

# Roosting and feeding behaviour of Pacific Golden Plover in the Hunter Estuary, NSW

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The Hunter Estuary hosts a significant proportion of the population of Pacific Golden Plover *Pluvialis fulva* in New South Wales (NSW). Although breeding in the northern hemisphere, these birds spend the majority of their time in the estuary, seven months of the year from mid-September to mid-April. Numbers have declined significantly from maximums of 700-800 birds during the 1980s to the present 2008/2009 season maximum of 180. Two distinct populations of Pacific Golden Plover were recognised: the North Arm population that roosted and foraged in the North Arm of the Hunter River upstream of Stockton Bridge; and a smaller population within Stockton Channel downstream of Stockton Bridge. The North Arm birds roosted mainly on the Kooragang Dykes during high tide and foraged during low tide on the North Arm Sandflats immediately opposite the dykes. Less used high-tide and intermediate-tide roosts were located on Ash Island and the Stockton Dunes. Subsidiary foraging areas were used in Fullerton Cove, Kooragang Dyke Ponds, North Arm Point Bar and Ash Island. The geographically separate Stockton Channel population roosted on the eastern shore of Stockton Channel and foraged upstream towards, but south of, Stockton Bridge. Rusting wrecks in the same area were used occasionally as an intermediate-tide or high-tide roost.

## INTRODUCTION

Located about 120km north of Sydney, the Hunter Estuary is one of the larger estuaries on the New South Wales (NSW) coast and, despite being a major coal exporting port, is of great importance as a feeding and roosting ground for migratory shorebirds. Pacific Golden Plover *Pluvialis fulva* are migratory shorebirds that arrive in the estuary during September and depart for their northern hemisphere breeding grounds during March and early April. The most important habitats for Pacific Golden Plover in the estuary are in the North Arm of the Hunter River: Kooragang Dykes and Dyke Ponds; North Arm Sandflats; and Fullerton Cove intertidal mudflats (**Figure 1**). These areas are all reserved in the Hunter Estuary National Park (formerly Kooragang Nature Reserve), but are subject to human disturbance by the proximity of boats and fishermen. Two tidal cycles occur every 25 hours, exposing intertidal sandflats and mudflats that are suitable for foraging at least once during daylight hours. Their nocturnal foraging behaviour in the estuary was not investigated.

The Hunter Estuary is one of the three main sites along the coast of NSW which support Pacific Golden Plover numbers in excess of 150 during the austral summer months. During the 2007/2008 summer the Richmond River hosted 246 birds, the

Shoalhaven River 214 and the Hunter Estuary 194 birds (R. Clemens pers. comm.).

Count data from the 1970s to the present were used to assess population trends in the Hunter Estuary. These data include historical counts from the 1970s to the 1990s, including sporadic shorebird counts by individual observers, annual counts coordinated by the Australasian Wader Studies Group (AWSG) during the 1980s, regular monthly counts since April 1999 by the Hunter Bird Observers Club (HBOC) and weekly monitoring by the authors over the summer months from September 2006 to April 2009. The weekly counts between 2006 and 2009 were commissioned by Sydney Ports Corporation as part of a study of the Penrhyn Estuary in Botany Bay, NSW.

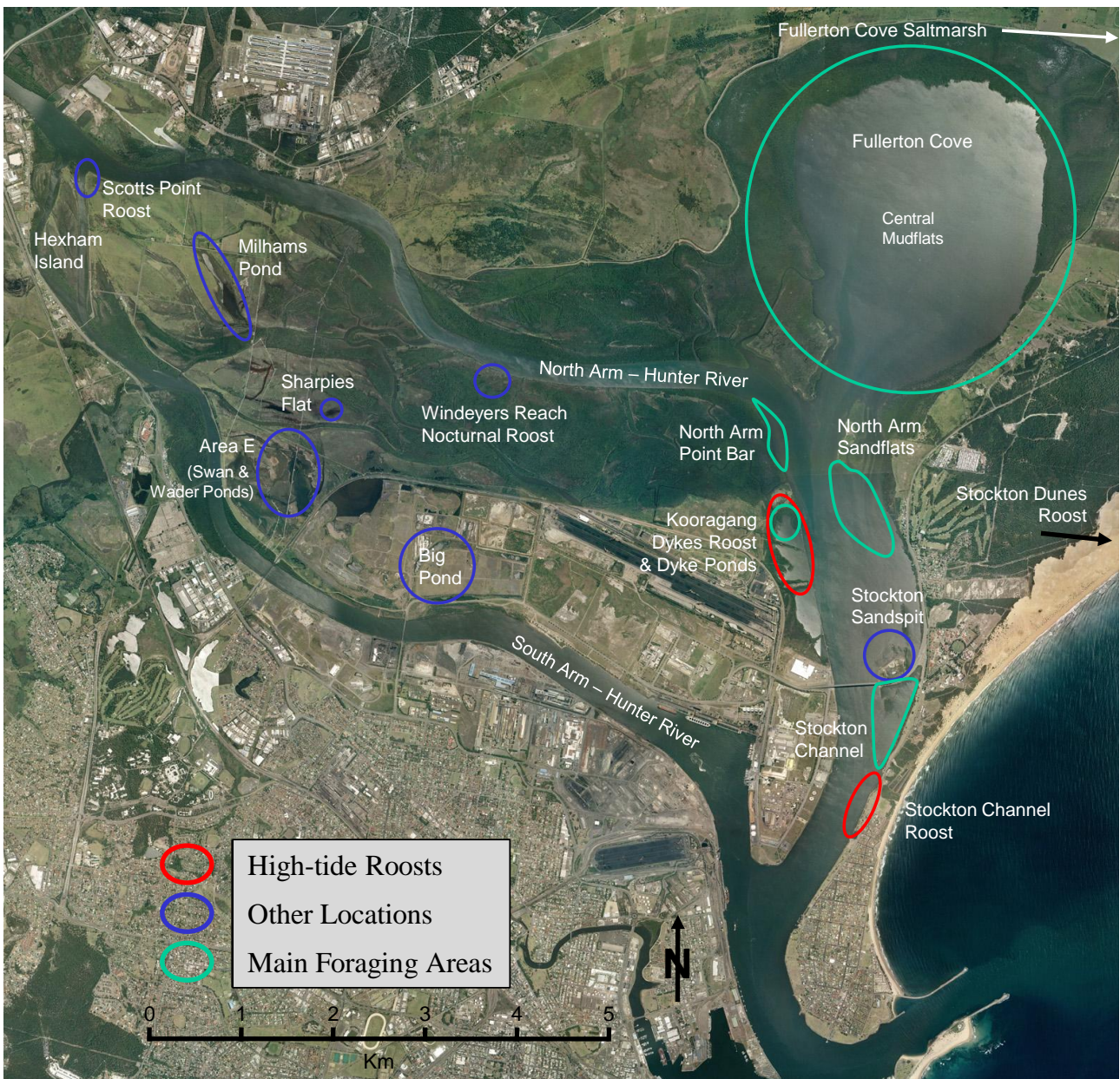
## METHODS

Access to Pacific Golden Plover localities in the Hunter Estuary was either by foot, by car, or by small, outboard-powered boats. During monthly HBOC shorebird surveys, from April 1999 to April 2009, several groups carried out simultaneous observations at known roosting localities, usually within an hour either side of local high tide. In addition, from September 2006 to April 2009, the authors undertook weekly surveys, usually on Friday mornings, regardless of tide height. During the 2006/2007 season, the authors

searched the Hunter Estuary extensively for Pacific Golden Plover, to determine preferred roost sites. Apart from the occasional use of other areas by small numbers of birds, the main roosting and foraging locations were in the Hunter River North Arm at Stockton Channel, on Kooragang Dykes and North Arm Sandflats. In the 2007/2008 and 2008/2009 seasons, weekly observations were restricted to the North Arm and Stockton Channel as the birds rarely used other areas in significant numbers. All observations were carried out during daylight hours, with occasional dusk and early evening

observations to determine the direction of flights to nocturnal roosts.

Historical records, including Holmes (1970), Gosper (1981), van Gessel and Kendall (1972a, b & c), Kingsford *et al.* (1998), the NSW Annual Bird Reports (Lindsey 1985, Cooper 1989, Morris & Burton 1992, 1993), Hunter Region Annual Bird Reports (Stuart 1993 to 2008) and the Australasian Wader Studies Group annual counts (1982-1992, provided by Wilma Barden) were consulted for the period 1970 to 1999.



**Figure 1.** Pacific Golden Plover roosting and foraging sites in the Hunter Estuary.

## RESULTS

### Abundance

During the 1970s and 1980s from 350 to 800 Pacific Golden Plover were recorded in the Hunter Estuary (Figure 2). From the 1990s to April 2009, numbers have fluctuated between 100 and 300, with a maximum of 304 in February 2007.

Two populations of Pacific Golden Plover were recognised in the Hunter Estuary – the larger population of North Arm birds, north of Stockton

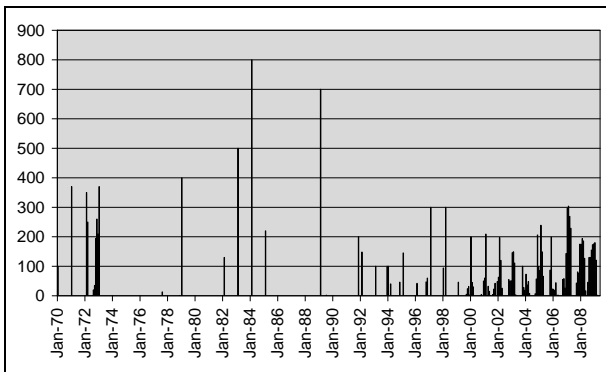


Figure 2. Historical counts of Pacific Golden Plover in the Hunter Estuary 1970s to 2009.

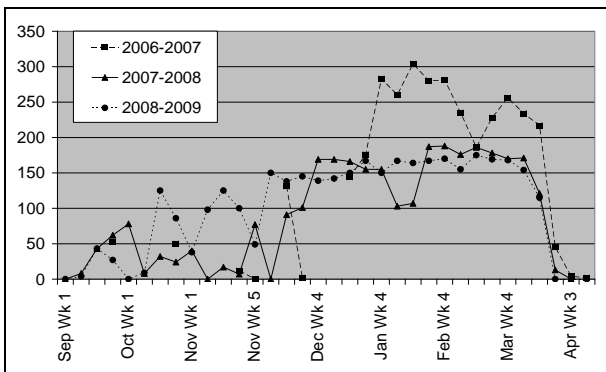


Figure 3. Weekly counts of North Arm Pacific Golden Plover for three consecutive summer seasons from 2006/07 to 2008/09.

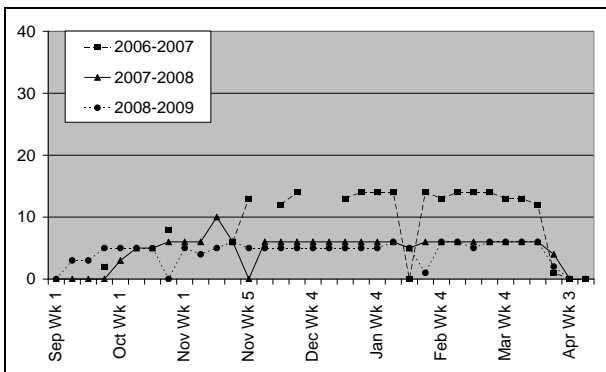


Figure 4. Weekly counts of Stockton Channel Pacific Golden Plover for three consecutive summer seasons from 2006/07 to 2008/09.

Bridge (Figure 3), and the much smaller population of Stockton Channel birds, south of Stockton Bridge (Figure 4). There appeared to be little to no crossover of birds between these two populations. During the 2008/2009 summer season a maximum of 175 North Arm birds were present while only 5-6 Stockton Channel birds were recorded.

Between April 1999 and November 2005, the North Arm birds were recorded on both Ash Island and Kooragang Dykes, but since that time, Pacific Golden Plover were rarely observed on Ash Island (Figures 5 and 6).

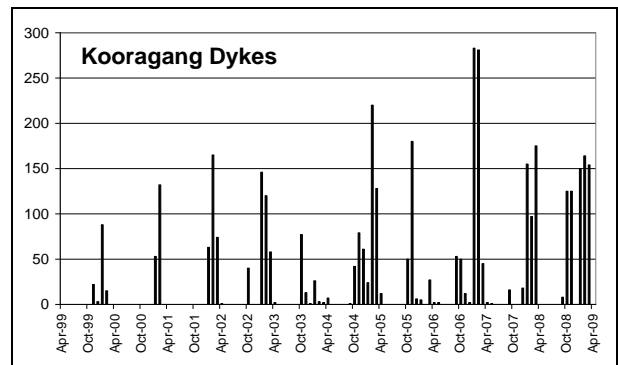


Figure 5. Kooragang Dykes monthly counts 1999/00 – 2008/09

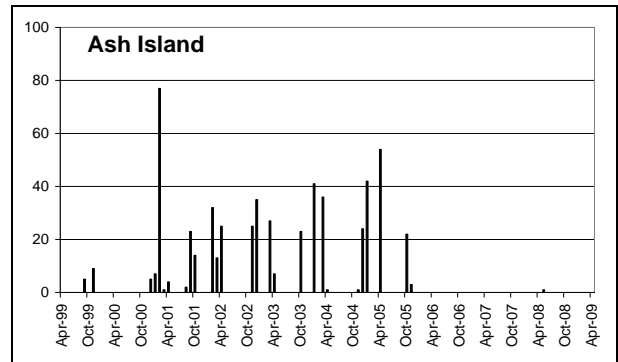


Figure 6. Ash Island monthly counts 1999/00 – 2008/09

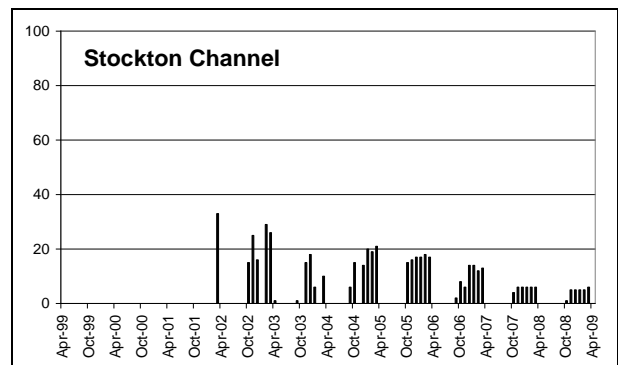


Figure 7. Stockton Channel monthly counts 1999/00 – 2008/09.

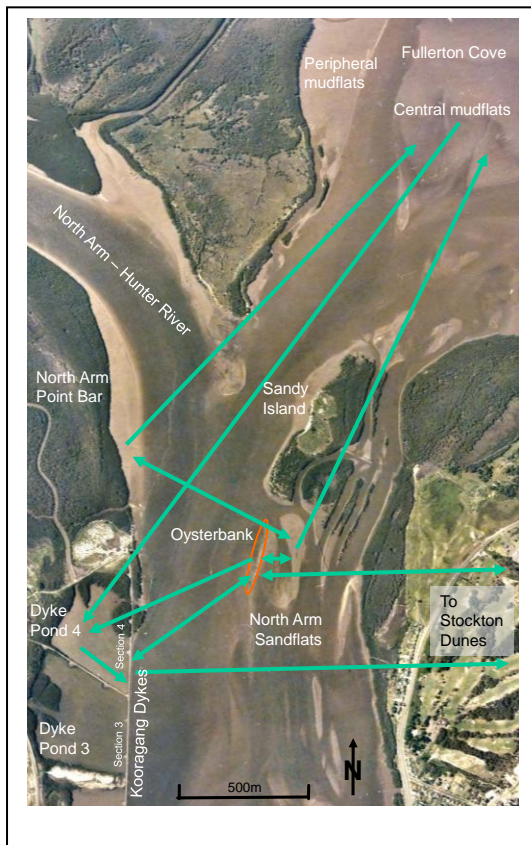
Monthly surveying of Stockton Channel commenced in March 2002 when 33 Pacific Golden Plover were recorded. Since then, the annual number has steadily decreased to only 5 to 6 birds in 2008/2009 (Figure 7).

### Major Diurnal High-tide Roosts

Kooragang Dykes are the most important diurnal high-tide roost site for the North Arm population (Plate 1). The dykes are a series of low rock training walls, composed of blast furnace slag, extending approximately 1.6km along the eastern margin of Kooragang Island (Figure 1). Four intertidal ponds behind the dykes are separated by rock walls and sandspits (Figure 8). The dykes are about 3m wide and partly submerged at spring high tides. Birds roost on the top surface and down the exposed flanks to the waterline. For long periods, North Arm birds were faithful to certain sections of

the dykes. Between April 1999 and December 2004, Pacific Golden Plover roosted mainly on Section 2 of the dykes. However, since March 2005 the birds roosted mainly on Section 4 and around the junction of Sections 3 and 4. On rare occasions when they have not been observed on the dykes, it is likely that the birds were still present in the estuary, but roosting at other locations, such as the nearby Stockton Dunes (see below).

The Stockton Channel birds roosted on boulders and logs along the eastern bank of Stockton Channel within a section extending about 100 metres downriver from a rocky point near a dilapidated jetty (Figure 9 and Plate 3). They usually roosted as a loose group spaced a metre or two apart, but individuals were sometimes separated by about 30 metres (Plate 4).



**Figure 8.** Habitat of the North Arm Pacific Golden Plover showing flight paths between roosting and foraging areas (green arrows).



**Figure 9.** Habitat of the Stockton Channel Pacific Golden Plover showing the main high-tide roost and low-tide foraging area.

## Other Diurnal High-tide Roosts

In addition to the Kooragang Dykes and Stockton Channel roosts, Pacific Golden Plover roosted, occasionally, at other locations in the Hunter Estuary, as discussed below. Except for Stockton Dunes, all these sites were included in monthly surveys by HBOC.

Stockton Dunes extend north from the mouth of the Hunter Estuary for approximately 30km along Stockton Bight. Only occasional observations were made in this area. Pacific Golden Plover have been observed roosting during the day in sparse spinifex grass on dune slopes and swales, between 50 and 300 metres from the beach. On several occasions in the last decade, one to 10 birds have been observed (Stuart 2001; L. Crawford pers. obs. on 3/4/2001 and on 7/12/2008), and on one occasion approximately 220 plovers were observed (S. Roderick in Stuart 2007). At various times during the last three years, all the North Arm birds have been observed flying towards the dunes from the Kooragang Dykes roost or from their foraging area on the North Arm Sandflats.

Scotts Point roost is a slag-boulder reinforced margin of the Hunter River on the northwestern tip of Ash Island (**Figure 1**). When disturbed from this site, the birds flew across the South Arm of the Hunter River to roost on a small beach on Hexham Island opposite Scotts Point. Small areas of saltmarsh adjacent to the river edge at Scotts Point are also occasionally used by the birds. The roost was not consistently used and then by only a few individuals. During HBOC monthly surveys, 28 birds were recorded in October 2001, 2 in November 2006 and 11 in December 2006. Other records include 48 birds during December 2001 (Stuart 2002). Pacific Golden Plover were found at Scotts Point on 26% (5 of 19) weekly surveys conducted from September to April 2006/2007, when 1 to 13 birds were present. Although weekly surveys were discontinued, monthly surveys failed to find any plovers at this site after December 2007 when 3 Pacific Golden Plover were recorded (N. McNaughton pers. comm.).

Milhams Pond is a shallow saltmarsh pond on Ash Island occasionally visited by Pacific Golden Plover. Four Pacific Golden Plover were recorded at Milhams Pond on 2 February 2007 (N. McNaughton pers. comm.).

Wader Pond is a mosaic of tidally-influenced saltmarsh ponds on Ash Island that have been used by small numbers (generally less than 23) of

Pacific Golden Plover in recent years. However, a maximum of 77 Pacific Golden Plover was recorded in February 2001.

Swan Pond is a deeper saltmarsh pond adjacent to Wader Pond that has also been used by small numbers of Pacific Golden Plover. Two HBOC monthly counts recorded 9 and 14 Pacific Golden Plover in November 1999 and October 2001 respectively. Pacific Golden Plover were recorded in Area E (Swan and Wader Ponds) on 18% of monthly surveys over the September-April season.

Sharpies Flat, on Ash Island, is an ephemeral saltmarsh pond fed by occasional high spring tides and rainfall, and is sometimes used by Pacific Golden Plover when shallow water is present. During the weekly surveys for 2006/2007, Pacific Golden Plover were recorded on 3 out of 19 surveys (16%), with a maximum count of 12 birds. They roosted above the waterline on a raised part of the muddy margin of this wetland. However, they were not recorded at this location after December 2006.

All the Ash Island localities mentioned above were rarely used by the Pacific Golden Plover after the 2005/2006 season (**Figure 6**).

Stockton Sandspit is a complex habitat of shallow, tidally-influenced lagoon, saltmarsh, grass, bare sand and beach adjacent to Stockton Bridge. During the 1970s it was the most important roost site for Pacific Golden Plover (van Gessel & Kendall 1972a). More recently however, Pacific Golden Plover were only occasionally recorded at this site: on 18 February 2007 when 12 birds were seen roosting in saltmarsh and on 22 February 2009 when 14 birds were present (T. Clarke pers. comm.).

Big Pond was a significant roosting and foraging site for Pacific Golden Plover until drained as part of impending industrial development. Twenty four plovers were last recorded there in October 1999 (Herbert 2007).

## Intermediate-tide Roosts

Several intermediate-tide roosts were used during falling and rising tides, usually immediately before or after foraging activity.

The North Arm Sandflats oysterbank roost is adjacent to the main daytime foraging area on the North Arm Sandflats (**Figure 8, Plate 5**). Pacific

Golden Plover used this roost at falling and rising tide immediately before and after foraging.

Two adjacent rusting hulks in Stockton Channel, known as “The Wreck”, were occasionally used as a roost by the Stockton Channel birds at intermediate-tide levels, as was a rocky point immediately upstream of a dilapidated jetty (**Figure 9**).

### Nocturnal High-tide Roosts

Geering and Winning (1993) noted that shorebirds did not roost on the Kooragang Dykes at night but instead flew to alternative nocturnal roosts. During this study, nocturnal high-tide roosts for the Pacific Golden Plover were inferred from observations of flocks flying from diurnal roosts and foraging areas at dusk or late in the afternoon. The location of these roosts was not verified because of the difficulty of observing in the dark. However, Pacific Golden Plover were observed flying from the Kooragang Dykes at dusk in three different directions: northwards, up-river towards Windeyers Reach nocturnal roost, which was used by most of the larger migratory shorebirds in the Hunter Estuary (Spencer 2009); northeast across the river, over Sandy Island, towards saltmarsh northeast of Fullerton Cove; and directly east towards the Stockton Dunes (**Figure 1**).

On three occasions, several flocks of plovers were observed late in the afternoon, on the rising tide, leaving the North Arm Sandflats oysterbank roost and flying east towards Stockton Dunes instead of the usual roost at Kooragang Dykes (which is in the opposite direction). It is probable that Stockton Dunes is a significant nocturnal roost site for Pacific Golden Plover using the Hunter Estuary. As mentioned previously the dunes are a proven diurnal roost.

### Foraging Areas

Pacific Golden Plover used two separate foraging areas in the Hunter Estuary. North Arm birds foraged upstream of Stockton Bridge while Stockton Channel birds foraged downstream of Stockton Bridge (**Figures 8 & 9**). During the day, North Arm birds foraged primarily on the North Arm Sandflats immediately south of Sandy Island. They foraged and loafed there from about 3 hours before low tide to about 2 hours after low tide. During neap tides the North Arm birds foraged exclusively on the North Arm Sandflats. Only during spring low tides did the birds move into Fullerton Cove to forage on the central mudflats

and/or peripheral mudflats near the mouth of Smiths Creek, having first foraged at the North Arm Sandflats. North Arm birds were also observed foraging on the North Arm Point Bar (**Plate 2**).

Stockton Channel birds foraged on mudflats and oysterbanks between their high-tide roost site and Stockton Bridge, apparently never venturing north of the bridge (**Figure 9**). They foraged along the muddy and, sometimes boulder-strewn, mangrove-lined eastern shoreline as far as a large oysterbank immediately south of Stockton Bridge.

Additional observations of small numbers of Pacific Golden Plover on Ash Island saltmarsh ponds such as Sharpies Flat, Wader Pond, Swan Pond, Milhams Pond and the shoreline near Scotts Point indicate that these areas may also be minor foraging locations.

## DISCUSSION

Observations of Pacific Golden Plover have been recorded at three different time scales: sporadic yearly observations (1970-1999), monthly observations (1999-2009) and weekly observations (2006-2009). Each scale of observation reveals different insights regarding abundance, habitat preference, movement throughout the estuary and timing of arrival and departure, etc. The discussion below integrates the different scales of observations which are summarised in **Figures 2, 3, 4, 5, 6 and 7**.

### Arrival, Departure and Abundance

North Arm Pacific Golden Plover began arriving in the Hunter Estuary from their northern hemisphere breeding grounds during the 2<sup>nd</sup> week of September (**Figure 3**). Rarely, a few may arrive as early as August (Stuart 2001). It is possible that, between September and December, many of the birds were staging in the Hunter Estuary during southward migration as shown by fluctuating numbers. The birds appeared to arrive and depart in groups of about 50 to 100 before progressively building up to a consistent maximum resident population during January and February. As many as 4 influxes were noted during the 2008/09 September to December period (**Figure 3**). Influxes and decreases observed during southward migration down the east coast at this time were also documented by Alcorn *et al.* (1994).

Numbers gradually declined during March as the birds started to migrate north. This was followed by a rapid decline in the last week in March and the first week in April as the majority of Pacific Golden Plover departed on northward migration (**Plate 6**). Any birds still present after the 2<sup>nd</sup> week in April left before the end of the month. Notable exceptions were two Pacific Golden Plover that were still present on 13 May 2006 (HBOC monthly survey), and one record of a single bird present in winter, 9 June 2001, on Stockton Sandspit (Stuart 2002). Apart from this one winter observation, Pacific Golden Plover generally did not overwinter in the Hunter Estuary.

While numbers varied from year to year there was an overall trend for maximum recorded numbers to increase between 1999/2000 and 2006/2007. A trend for decreasing maximum numbers was apparent from 2006/2007 to 2008/2009. The reasons for fluctuations in peak numbers are not clear but could be related to recruitment as a result of breeding success in the northern hemisphere or to movements between sites along the east Australian coast. The exceptional maximum number of 304 North Arm birds during February 2007 could have been caused by the addition of a number of birds in the process of migrating up the coast from more southerly locations (**Figure 3**). The latter is more likely at this time of year as Starks and Lane (1987) suggested that a significant proportion of Pacific Golden Plover moved northwards along the eastern coast on northward migration from as early as February. This is supported by additional records of peak numbers observed during February and March 2008 for the Manning River (Stuart 2008), during February 2002 for the Clarence Estuary and as early as mid-January for the NSW North Coast at Lake Cakora (Greg Clancy pers. comm.).

It is not known whether the sudden decrease in numbers recorded in the 1<sup>st</sup> and 2<sup>nd</sup> weeks of February 2008 (**Figure 3**) was due to migration movements or birds moving locally from monitored roost sites to the Stockton Dunes roost. The latter is considered more likely because, during that February, the river level was high with limited exposure of foraging areas on the 1<sup>st</sup> week and limited roosting areas on the 2<sup>nd</sup> week due to floodwaters affecting water levels in the river. In addition, Pacific Golden Plover were observed flying out of the estuary towards Stockton Dunes on 8 February 2008.

During 2007/2008 and 2008/2009, the smaller group of Stockton Channel birds reached and

stabilised at their maximum number of 5-6 in late September to October, much earlier than numbers stabilised for the North Arm population (**Figure 4**). The increase from 6 to 10 Pacific Golden Plover on 16 November 2007 suggests the temporary addition of birds on southward passage. Overall, the North Arm and Stockton Channel birds arrived and departed at about the same times. The consistent number of Stockton Channel birds during each summer season together with their localised roosting and foraging behaviour suggests that they were a separate group from the North Arm birds. The constant and rapid decline in the number of Stockton Channel birds since monitoring began in April 2002 is of concern (**Figure 7**).

### Foraging Activity

North Arm birds foraged mainly on the North Arm Sandflats and used Fullerton Cove as a supplementary feeding area only when tidal flats were exposed at spring low tides. Mudflats in Dyke Ponds 3 and 4 were also used for foraging during suitable tides. The ponds enclosed by Kooragang Dykes were fed by tidal inflow through narrow breaks in the dyke wall. These constrictions created a considerable lag between low tide in the estuary and low tide in the ponds. This provided additional foraging time in the ponds for shorebirds as the tide rose significantly later than in the open estuary. Recent observations revealed that the North Arm Point Bar (**Figure 8**) was also used to extend their foraging period.

Stockton Channel birds appeared to forage exclusively on the eastern shore of Stockton Channel downstream of Stockton Bridge towards their regular high-tide roost.

Our observations indicate that Pacific Golden Plover are visual feeders that walk or run short distances before pecking at the surface. Worms were the most common prey observed, with occasional crustaceans (small crabs and nippers), but most items were too small to be visible to observers with binoculars. When a worm was discovered, the bird slowly withdrew it from the substrate, often carrying it to a nearby puddle to wash it before eating. In the literature, they have been recorded eating molluscs, worms, insects, crustaceans, spiders and occasionally seeds, leaves, lizards, bird's eggs and small fish (Marchant & Higgins 1993, Kato *et al.* 2000).

Pacific Golden Plover were observed feeding at an average rate of 4 pecks/min (3/4 hrs of

observations), which was a much slower rate than observed for other shorebirds on the same tidal flat (e.g. Grey-tailed Tattler *Tringa brevipes*, Bar-tailed Godwit *Limosa lapponica* and Red-necked Stint *Calidris ruficollis*). Although these birds have different foraging methods, it is noteworthy that Thomas (1988) also found low rates of 12 pecks/minute for Pacific Golden Plover, compared to 38 pecks/minute for Grey-tailed Tattler, 13 pecks/minute for Bar-tailed Godwit and 59 pecks/minute for Red-necked Stint. Overall time spent foraging was also less than other shorebirds, with Pacific Golden Plover apparently spending a large amount of time loafing between desultory feeding bouts. A further apparent lack of interest for feeding during daylight hours was observed on several occasions when none of the birds moved off their day-time high-tide roosts at all during some entire neap low-tide periods! On another occasion, Pacific Golden Plover roosting on the Kooragang Dykes did not leave to forage on the North Arm Sandflats (although these were exposed), but instead delayed their foraging activity for a couple of hours and then moved only a short distance to the adjacent dyke ponds to forage for a relatively short period.

The slow pecking rate and short time spent foraging during the day together with the observation that, at times, the birds remained roosting during what was normally their low-tide foraging period, strongly suggest that Pacific Golden Plover fed more actively at night. This has not been verified by direct observation. However, in Europe, Golden Plover *Pluvialis apricaria* can find earthworms so successfully at nights near full moon that they can afford to sleep during the day (van de Kam *et al.* 2004, p.43).

## Movements within the Hunter Estuary

Pacific Golden Plover moved around the Hunter Estuary in predictable directions according to the state of the tide and time of day or night. About 6 hours separated maximum high tide from dead low tide.

During daylight hours Pacific Golden Plover spent a large amount of time roosting over the high-tide period. At times they were present on the main Kooragang Dykes roost from 4.5 hours before high tide to 4.5 hours after high tide during spring tides and for an even longer period during neap tides. Also, during some daytime neap tides the birds have been observed to remain on their roost throughout the entire low-tide period without venturing out to forage.

During neap tidal cycles, after mid-falling tide, the North Arm birds flew from the Kooragang Dykes roost to the intermediate-tide North Arm Sandflats oysterbank roost where they waited until the tide exposed the adjacent sandflats. They then moved onto the North Arm Sandflats and commenced foraging and loafing until the subsequent rising tide induced the birds to return to the oysterbank roost. As the continually rising tide eventually threatened to inundate the oysterbank, the birds flew directly to Dyke Pond 4 or, occasionally, to Dyke Pond 3, where they resumed foraging or loafing. They ceased foraging in the dyke ponds as the tide rose, often staying to rest or loaf in shallow water. Eventually the rising tide forced the birds to fly onto the main Kooragang Dykes roost where they stayed until the tide receded again or flew off to a nocturnal roost if the high tide occurred during the evening.

North Arm birds also moved into Fullerton Cove to forage. They did so only after feeding on the North Arm Sandflats and usually only during spring low tides less than about 0.4m. The birds have also been observed to move from the North Arm Sandflats to forage on the North Arm Point Bar on the opposite side of the river, sometimes as a prelude for some to move into Fullerton Cove. When the tide rose the plovers returned to the Kooragang Dykes or dyke ponds.

In contrast the Stockton Channel birds confined their foraging activities downstream of Stockton Bridge. After about mid-falling tide they moved upstream from their high-tide roost to forage and loaf on mudflats along the eastern side of Stockton Channel as far upstream as a large oysterbank immediately south of Stockton Bridge.

## CONCLUSIONS

The Hunter Estuary hosts a significant proportion of the population of Pacific Golden Plover that use the New South Wales coast. Although they are international travellers that breed in eastern Siberia and Alaska, the majority of their time, seven months of each year, is spent in the Hunter Estuary. However, numbers have decreased significantly from the maximums of 700-800 recorded during the 1980s to less than 200 in 2008/2009, perhaps stabilizing at around 200 for the last decade.

Fluctuating numbers recorded during the first 2-3 months of their arrival in the estuary, indicate that the birds are staging and moving on through the



estuary during southward migration. This indicates that many more Pacific Golden Plover use the Hunter Estuary on southward migration than are recorded at any one time. Although regular monitoring of the Stockton Channel birds did not commence until 2002 the steady decline in their number is evident and of concern. Is this decline due to changes in the over-wintering locality in the Stockton Channel or is it related to changes in the breeding ground or at other localities along the East Asian-Australasian Flyway?

It is acknowledged that there are many problems, mainly loss of habitat, along the flyway, that may be contributing to population declines in south-eastern Australia. However, loss of habitat in the Hunter Estuary has been, and still is, a major problem affecting shorebird numbers locally. It is vital to preserve all remaining shorebird habitat in the estuary and minimise human disturbance at roost sites and foraging areas.

## ACKNOWLEDGEMENTS

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**Plate 1.** Roosting on the Kooragang Dykes.



**Plate 2.** Foraging on North Arm Point Bar.



**Plate 3.** Stockton Channel roost.



**Plate 4.** Roosting at Stockton Channel.



**Plate 5.** North Arm Sandflats oysterbank roost.



**Plate 6.** V-formation practice days before departure.