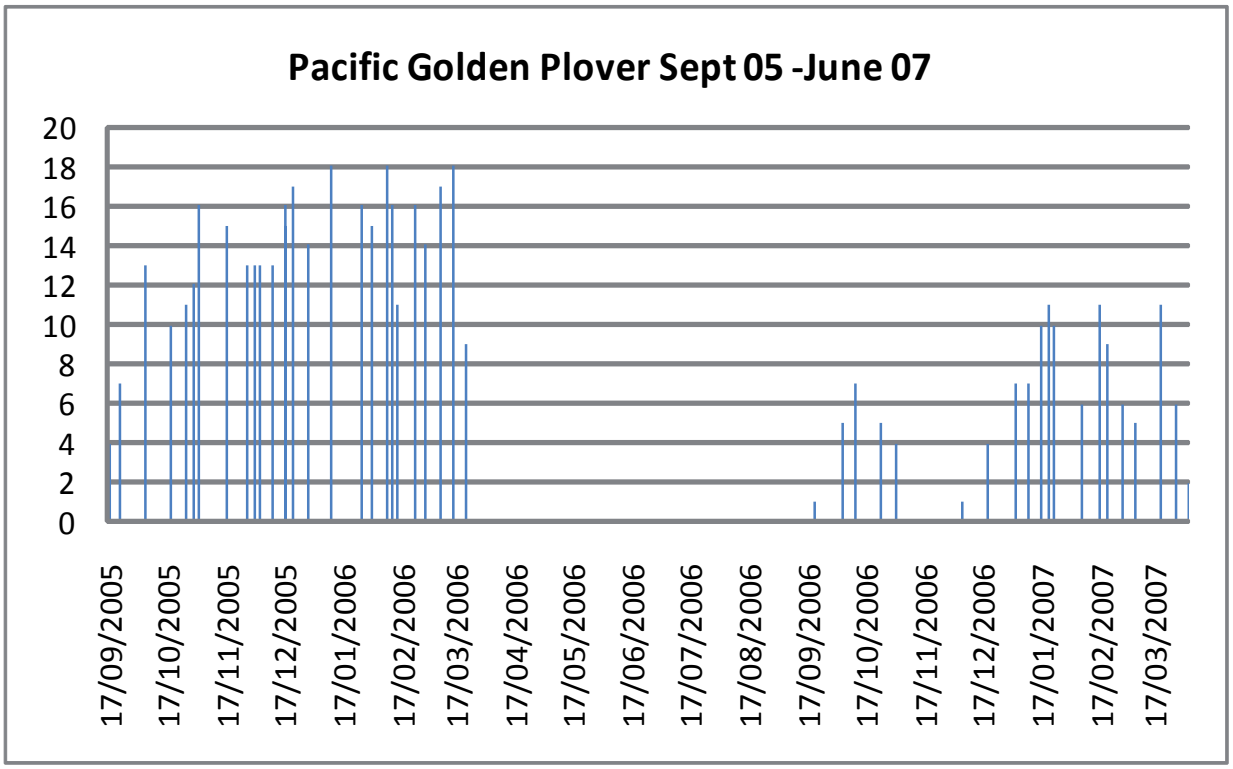


Figure 5b: Penrhyn Estuary counts during this study



4.6 Red Knot

The Red Knot is an interesting passage migrant that generally stays only a few days at Penrhyn Estuary before moving on to Victoria and New Zealand. Once in New Zealand a large proportion of these birds return to their breeding grounds direct and from then on only fly between the Arctic and New Zealand. Botany Bay has long been an important staging area for this species although numbers have been in decline for some years. Penrhyn Estuary is the most important site in the Bay for this species.

Up to 18 Red Knot were observed during the 2005/2006 but only seven birds were counted during 2006/2007. These counts may not reflect on the trends shown from the 2001-2007 data of the NSW WSG data because NSW WSG data was collected on a monthly basis and may have missed flocks moving through the Bay, whereas counts during this study were carried out on a weekly basis and more likely to coincide with birds moving through the Bay.

Figure 6a: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

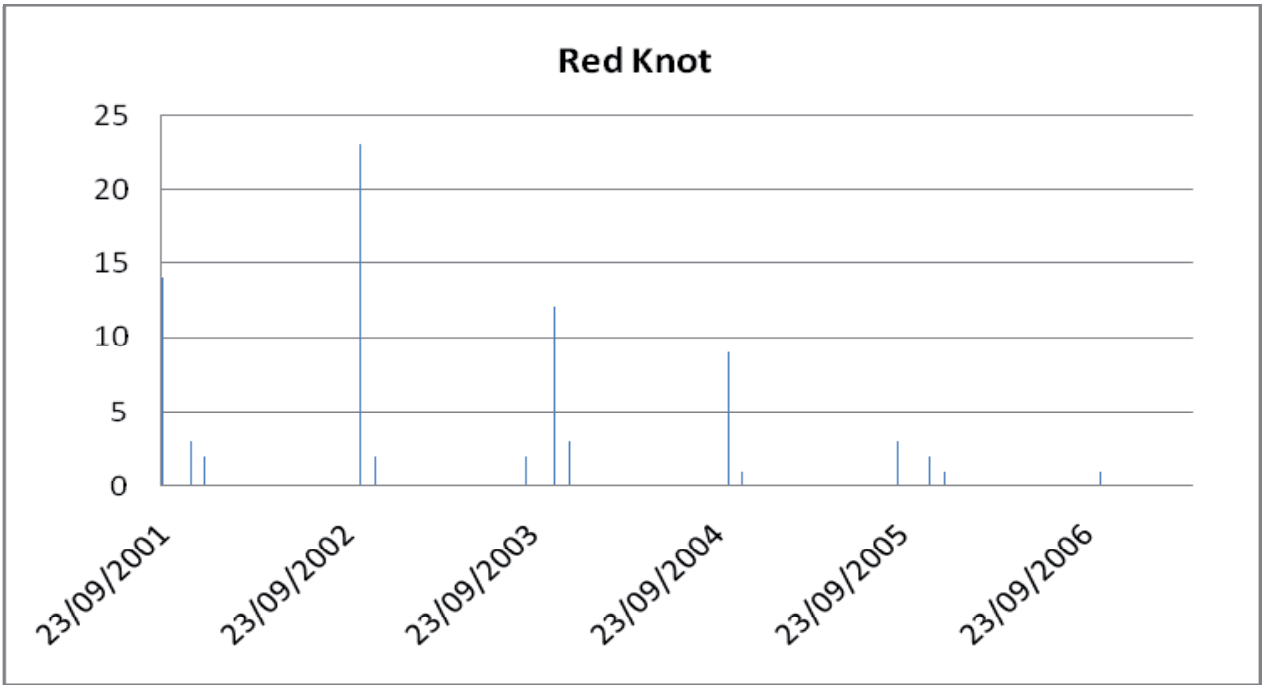
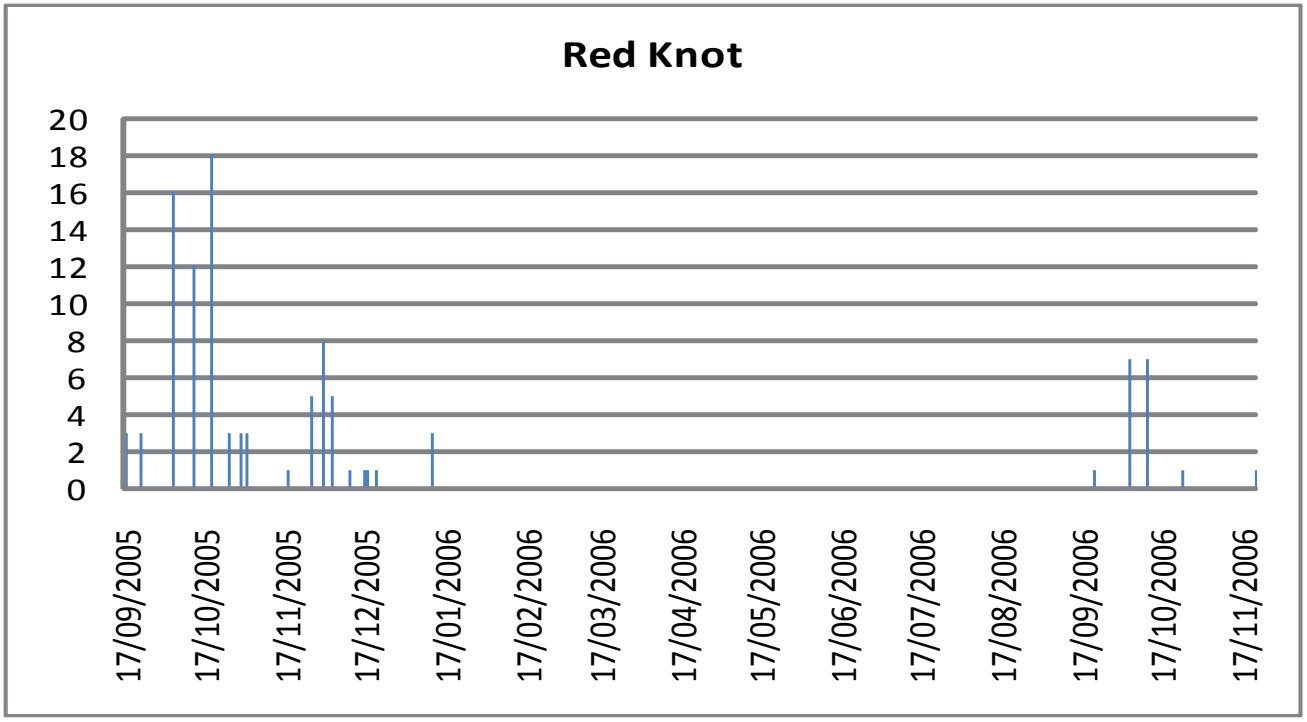


Figure 6b: Penrhyn Estuary counts during this study



4.7 Double-banded Plover

Counts by the NSW Wader Study Group between 2001 and 2006 identified two sites as being used by the Double-banded Plover, Penrhyn Estuary and Boat Harbour (on the ocean side of the Kurnell peninsula). The majority of the population were found at Penrhyn Estuary with the balance being found at Boat Harbour, although the whole population was occasionally found at Boat Harbour soon after arrival from New Zealand, as shown in Figure 7a. The Double-banded Plover population has been comparatively steady at Penrhyn Estuary in recent years with maximum counts of between 50 and 60 birds (Figure 7a, although this is a decline of about 50% of counts regularly made of 120 birds or more between in the northern part of Botany Bay between 1977 and 1989. During this study this species spent significant time feeding at the upper reaches of the Estuary or on oyster covered rocks at a beach between the Estuary and the Patricks terminal during the day (P. Straw pers. obs.). Although the study did not include control sites, Double Banded Plovers were recorded at Boat Harbour by the NSW Wader Study Group during that period.

Figure 7a

Double-banded Plover counts over whole of Botany Bay including Boat Harbour (blue) and proportion of birds found at Penrhyn Estuary (red).

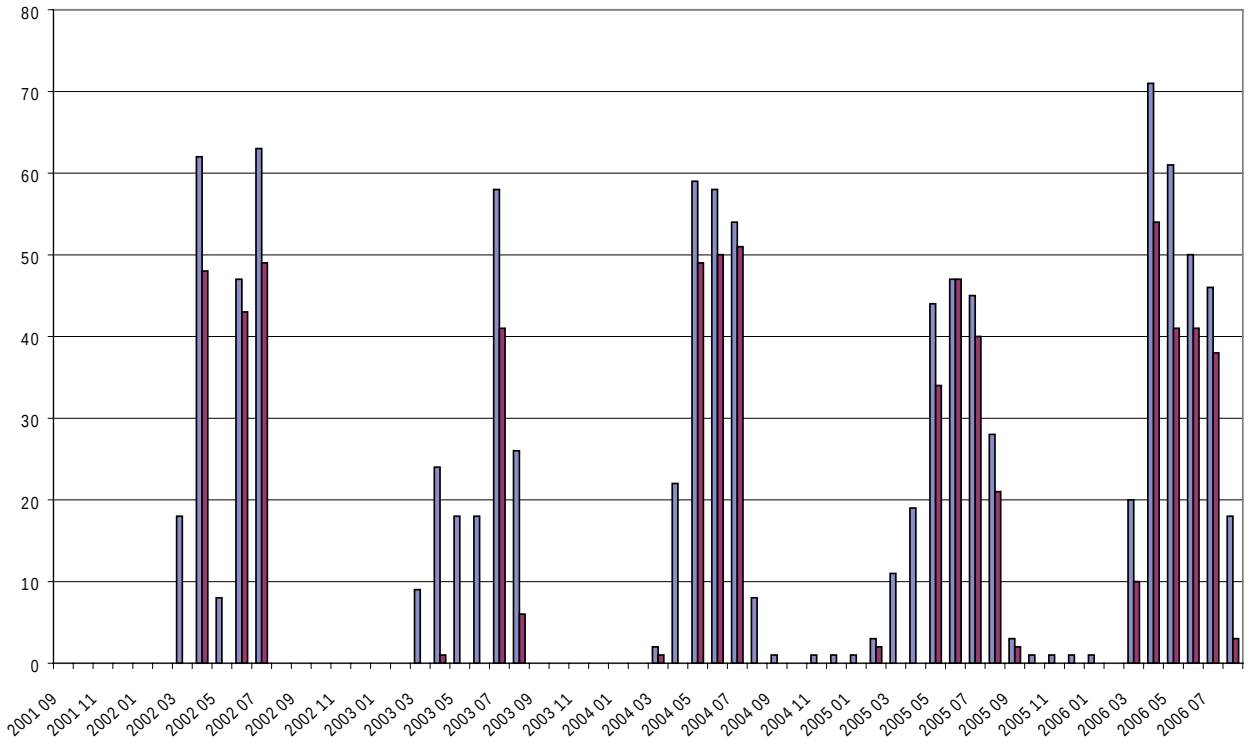


Figure 7b: Penrhyn Estuary counts (NSW WSG data) 2001 - 2007

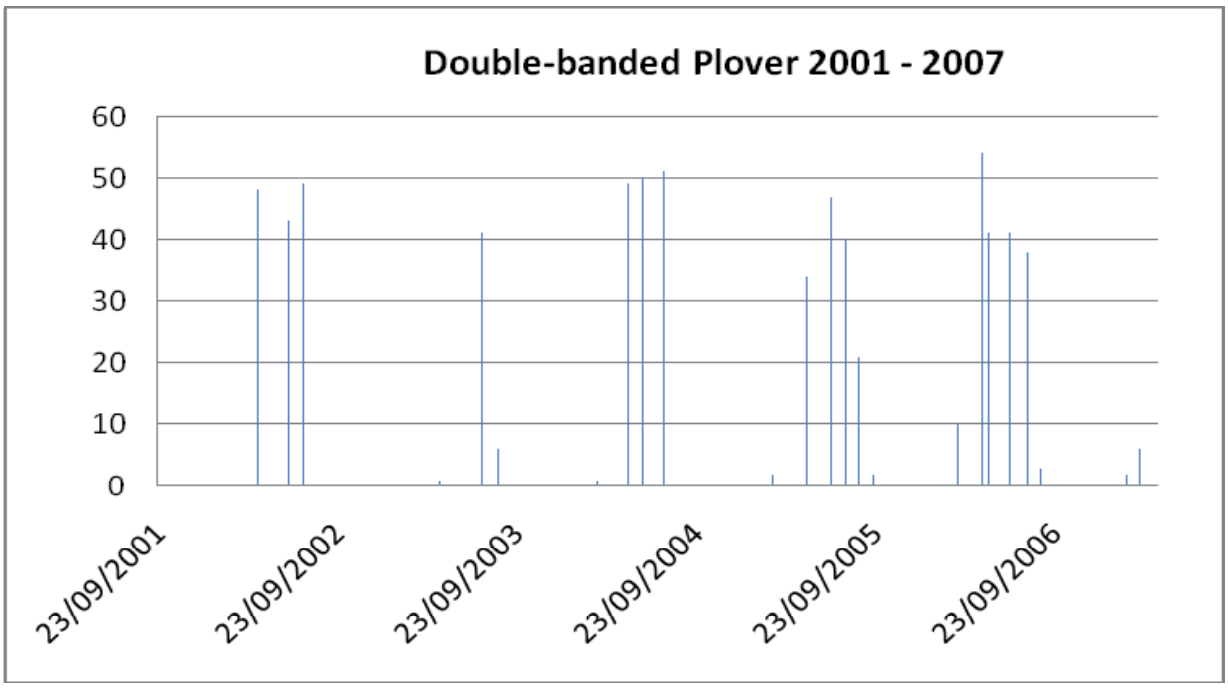


Figure 7c: Penrhyn Estuary counts during this study

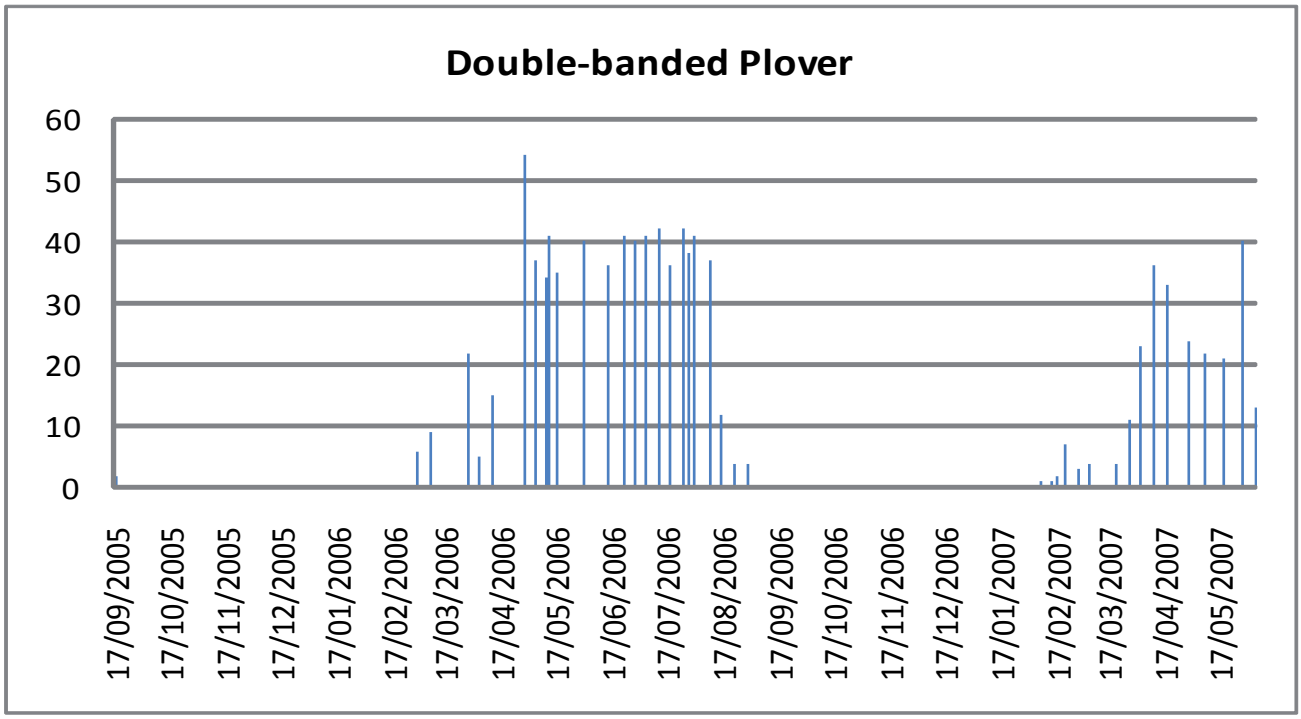


Figure 1: Transects used to count shorebirds at Penrhyn Estuary.

5.0 Counts

Counts of all waterbirds during 2006-07 were similar to those in the previous year of monitoring for most species. However and increase in the maximum count of Sharp-tailed Sandpipers 72 (22), Red-necked Stints 63 ((45), Red-capped Plover 14 (8) were noted (see count charts on pages 10 and 11). Little Terns increased in numbers and frequency of visits and successfully nested at the mouth of the Estuary for the first time for many years, raising 14 chicks to fully flying stage. This appears to be as a result of the main nesting site not being managed for the birds this season, rather than any changes at the Estuary. The only marked decline noted was that to the Curlew Sandpiper with only two birds being present, compared with 16 birds last year. This seems to following a trend of general decline in Australia of this species.

Table 1: Birds recorded at Penrhyn Estuary September 2005 – June 2007

Scientific name	Common name	max count	Resident/migratory	Listing
Tringa nebularia	Common Greenshank	1	M	JC/EPBC
Actitis hypoleucos	Common Sandpiper	1	M	JC/EPBC
Arenaria interpres	Ruddy Turnstone	1	M	JC/EPBC
Calidris acuminata	*Sharp-tailed Sandpiper*	*72*	M	JC/EPBC
Calidris alba	Sanderling	3	M/Th	JC/EPBC
Calidris canutus	*Red Knot*	*18*	M	JC/EPBC
Calidris ferruginea	*Curlew Sandpiper*	*16*	M	JC/EPBC
Calidris melanotos	Pectoral Sandpiper	1	M	JC/EPBC
Calidris ruficollis	*Red-necked Stint*	*63*	M	JC/EPBC
Calidris tenuirostris	Great Knot	2	M/Th	JC/EPBC
Charadrius bicinctus	*Double-banded Plover*	*54*	M	EPBC
Charadrius ruficapillus	Red-capped Plover	14	R	
Elseyornis melanops	Black-fronted Dotterel	2	R	
Haematopus fuliginosus	Sooty Oystercatcher	1	R/Th	
Haematopus longirostris	Pied Oystercatcher	2	R/Th	
Heteroscelus brevipes	Grey-tailed Tattler	3	M	JC/EPBC
Himantopus himantopus	Black-winged Stilt	12	R	
Limosa lapponica	*Bar-tailed Godwit*	*162*	M	JC/EPBC
Pluvialis fulva	*Pacific Golden Plover*	*18*	M	JC/EPBC
Pluvialis squatarola	Grey Plover	1	M	JC/EPBC
Xenus terek	Terek Sandpiper	1	M/Th	JC/EPBC
Numenius madagascariensis	Eastern Curlew	1	M	JC/EPBC
Numenius phaeopus	Whimbrel	1	M	JC/EPBC
Vanellus miles	Masked Lapwing	2	R	
Other birds associated with the wetlands				
Anas superciliosa	Pacific Black Duck	2	R	
Anas castanea	Chestnut Teal	6	R	
Anhinga melanogaster	Darter	1	R	
Ardea novaehollandiae	White-faced Heron	1	R	
Ardea ibis	Cattle Egret	4	M	JC/EPBC
Egretta alba	Great Egret	2	M	JC/EPBC
Egretta garzetta	Little Egret	1	R	
Butorides striatus	Striated Heron	2	R	
Threskiornis molucca	Australian White Ibis	16	R	
Platelea regia	Royal Spoonbill	1	R	
Pelecanus conspicillatus	Australian Pelican	12	R	
Phalacrocorax carbo	Great Cormorant	2	R	
Phalacrocorax melanoleucos	Little Pied Cormorant	4	R	
Phalacrocorax sulcirostris	Little Black Cormorant	55	R	
Phalacrocorax varius	Pied Cormorant	3	R	
Sterna nilotica	Gull-billed Tern	2	R	
Sterna albifrons	Little Tern	48	M/En	JC/EPBC
Sterna bergii	Crested Tern	24	R	
Sterna caspia	Caspian Tern	2	M	JC/EPBC
Sterna striata	White-fronted Tern	1	M	EPBC
Sterna hirundo	Common Tern	130	M	JC/EPBC
Chlidonias leucopterus	White-winged Black Tern	1	M	JC/EPBC
Chlidonias hybridus	Whiskered Tern	1	R	
Larus dominicanus	Kelp Gull	2	R	
Larus novaehollandiae	Silver Gull	410	R	
Falco peregrinus	Peregrine Falcon	1	R	
Falco berigora	Brown Falcon	1	R	

En, Th = listed under the TSC Act as Endangered or Threatened
JC/EPBC = listed under JAMBA, CAMBA or EPBC Act as migratory species
M= migratory R= resident. Species in bold were considered key species for this study

6.0 Health of Birds

While the numbers and species diversity of shorebird species at the Penrhyn Estuary will provide an indicator of the availability of feeding and roosting habitat it is important to assess the quality of habitat through the general condition and health of the birds. For example large numbers of shorebird present, but unable to maintain peak physical condition may mean that birds are not able to build up fat reserves prior to an arduous migration or even maintain sufficient condition for predator avoidance and long term survival.

The Bar-tailed Godwit was used as an indicator species for this study due to the fact that birds were present throughout the year and, being the largest of the migratory species, was the easiest to measure body profiles.

During the study Bar-tailed Godwits maintained body profiles above the minimum score of 1, out of a range of 1 to 5, 1 being the estimated fat free weight of the bird and 5 being the maximum weight prior to migration (an increase of 50-60% of base body mass). No birds were observed to have a body profile of 5 which indicates that Botany Bay may not be a main launch site for migratory birds flying to the Yellow Sea.

Figure 2: Bar-tailed Godwit in full breeding plumage, with a body profile score of 3. No birds reached a body profile score of 5 (inset taken elsewhere in the Flyway, photo courtesy of Phil Battley)

Figure 3: Mixed flock of shorebirds during southward migration

The birds illustrated in Figure 3 include Red Knot (medium sized birds) which are still in partial breeding plumage (chestnut blotching) and are likely to be on their way to Victoria or New Zealand with a body score of 3 or 4, as are the Curlew Sandpiper (the smaller birds with down-curved bills). On the other hand the Bar-tailed Godwits are not preparing for further migration and will stay in Botany Bay to complete their moult of flight feathers before continuing or may stay in the Bay until it is time for their northern migration.

7 Conclusion

The shorebird monitoring program at Penrhyn Estuary indicates the numbers and species diversity of shorebirds in the Estuary are similar to previous population trends shown by the data collected by the NSW Wader Study Group over the past six to seven years. While there have been marked declines in many of the shorebirds when compared with counts carried out by the Australasian Wader Studies Group in the 1970s and 1980s most species have been relatively stable over the past six years and maintained similar populations during the 2006/2007 season.

One species that continues to decline in numbers at Penrhyn Estuary is the Curlew Sandpiper with only two birds being present at Penrhyn Estuary during the 2006/2007 season. However this is a species that is in decline throughout its range in Australia and not as a direct result of local impacts in Botany Bay.

There appears to be no evidence from the data collected so far that numbers of shorebirds were influence by any changes in to groundwater flows into the Estuary. However, Bar-tailed Godwits appear to have shifted preference from the upper reaches of the estuary to the outer reaches.

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