Monitoring **Y**ellow **S**ea **M**igrants in **A**ustralia (MYSMA): North-western Australian shorebird surveys and workshops, December 2008

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Terek Sandpiper (top left), Greater Sand Plover (top right) and shorebird flock on Eighty-mile Beach (below). Photos D.I. Rogers

TABLE OF CONTENTS

EXECUTIVE SUMMARY

In non-breeding season, North-western Australia is home to more migratory shorebirds than any other region in Australia and arguably in the East Asian – Australasian flyway. The most important two sites in north-western Australia are Roebuck Bay and Eighty-mile Beach, both of which are designated as Ramsar areas. This report presents findings from workshops and extensive shorebird and waterbird surveys carried out in north-western Australia in December 2008.

The workshops were carried out to provide shorebird counters with further training in identification and monitoring, with particular emphasis on counting shorebirds at sites with very large numbers of shorebirds. The workshops consisted of two days of lectures and field sessions, after which participants gained extensive practical experience by joining one of the north-western Australian surveys carried out twice each summer by the Monitoring Yellow Sea Migrants in Australia (MYSMA) project.

With the unusually large team available - six international participants from China and South Korea, ten participants from the Shorebirds 2020 project, and the usual MYSMA team of *c*. 10 Broome residents and contractors – we had the resources to carry out unusually extensive surveys. In addition to monitoring the regularly counted MYSMA sites at Roebuck Bay (northern beaches and Bush Point) and a 60 km stretch of Eighty-mile Beach, it was also possible count all 225 km of Eighty-mile Beach, to carry out the first ground counts of the 130 km stretch of coastline that separates Eighty-mile Beach and Roebuck Bay, and a number of sites around Broome and on the west coast of the Dampier Peninsula (including two areas that have been proposed as potential sites for an LNG hub).

Our surveys confirmed that Eighty-mile Beach and Roebuck Bay are the most important shorebird sites in north-western Australia. Several "new" sites were found to have internationally significant numbers of shorebirds or terns: six species occurred in internationally significant numbers between Roebuck Bay and Eighty-mile Beach, including internationally significant numbers o f Little Tern at Dessault Bay, and Sanderling and Greater Sand Plover at Jack's Creek. The latter two species were also found in internationally significant numbers on the Indian Ocean beaches immediately adjacent to, or just north, of the town of Broome.

Our surveys demonstrated that shorebird numbers have declined on Eighty-mile Beach since the last complete summer surveys were carried out there in 1999 and 2001, and within the MYSMA study area since the MYSMA program began in 2004. The scale of the declines was deeply worrying: of the 15 most common coastal shorebird species in the region, 12 have undergone detectable declines, and for some of these species, the declines are considerable: at Eighty-mile Beach, for example, four species have declined by more than 50% in the last 7-9 years. The declines observed in north-western Australia cannot be attributed easily to local habitat changes, as they occurred at sites which are remote and almost pristine. Rather, they reflect flyway-wide population declines.

The most likely cause of these flyway-wide declines is habitat loss in the staging areas; in particular the tidal flats of the Yellow Sea, a crucial staging area for large numbers of staging shorebirds from Australia, are rapidly being lost to land claim projects. The most topical of these reclamations has been at Saemangeum, South Korea. Of the five species predicted to decline in Australia as a result of the Saemangeum reclamation, five showed an abrupt decline in at least some of our study areas in the two years following closure of the Saemangeum sea-wall. Recommendations for further analyses to assess whether these changes were coincidental are recommended in the report.

In view of the importance of north-western Australian shorebird surveys, both in meeting monitoring obligations under the Ramsar treaty, and as a barometer of the health of flyway populations, we recommend that annual surveys of north-western Australia should be continued. We also emphasise the importance of increasing the repeatability of Eighty-mile Beach surveys by extending coverage so that all of the beach is surveyed.

INTRODUCTION

Shorebird counts are an essential part of the armoury of shorebird biologists and conservationists. We need count data to identify those sites that are most important to shorebirds and therefore need the highest levels of protection; we need to monitor shorebird numbers through counts if we are to identify their greatest threats, the effects of habitat loss, and (hopefully) the success of conservation measures. In many sites, regular shorebird counts are also a statutory requirement. By signing the Ramsar Treaty the Australian government accepted an obligation to monitor waterbirds at sites listed as Ramsar areas.

The coastline of north-western Australia is internationally renowned for its large non-breeding populations of migratory shorebirds. A large proportion of these birds occur in two areas that have been given Ramsar status: Eighty-mile Beach and Roebuck Bay. Monitoring shorebirds in these sites is challenging and costly, as the area is large, remote and difficult to access. Moreover, carrying out accurate shorebird counts is not easy, especially at bewildering sites where tens of thousands of shorebirds may need to be counted in a short period at high tide. The shortage of counters with the experience and skills to cope with this kind of situation limits the amount of monitoring work that can be carried out in sites like north-western Australia and the shores of the Yellow Sea.

Monitoring shorebirds in north-western Australia is nevertheless worth the enormous effort involved. The coastline is dominated by large tidal ranges and enormous tidal flat systems, and these hold large numbers of shorebirds. It is the most important non-breeding region in Australia (arguably in the East Asian Australasian flyway) for many species of long-distance migrant shorebirds, with highlights including the site with the largest numbers of non-breeding shorebirds in Australia (Eighty-mile Beach) and the Australian site containing most migratory shorebird species in internationally significant numbers (Roebuck Bay).

The Australasian Wader Studies Group (AWSG) has been carrying out shorebird surveys at selected sites in north-western Australia for many years. Survey effort there has increased since the launch of the MYSMA (**M**onitoring **Y**ellow **S**ea **M**igrants in **A**ustralia) project in 2004, with shorebird counts being carried out by an experienced team twice each austral summer, and once each austral winter, at Roebuck Bay, Bush Point and a sixty km stretch of Eighty-mile Beach. The core objective of the counts is to monitor changes in shorebird numbers over reasonably short time-frames (Rogers et al. 2006), not only for local management purposes, but because the surveys serve as a barometer of shorebird numbers in the flyway. In recent years a particular focus has been the Great Knot *Calidiris tenuirostris*; north-western Australia is the non-breeding stronghold for this species, and a decline in the world population of Great Knot populations has been predicted as a result of habitat loss at Saemangeum (on the west coast of south Korea), formerly the world's most important staging site for Great Knot (Rogers *et al*. 2006a; Moores *et al*. 2006, 2007, 2008)

The large MYSMA count area includes the biggest shorebird strongholds known in north-western Australia, but it is very far from being a complete survey of the north-west. Eighty-mile Beach is 225 km long, and although only a 60 km stretch is regularly counted due to logistical and financial constraints), the entire beach holds shorebirds. The coastline between Eighty-mile Beach and Roebuck Bay holds a number of embayments with tidal flats, and although there has been a little aerial surveying of these sites, most have never been ground-surveyed. There are also few count data available for the freshwater lakes on Roebuck Plains, or the west coast of the Dampier Peninsula, though these sites are known to local birdwatchers to hold interesting waterbird populations at times. Documenting waterbird numbers in these sites is important to fulfil Ramsar obligations (some of them are part of the Roebuck Bay and Eighty-mile Beach Ramsar areas), and also because increasing development of north-western Australia may influence their conservation values in the future. A particularly topical project in discussion at present is construction of a large

industrial complex to process Liquified Natural Gas from the Browse Basin; potential sites under discussion have included Gourdon Bay (between Eighty-mile Beach and Roebuck Bay) and sites on the west coast of the Dampier Peninsula. One of these, James Price Point, has now been selected by the WA government as the preferred site for an LNG hub.

In December 2008, we had the opportunity to address some of these knowledge gaps. The Department of Environment, Water, Heritage and the Arts, who have been funding the MYSMA surveys for some time, provided additional funds to the AWSG to conduct a training workshop on shorebird counting techniques. The workshop was to be targeted at researchers invited from other countries in the East Asian – Australasian Flyway, to increase their capacity to monitor their own shorebird populations. It was decided that these workshops should be held in conjunction with the December 2008 MYSMA surveys, as this would give participants the opportunity to gain crucial practical experience of shorebird surveys at "difficult" sites with very large numbers of shorebirds. We also invited the Shorebirds 2020 project (based at Birds Australia) to participate in the program, as it was an opportunity to provide training and counting experience at "difficult" sites to their network of regional co-ordinators. All participants had previous shorebird counting experience, and they contributed to an unusually large counting team, comprising the workshop co-ordinators from the AWSG and Shorebirds 2020, six workshop participants from the Republic of Korea and China (co-ordinated by the AWSG and Birds Korea), seven regional count organisers from Australia (co-ordinated by Shorebirds 2020), in addition to the regular network of locally-based participants in MYSMA surveys. With top-up funding (which was provided by the Western Australian Department of Environment and Conservation) we therefore had the resources to a carry out unusually extensive survey work in north-western Australia.

This report summarises the outcomes of the program held in north-western Australia in December 2008. The objectives were to:

- Conduct shorebird monitoring workshops, introducing participants to the skills required to conduct independent surveys of shorebird-rich sites;
- Carry out surveys of all waterbird species (not only shorebirds) of the Eighty-mile Beach and Roebuck Bay Ramsar sites;
- Explore the region for new shorebird and waterbird sites.
- Report changes in shorebird populations at sites which have been counted previously.

WORKSHOPS AND TRAINING

The formal training workshops were held immediately before the MYSMA surveys, on 8th and 9th December 2008. They were arranged as a combination of seven lectures (given in the air conditioned wet-lab of Broome Bird Observatory in the heat of afternoon) and four field outings in the mornings and afternoons. There was an organisation session each evening (starting on arrival day, 7th Dec.), in which the objectives and activities for the next day were explained and logistics were finalised. Otherwise we kept formal activities to a minimum after dinner. This was in part because we had a lot of early mornings ahead of us. Moreover, as all participants were staying at Broome Bird Observatory, the evenings provided an opportunity for all participants to get to know each other and discuss shorebird monitoring and conservation in many very different parts of the world.

The first activity of the workshops was a survey of Taylor's Lagoon. This is a small and relatively easily surveyed wetland, with a good diversity of waterbirds; it worked well as a site in which to introduce visitors to the fresh waterbirds of north-western Australia. Holding a field trip before lectures began was considered important so that the course co-ordinators could make an assessment of the skill levels and experience of all other participants, and tailor the workshops to their requirements.

Lectures on the first day of the workshop dealt largely with shorebird identification. We started with a presentation on the life history and plumage cycles of migratory shorebirds, so that participants understood what shorebird plumage stages they were likely to see during the surveys. In December, nearly all migratory shorebirds in north-western Australia are in non-breeding plumage, and these plumages were unfamiliar to the Asian participants. Lectures were then given on identification of sandpipers and allies, and identification of plovers and other shorebirds. The emphasis was on the quick identification techniques used to identify shorebirds during counts in north-western Australia, focussing on non-breeding plumages. Lecture style was informal, and questions and comments from the audience were welcomed; this often led to helpful contributions on field identification hints, and sometimes to quite involved discussion about moults and plumages. A presentation on the Shorebirds 2020 program was also given, which highlighted the background, methods and development of this national shorebird population monitoring program.

These lectures were followed by another field session, held on the shores of Roebuck Bay at high tide. The main objective was to ensure that all participants saw the most common shorebird species of the region and were confident in their identification; first attempts to count birds in large flocks were also made.

The second day began with a survey of Lake Eda, a somewhat larger freshwater wetland on Roebuck Plains. After more time spent ensuring that participants were familiar with identification techniques, all were asked to carry out a count, and the varying totals obtained were discussed. Returning to the wetlab, lectures were given on identification of the terms of north-western Australia (carried over from the previous day); on recording sightings of colour-banded and leg-flagged birds; and on the techniques used to count shorebirds in flocks. This was followed by another field excursion to the high tide roosts of Roebuck Bay, in which emphasis was laid on counting shorebirds in large flocks by using the "block" method.

Finally, a lecture was given on the tactics used to count shorebirds in large sites. This lecture emphasised the importance of working with the tide to ensure counts are reproducible, discussed the sources of error in shorebird counts, and summarised how count data are analaysed. This information was considered important because an understanding of future data use helps shorebird counters to understand how to collect their data so that can it be analysed without

misinterpretation, and so that analysts can estimate the amount of error associated with counts. The lecture led on to an organisation session in which the plans for subsequent surveys were explained.

For the next five days (10th-14th December) the expedition was engaged full-time in serious shorebird surveys, nearly all of them at high tide roosts on beaches between the southern end of Eighty-mile Beach and the Dampier Peninsula (Figure 1). We broke the expedition into smaller teams of 3-4 people to carry out the surveys. Each team had a combination of very experienced and not-so-experienced members, and there were so many birds to count that sitting back and leaving the counts to the most experienced members was not an option for the volunteers. Several participants expressed doubts before the surveys that they had developed the field skills required for the counts, and felt that they were being thrown in the deep end. Yet in the event all participants, without exception, played a valuable role. We remain convinced that the best way to learn to count shorebirds is to go out and do shorebird counts.

The final day of the expedition was a “mopping-up” day held at Broome Bird Observatory. One of the more important activities of the day was completion of data entry, which had been carried out in free periods throughout the counts. Workshop participants were invited to give presentations about their shorebird sites and studies at home (all had prepared excellent presentations); these were kept brief, so that the day was not tightly scheduled and there was time for informal discussions after the talks. The talks included summaries of related work happening in China, Korea, Western Australia, South Australia, New South Wales, the Northern Territory and Queensland.

Feedback from the workshop participants was favourable, and all seemed to consider the workshops educational and enjoyable, as well as providing welcome networking opportunities. In retrospect we thought the first two training visits to high tide roosts might have been more informative and less intimidating to participants if we had found smaller, more diverse roosting flocks on the shores of Roebuck Bay. Our choices on those days were constrained by rather neap tides, and this may be worth bearing in mind when scheduling subsequent workshops. Otherwise we thought the organisation of the event worked well, and at the end of the fieldwork we felt that many of the participants had developed the skills required to lead shorebird counts in challenging sites. Some participants who did not quite reach that level, though we were very pleased by the tangible improvement in their identification and counting skills in the course of the fieldwork; we felt their main requirement was more experience in the extremely quick (yet accurate) identifications needed when counting large numbers of shorebirds.

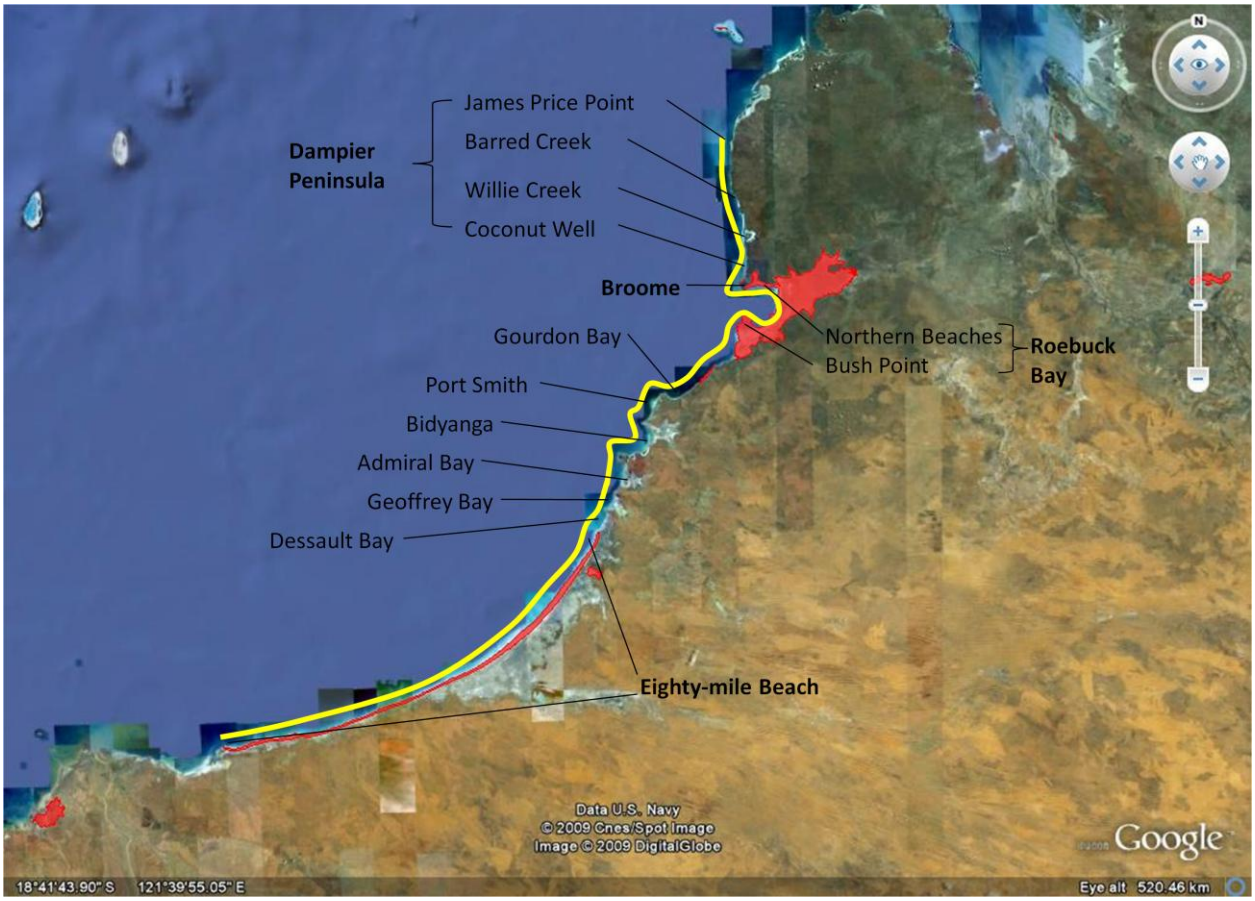

Figure 1. General study area and key sites in North-western Australia, based on satellite imagery from Google Earth. Red areas depict areas for which previous ground-count data on shorebirds are available. The thick yellow line indicates the coastline area surveyed in December 2009 (mostly ground-counted, but includes some areas surveyed from the air).

DECEMBER 2008 SURVEYS

Schedule, logistics and methodology

The fieldwork schedule of the counts is summarised in Table 1. Shorebird monitoring surveys in north-western Australia are now carried out between late October and early December, after migrants from the northern hemisphere have arrived but before the onset of wet season rains. In addition to making often closing roads, wet season rains influence roosting behaviour of north-western Australian shorebirds in some sites, creating alternate roosts on near-coastal claypans to which access by survey teams is generally impossible.

Table 1. Summary of fieldwork schedule in north-western Australia in December 2009.

Date	Tide height	Tide time	Areas surveyed
8 Dec.	6.22 m	18:08	Taylor's Lagoon
9 Dec.	6.62 m	19:27	Lake Eda
10 Dec.	6.24 m	08:20	Eighty-mile Beach: -10 to 30 km S, 75-120 km S, 185-190 km S
11 Dec.	6.79 m	9:15	Eighty-mile Beach: -10 to -20 km S, 40-60 km S, 120-205 km S. Cape Missiessy to Dessault Bay.
12 Dec.	7.29 m	10:04	Eighty-mile Beach: 30 -40 km S, 60-80 km S. Bidyadanga, Gourdon Bay, Port Smith.
13 Dec.	7.69 m	10:49	Roebuck Bay North, Dampier and Broome Peninsulas. Aerial surveys from Desault Bay to Bush Point; Willie Creek and Nimilica.
14 Dec.	7.95 m	11:31	Roebuck Bay North (repeat count) and Bush Point

The majority of sites were coastal and were surveyed in the two hours before, and the two hours after, the peak of high tide. Counts were also carried out at some freshwater wetlands around Broome and on Roebuck Plains. However, few of these wetlands held water, as rainfall had been low over much of the preceding year, and counts at these sites were much lower than they would have been in optimal conditions. Some reconnaissance was carried out before the counts were done, with excursions made to freshwater wetlands known to be important to waterbirds at times. Sites revealed to be dry were not visited during the count series.

In general terms we worked from south to north, starting at Eighty-mile Beach on a rising tide series. This general sequence was chosen so that critical sites (known to hold very large numbers of shorebirds) were surveyed in the most suitable tide conditions. Previous surveys have revealed that counts at Eighty-mile Beach are most repeatable if carried out on relatively small high tides (<7m), and that light conditions for counts are better at this site in the mornings (Price et al. in prep.; Rogers et al. 2006b). In contrast, tides of intermediate height are ideal for shorebird surveys on the northern shores of Roebuck Bay, and very large tides (>8m) are required for repeatable surveys at Bush Point (Rogers et al. 2006b).

Little information was available on shorebird sites between Eighty-mile Beach and Roebuck Bay, as no ground-based shorebird counts had been carried out here before. An aerial reconnaissance of this stretch of coastline was carried out by Adrian Boyle in October 2008, as part of a national aerial

waterbird survey co-ordinated by Richard Kingsford and John Porter (University of NSW) and Stuart Halse. This reconnaissance was invaluable not only in establishing which areas were the priorities for ground surveys, but in establishing the most likely access routes into the sites. Google Earth imagery or other aerial photographs of all unfamiliar count sites was printed and laminated before the counts began to assist counting teams in getting to their count sectors. An aerial survey, led by Adrian Boyle, was also conducted as part of the December counts, focussing on inaccessible sites in and to the south of Roebuck Bay. These surveys produced less detailed data than ground counts, as identification of "grey" waders to species level is usually impractical from the air; in addition, any shorebirds which are not flushed by the survey plane will typically be overlooked.

As we had such a large area to cover in a short time, it was necessary to divide into small teams so we could count many different sites concurrently in the course of each high tide. In general each team comprised a single 4WD vehicle containing a team leader, a scribe and 1-3 supplementary counters; in addition some stretches of Eighty-mile Beach were surveyed by two-person teams, each team member riding a quad-bike. All teams were equipped with food, water and the safety equipment required for work in remote places. This equipment included satellite phones, and we had a system of regular phone-ins to count co-ordinator Chris Hassell to ensure that no teams went missing.

All counts were carried out with binoculars and tripod- or window-mounted telescopes. Observations were recorded directly onto count sheets (shown in Appendix 1). We recorded all component counts, rather than simply recording grand totals at each site. Component count data were important as they could be used to estimate the errors associated with each count, following the methodology outlined by Rappoldt *et al*. (1985) and Rogers *et al*. (2006b).

Numbers of tracks left by nesting turtles were also recorded systematically. These data have been provided separately to DEC, and are not discussed further in this report. A daily log of count activities was maintained during the fieldwork, and this is provided in Appendix 2. Notes on counts in specific regions are provided in the results section below.

Eighty-mile Beach

Despite its name, Eighty-mile Beach is 225 km (140 miles) long. There are few access points to the beach, and although most of the beach can be negotiated by 4WD vehicles, it is in general a difficult site to get to. It is lined by extensive tidal flats (2-5km wide; Piersma et al. 2005) which support enormous numbers of shorebirds. Counting these birds is only practical for 1-2 hours either side of high tide, when they congregate into densely packed roosts on the beach. This combination of huge shorebird numbers, inaccessibility, and short periods of effective surveying time, make Eighty-mile Beach an especially challenging site to count.

The first estimates of shorebird numbers on Eighty-mile Beach were made in the early 1980's, on the basis of aerial surveys which provided overall count totals, and incomplete grounds counts which were used to gain an understanding of species composition (Lane 1987, Watkins 1993). Since then, more extensive ground surveys have shown that distribution of many species on the beach is patchy, and that obtaining species totals from the entire beach from incomplete ground counts is therefore potentially risky. However, only two complete summer ground-counts of Eighty-mile Beach had been carried out before we began our December 2008 survey. These previous counts were conducted by the AWSG in October 1998 and November 2001 (Minton et al. in prep.). These surveys established a convention of counting Eighty-mile Beach in 5km blocks, with the access track to Eighty-mile Beach from Anna Plains station (20 km south of the northernmost end of Eighty-mile Beach at Cape

Missiessy) being treated as the starting point, 0 km. They also revealed that counts of this beach are most repeatable on reasonably small high tides, between 6 and 7 m high. On lower tides not all birds are forced onto beach roosts. On higher tides the beach becomes so narrow that vehicle-based shorebird counters cannot skirt shorebird flocks without flushing them; in addition there have been indications that shorebirds make extensive long-shore movements on higher tides (perhaps so as to avoid roosting on the narrowest sections of beach), and these movements might cause birds to be overlooked or double-counted.

Northern sections of Eighty-mile Beach have been counted more frequently. A thirty-km stretch was counted twice annually (once in summer, once in winter) from 1993 to 2003. In 2004 these counts were expanded as part of the MYSMA project, with counts of a 60km stretch being carried out twice each summer, and once each winter. Methodology of these counts has been described fully by Rogers et al. (2006b).

In December 2008 we stuck as closely as we could to the Eighty-mile Beach survey methodology used in the past. However, some important changes were made. At the southernmost end of the beach, near Cape Keraudren, a 25 km stretch of beach was counted from quad-bikes rather than 4WD vehicles, as there are some patches of especially soft sand on this stretch of beach and the risk of getting a 4WD vehicle bogged and then losing it to an incoming tide was considered too high. The 1998 and 2001 surveys had accessed those sections of Eighty-mile Beach between *c*. 60 and 80m S of the Anna Plains Station access track by another access track through Mandora station. Sand dunes have drifted over this track, and it is no longer possible to reach this section through Mandora Station; in addition, a creekline to the south restricts access from the southern sections of Eighty-mile Beach. Eventually much of this beach-section needed to be counted from quad-bikes, and other parts of it were counted by teams that walked a long way in very hot conditions. Delays caused by the unexpected difficulty of beach access caused us to extend our Eighty-mile Beach count by a day – we had planned to complete the count on 10th and 11th December, but *c*. 20 km of beach were eventually counted on 12th December. Eight km of Eighty-mile Beach (in several discrete small stretches) were not reached during the December survey, but telescope scans of these “gaps” from very long range indicated that they did not hold large numbers of shorebirds.

In the northern third of Eighty-mile Beach, and in the southernmost sections near Cape Keraudren, individual counting teams were asked to count a 10km stretch of beach (two 5-km blocks) in each high tide period. Bird densities were lower along much of the remaining beach, and teams were sometimes able to cover much more ground during high tide: one team countied 42.5 km of beach on one day, and 30km on the next. In contrast, two teams were required to count the 10 km stretch of beach from 50-60 km s of the Anna Plains access track in a single high tide. This stretch of beach has proved problematic in recent MYSMA surveys, with large numbers of shorebirds flying into the area at about the peak of high tide. In December 2008 we carried out two counts or visits to the section of beach from 30-50 km S of the Anna Plains access track, as we were concerned that birds from these areas could be flying south on larger tides, and then being double-counted in the stretch of beach from 50-60 km south of the Anna Plains access track. Our data confirmed that this movement was occurring. Accordingly, our formal count of the beach section from 30-40 km S was made on 12th December **after** birds had flown south out of this survey area, ensuring that these birds were not double-counted in blocks further south.

We do not have comparable data from immediately south of the block from 50-60 km S; this area was only counted on 12th December. However, we consider it likely that if the beach stretch from 50-60 km S attracts birds from feeding grounds further north, it is likely to also attract birds from further south. We do not fully understand what attracts roosting shorebirds to this stretch of beach, but suspect that two factors are involved. First, the beach here is much broader here than it is to

the north or the south, allowing shorebirds to roost on open ground which is at least 0.5km from the nearest coastal dunes that could be used as cover for an attack by a bird of prey; shorebirds may therefore perceive this area as particularly safe. Secondly, the lower stretches of this beach may provide foraging opportunities as the tide begins to ebb which are unavailable on the steeper beaches to the north and south. As the tide ebbs in this relatively flat area a patchwork of shallow pools and wet sand becomes exposed. These kinds of areas do not become available as soon on steeper beaches to the north and south, but provide a valuable chance for extra foraging up to ½ hour earlier. This may be a particularly important consideration for Great Knots and Red Knots. Both species are bivalve specialists, and as the tide ebbed during December 2008, they were seen foraging for bivalves on the lower beach (above the tidal flats). The bivalves sought were thought to be *Paphies* cf. *altenai* and *Donax cuneatus*; these bivalve species are very suitable prey for knots, and have been confirmed as part of their diet at Eighty-mile Beach in 1999 (Rogers 2005; unpubl. data). The 1999 study demonstrated that at Eighty-mile Beach these species are abundant but restricted to a narrow band on the lower beach (above the open tidal flats of Eighty-mile Beach; Piersma et al. 2005).

Weather varied over the course of our Eighty-mile Beach surveys. It was overcast and unusually mild for December when counts were carried out on 10th December; 11th December was sunnier, but still relatively mild; temperatures increased abruptly (to the mid-40's) when easterly winds developed on 12th December. The mild conditions on the 10th and 11th influenced our counts of Oriental Plovers, Little Curlews and Oriental Pratincole. Unlike the other shorebird species of Eighty-mile Beach, these species do not feed on intertidal flats at low tide; instead they forage on the plains of Anna Plains and Mandorah Stations. In the mid-day heat they usually move onto Eighty-mile Beach to roost, as they can settle on recently wetted sand or mud where the microclimate is considerably cooler than that on the inland plains. On the 10th and 11th December temperatures were so mild that very few shorebirds on the plains needed to take refuge on Eighty-mile Beach. As a result our counts of these species (especially Oriental Plover) underestimated the number of birds present in the region.

The numbers of shorebirds counted on Eighty-mile Beach are summarised in Table 2. Analysis of changes in numbers of shorebirds, gulls and terns is given later in this report. Fifteen shorebird species were found in internationally significant numbers (>1% of the flyway population), and it is likely that three other shorebird species also occur in internationally significant numbers at times. The largest count ever made of Oriental Pratincole (2.88 million birds!) was recorded on Eighty-mile Beach in February 2004, when weather conditions apparently concentrated a very large proportion of the world population into north-western Australia (Sitters et al. 2004). Grey Plover numbers almost reached internationally significant numbers in December 2008, and the species was recorded in internationally significant numbers during the summer surveys held by the AWSG in 1998 and 2001. Because of the cool weather, Little Curlew numbers observed on Eighty-mile Beach were a substantial underestimate of the numbers present in the district; we think it is probable that they too were present on the adjacent plains in internationally significant numbers (>1800 birds).

Another noteworthy shorebird species seen in 2008 was Eurasian Curlew. This is considered to have been the individual recorded on Eighty-mile Beach (30 km to the north) in November 2007; this was the first accepted record of the species in Australia (Birds Australia Rarities Committee, Case 545: http://users.bigpond.net.au/palliser/barc/summ545.htm).

Numbers of gulls, terns and other waterbirds are summarised in Table 3. Assessing whether or not particular species occurred in internationally significant numbers was problematic because of limited information on flyway populations. Nevertheless, both subspecies of Gull-billed Tern on Eighty-mile Beach (the resident subspecies *macrotarsa*, and the migratory subspecies *affinis* from NE Asia) were present in internationally significant numbers, as were Little Tern of the migratory subspecies

sinensis. Our count totals for Gull-billed Terns are probably close to the real number of birds present, as this species forages on intertidal flats and roosts with shorebirds at high tide (Rogers *et al*. 2005). (Subspecies *macrotarsa* also forages on freshwater wetlands, but there was no extensive freshwater habitat near Eighty-mile Beach at the time of this survey). Numbers of other tern species on Eighty-mile Beach could easily be higher at times than recorded during our surveys; most of these species feed at sea, and though they tend to come to roost in the middle of the day, we cannot be sure that all birds were on roosts at the time we carried out our shorebird counts. Moreover, previous surveys of the northern parts of Eighty-mile Beach, around Broome and on the west coast of the Dampier Peninsula suggest that there are substantial movements of terns along this coastline, and that the timing of these movements is rather unpredicatable and poorly understood.

Numbers of other largely piscivorous waterbirds such as pelicans, cormorants and herons were remarkably low along Eighty-mile Beach, considering the length of this stretch of coastline.

Table 2. Shorebird numbers on Eighty-mile Beach, 10-12 December 2008. Flyway population estimates for migratory shorebirds are from Bamford et al. (2008); those for other species are from Delaney and Scott (2007). Species are considered to occur in internationally significant numbers at a site if it holds more than 1% of the flyway population.

Species	Count	Flyway Population	Notes
Asian Dowitcher	2	24,000	
Australian Pratincole	1	60,000	
Bar-tailed Godwit	51,114	325,000	Internationally significant
Black-tailed Godwit	52	160,000	
Black-winged Stilt	10	300,000	
Broad-billed Sandpiper	35	25,000	
Common Greenshank	2,531	60,000	Internationally significant
Common Sandpiper	5	25-100,000	
Curlew Sandpiper	3,291	180,000	Internationally significant
Eastern Curlew	423	38,000	Internationally significant
Eurasian Curlew	1	40,000	
Great Knot	128,623	375,000	Internationally significant
Greater Sand Plover	22,698	110,000	Internationally significant
Grey Plover	1,119	125,000	Nationally significant
Grey-tailed Tattler	7,945	50,000	Internationally significant
Lesser Sand Plover	7	140,000	
Little Curlew	784	180,000	
Marsh Sandpiper	127	100,000 – 1,000,000	
Oriental Plover	17,298	70,000	Internationally significant
Oriental Pratincole	1,100	2,880,000	
Pacific Golden Plover	73	100,000	
Pied Oystercatcher	804	11,000	Internationally significant
Red Knot	23,123	220,000	Internationally significant
Red-capped Plover	6,660	95,000	Internationally significant
Red-necked Stint	28,168	325,000	Internationally significant
Ruddy Turnstone	2,432	35,000	Internationally significant
Sanderling	3,427	22,000	Internationally significant
Sharp-tailed Sandpiper	205	160,000	
Sooty Oystercatcher	25	4,000	
Terek Sandpiper	4,620	60,000	Internationally significant
Unidentified Waders	3,000		
Whimbrel	351	100,000	
Total	310,054		

Table 3. Numbers of other waterbirds on Eighty-mile Beach, 10-12 December 2008. Flyway population estimates are from Delaney and Scott (2007); they are not available for all species. Species are considered to occur in internationally significant numbers at a site if it holds more than 1% of the flyway population.

Species	Count	Flyway Population	Notes
GULLS AND TERNS			
Caspian Tern	90	10,000-100,000	
Common Tern	2069	25,000-1,000,000	
Crested Tern	1963		
Gull-billed Tern *affinis*	921	10,000 – 100,000	Internationally significant
Gull-billed Tern *macrotarsa*	1366	25,000 – 100,000	Internationally significant
Lesser Crested Tern	500		
Little Tern	1880	10,000-100,000	Internationally significant
Roseate Tern	1780		
Silver Gull	757	100,000 – >1,000,000	
Whiskered Tern	847	100,000 – 1,000,000	
White-winged Black Tern	1134	25,000 – 1,000,000	
Total	13,307		
OTHER WATERBIRDS	Count		
Australian Pelican	237	100,000 – 1,000,000	
Black-necked Stork	2	30,000	
Brolga	2	25,000 – 100,000	
Eastern Reef Egret	4	100,000 – 1,000,000	
Lesser Frigatebird	1		
Little Egret	9	25,000 – 100,000	
Pied Cormorant	6	100,000 – 1,000,000	
Pink-eared Duck	2	➢ 1,000,000	
Reef Egret	2	100,000 – 1,000,000	
Striated Heron	1		
White Ibis	3	100,000 – 1,000,000	
White-faced Heron	1	25,000 – 1,000,000	
Total	270		

Distribution of birds along Eighty-mile Beach was far from uniform. In general shorebird numbers were higher at the northern end of the beach, but the “hotspots” where abundance was highest varied considerably among species. Tabulation of species counts in each 5-km block is difficult in the confines of an A4 report, but details are available in the master dataset, which has been lodged with DEWHA, DEC and the National Shorebird Dataset at Birds Australia. Figures 4 and 5 summarise distribution along Eighty-mile Beach for a selection of the more abundant species.

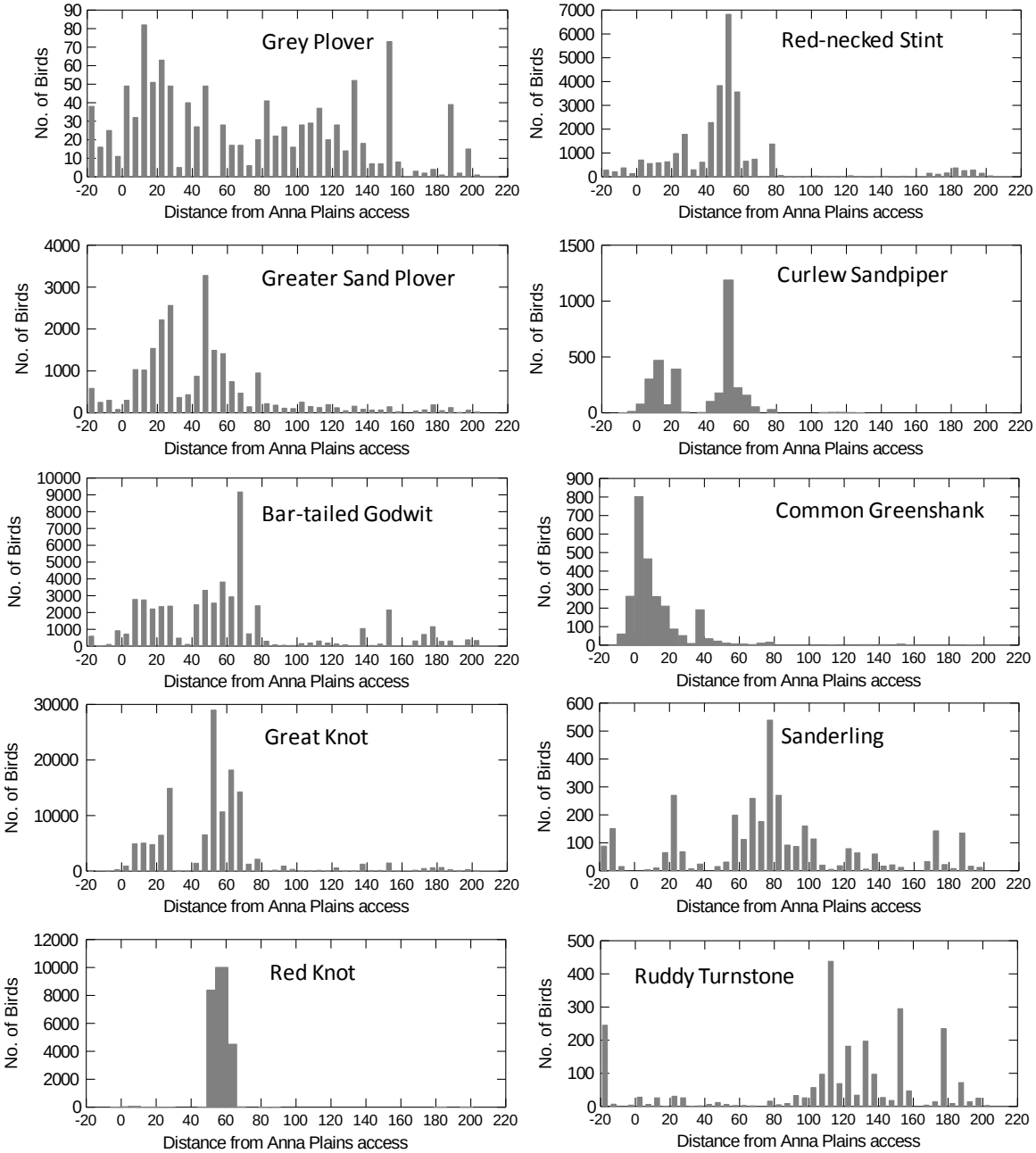

Figure 4. Distribution of common migratory shorebird species on Eighty-mile Beach. The X-axis shows the distance (km) from the access road onto Eighty-mile Beach from Anna Plains station; the Y-Axis indicates number of birds.

Grey Plover was the only common shorebird species which appeared to be uniformly distirubted along Eighty-mile Beach. In many of the most abundant species (e.g. Great Knot, Bar-tailed Godwit, Greater Sand-Plover, Red-necked Stint and Curlew Sandpiper) there was a clear tendency for the highest numbers to occur in the northern third of the beach, with highest numbers between *c*. 40 and 70 km south of the Anna Plains access road. This applied particularly strongly to Red Knot, which was seen in thousands along a 15km stretch of beach between 50 and 65 km south, but was virtually absent elsewhere. The stretch of beach from 25-45 km south of the access road is relatively narrow, and, it had lower numbers of most species than the beach areas to the north and south. On the second and third days of our survey (on tides of 6.79 and 7.27m) we saw large numbers of birds flying south towards the very broad beaches between 50-65 km south. We suspect this movement may occur regularly on bigger tides, and it has important implications for count methodology on Eighty-mile Beach.

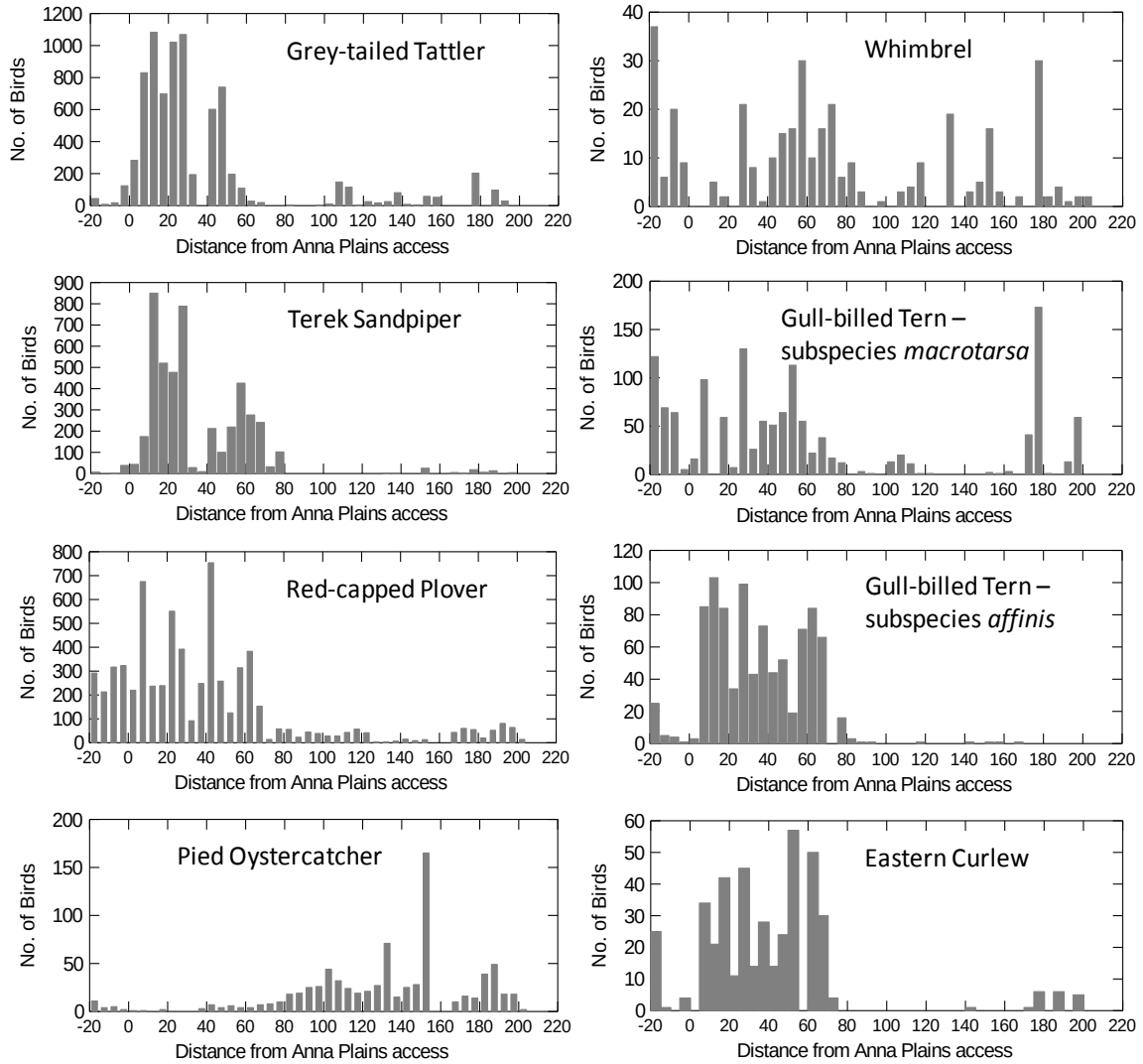

Figure 5. Distribution of more common migratory shorebird species on Eighty-mile Beach. The X-axis shows the distance (km) from the access road onto Eighty-mile Beach from Anna Plains station; the Y-Axis indicates number of birds.

Different distributional patterns were shown by other species. Common Greenshanks were only common at the far northern end of Eighty-mile Beach, as has been the case in all previous MYSMA surveys. Sanderlings were most abundant from 55 to 100 km south of the Anna Plains access point; Ruddy Turnstone and Pied Oystercatcher were most abundant in the southern half of Eighty-mile Beach.

The patchy distribution of Whimbrels was closely matched by that of Gull-billed Terns, subspecies *macrotarsa*. A similar correlation has been previously reported in Roebuck Bay (Rogers et al. 2005), where *macrotarsa* Gull-billed Terns (a large resident Australian subspecies) forages predominantly by stealing large crabs from Whimbrels. The migratory Gull-billed Tern subspecies *affinis* has a quite different distribution on Eighty-mile Beach; it is curiously similar to the distributions of Eastern Curlew and Red-capped Plover.

Between Eighty-mile Beach and Bush Point

Some 130 km of coastline lie between Cape Missiessy (at the northern end of Eighty-mile Beach) and Jack's Creek (just south of Bush Point). Although this coastal stretch lies between Australia's two premier shorebird sites (Figure 6), it has received little attention since some aerial surveys were carried out in the early 1980's, and no ground counts of shorebirds had been carried out here before. In December 2008 we carried out the first partial ground counts, focussing on bays and other stretches of this indented coastline which had some tidal flats, and in which some shorebirds had been seen during an aerial reconnaissance in October. We were unable to reach some of the sites in the time available, but these were surveyed from the air on 13th December 2008.

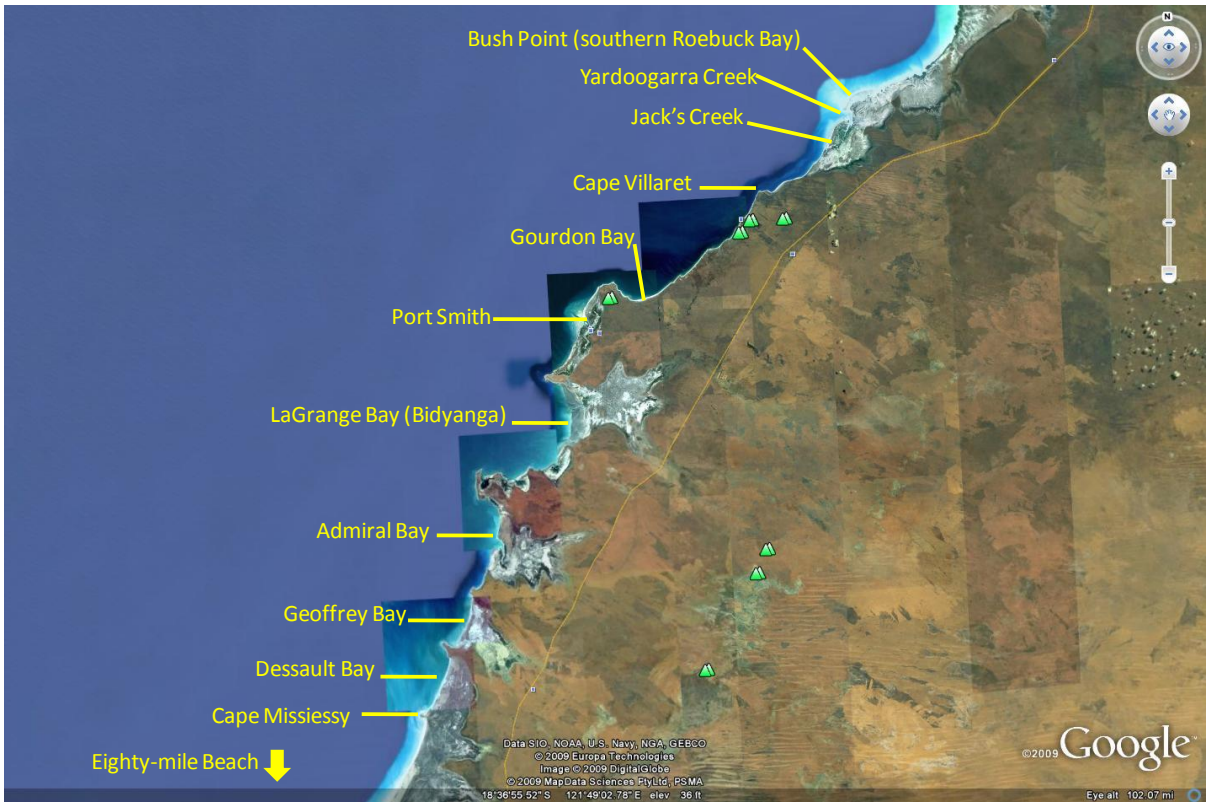

Figure 6. Google Earth imagery of the coastline between Eighty-mile Beach and Roebuck Bay, indicating the sites named in the text.

Dessault Bay

Dessault Bay was reached by driving north along the beach from Anna Plains Station on 11th December. Access was reasonably straightforward, though there were patches of soft sand, and the northernmost sections of the bay lay behind a creek which probably cannot be crossed at high tide.

Ground counts made on this survey are summarised in Table 4. Over 2000 shorebirds were found on this stretch of coastline. None were found in internationally significant numbers, but numbers of two shorebird species typically associated with sandy coastlines such as this were noteworthy: counts were made of 528 Greater Sand Plovers (c. 0.5% of the flyway population) and 200 Sanderling (0.91% of the flyway population). Given that Sanderling frequently make long-shore movements along beaches, and that there were over 230 more Sanderling just to the south (on the northernmost 10 km of Eighty-mile Beach), it is likely that this species sometimes occurs in Dessault Bay in internationally significant numbers.

The most noteworthy discovery on this beach section was at the creek mouth highlighted in Figure 7. The large flock of roosting terns there included internationally significant numbers of Little Tern. Moreover, there was a nesting colony of Little Terns on a spit on the north side of the creek line. In the time available, it was not possible to count the nesting terns, or to estimate the relative number of migrant Little Terns from the northern hemisphere, and from the local breeding population. Nevertheless, any Australian breeding colony of Little Tern is noteworthy. The Australian breeding population has been estimated to be no more than 3,000 pairs, and little is known about the taxonomic status or size of the small populations nesting in north-western Australia.

Figure 7. Google Earth satellite image of Dessault Bay.

Table 4. Waterbird counts in Dessault Bay, 11th December 2009.

Species	0-5 km N of Cape Missiessy	5-10 km N of Cape Missiessy	Total
SHOREBIRDS			
Bar-tailed Godwit	140	10	150
Common Sandpiper		2	2
Eastern Curlew		2	2
Great Knot	24		24
Greater Sand Plover	211	317	528
Grey Plover	14	29	43
Grey-tailed Tattler	33	9	42
Lesser Sand Plover		1	1
Pied Oystercatcher	3	12	15
Red-capped Plover	176	285	461
Red-necked Stint	141	227	368
Ruddy Turnstone	159	15	174
Sanderling	11	189	200
Sharp-tailed Sandpiper		1	1
Terek Sandpiper	4		4
Whimbrel	27	6	33
Total	943	1105	2048
GULLS AND TERNS			
Caspian Tern		2	2
Common Tern	88	57	145
Crested Tern	390	46	436
Gull-billed Tern *affinis*	2	5	7
Gull-billed Tern *macrotarsa*	50	74	124
Lesser Crested Tern	80	5	85
Little Tern	653	425	1078
Silver Gull	4	20	24
Whiskered Tern	59	138	197
White-winged Black Tern	3		3
Total	1329	772	2101
OTHER WATERBIRDS			
Australian Pelican	7	3	10
Black-necked Stork		2	2
Lesser Frigatebird	1		1
Little Egret		2	2
Total	8	7	15
GRAND TOTAL	2280	1884	4164

Geoffrey Bay

No ground count was made here, as the site would have been difficult and time-consuming to access, and aerial reconnaissance had suggested it held few shorebirds. An aerial survey was made on 13th December. Unfortunately, the division between Geoffrey Bay, and Dessault Bay to the south, was not recognised from the air, with the result that counts for these two areas were combined.

The results of this aerial survey are summarised below. The most noteworthy feature of the table is the large numbers of terns, especially Little Tern, but these were presumably largely birds from the large tern flock and nesting colony in Dessault Bay. Numbers of Grey-tailed Tattler, Terek Sandpiper, Silver Gull and White-faced Heron exceeded those seen in ground counts in Dessault Bay, so presumably at least some of these birds occurred in Geoffrey Bay. The data are too patchy to make firm assessments of waterbird numbers in Geoffrey Bay, but there is no reason to believe the site held any waterbird species in internationally significant numbers.

Table 5. Waterbird counts recorded by aerial survey for Dessault Bay and Geoffrey Bay combined, 13th December 2008.

Species	Count
SHOREBIRDS	
Pied Oystercatcher	10
Grey-tailed Tattler	80
Terek Sandpiper	20
Whimbrel	40
Waders medium	120
Total	270
GULLS AND TERNS	
Silver Gull	439
Little Tern	510
Tern sp.	280
Total	1229
OTHER WATERBIRDS	
White-faced Heron	2
Egret sp.	3
Total	5
Grand Total	1,504

Admiral Bay

No ground count was made here, as the site would have been difficult and time-consuming to access; indeed we were not confident that we would be able to get to it at all. Aerial reconnaissance had suggested the site held few waterbirds, and this was still the case when the site was surveyed from the air on 13th December (Table 6).

Table 6. Waterbird counts recorded by aerial survey, Admiral Bay, 13th December 2008.

Species	Count
SHOREBIRDS	
Pied Oystercatcher	4
Grey Plover	2
Common Greenshank	2
Terek Sandpiper	10
Whimbrel	23
Waders small	34
Wader sp.	124
Total	199
GULLS AND TERNS	
Silver Gull	6
Tern sp.	120
Total	126
OTHER WATERBIRDS	
Egret sp.	4
Black-necked Stork	1
Total	5
Grand Total	330

Lagrange Bay (Bidyadanga)

Almost 20 km wide, this is the largest of the bays between Eighty-mile Beach and Roebuck Bay, and it has extensive tidal flats in the northern half. Access to the site (which has to be arranged in advance with the traditional owners) is reasonably good in dry conditions, with a network or tracks radiating out from the community of Bidyadanga. On the ground count on 12th December, tides had reached the bases of sand dunes and low cliffs along much of the south end of the bay. Attention was therefore focussed on the northern end of the bay where reasonable numbers of shorebirds were found. The largest concentrations were by the creek mouth and on the south-facing beach visible in Figure 8, with smaller numbers of birds roosting on rock platforms jutting out from this south-facing beach.

An aerial survey conducted the next day (13th December) produced a higher count of waterbirds (Table 7), suggesting that birds were missed during the ground counts. About 2,600 birds were seen north of Bidyidanga in the region where most birds were seen on the ground count, including 82 Pied Oystercatchers (a particular conspicuous species) and 2260 “grey” waders, suggesting that some wader flocks had been overlooked on the ground. This is not surprising considering the size of the area and the lack of previous exploration. A further 1600 “grey” waders and 43 Eastern Curlew were found in LaGrange Bay south of the southernmost point reached by the ground team, mostly in creek mouths.

Figure 8. Google Earth satellite image of LaGrange Bay and Bidyadanga.

As the tide ebbed, the ground-counting team was struck by how low shorebird densities were on the extensive tidal flats; LaGrange Bay does not appear to hold feeding shorebirds in densities like those observed on Roebuck Bay and Eighty-mile Beach. Nevertheless, count totals for Bidyadanga and LaGrange Bay, summarised in table 7, indicate the site to be of some importance to shorebirds. Given that the ground count was incomplete and aerial surveys tend to undercount shorebirds, it is quite possible that the site holds over 5000 shorebirds. No species are known to occur there in internationally significant numbers, but more comprehensive ground count data are needed from the site.

Table 7. Waterbird counts at LaGrange Bay: ground count on 12th December and aerial count on 13th December 2008.

Species	Ground Count	Aerial Count (13th December)
SHOREBIRDS		
Bar-tailed Godwit	686	
Common Greenshank	3	
Common Sandpiper	2	
Eastern Curlew	17	48
Great Knot	391	
Greater Sand Plover	388	
Grey Plover	31	
Grey-tailed Tattler	64	175
Lesser Sand Plover	1	
Pacific Golden Plover	1	
Pied Oystercatcher	63	82
Red-capped Plover	78	
Red-necked Stint	90	
Ruddy Turnstone	61	
Sanderling	8	
Sooty Oystercatcher	1	
Terek Sandpiper		135
Whimbrel	61	2
Wader sp.		2,810
Waders small		350
Waders medium		320
Total	1,946	3,922
GULLS AND TERNS		
Crested Tern	17	
Gull-billed Tern *macrotarsa*	34	
Lesser Crested Tern	1	
Silver Gull	11	15
Tern sp.		209
Total	63	224
OTHER WATERBIRDS		
Australian Pelican		31
Black-necked Stork		2
Egret sp.		32
Little Black Cormorant		10
Total	0	75
Grand total	2,009	4,221

Port Smith

Rather few birds were seen in our ground count at Port Smith (Figure 9); we found one group at the mouth of the inlet roosting at high tide, and scattered birds feeding on the centre of the lagoon as the tide dropped. Unlike most coastal shorebird sites, we believe this to be a site which would be most reliably counted at low tide. Vehicle access around the area to potential high tide roosts is limited, and it is easy to get bogged in soft sand. However, at low tide, the coarse white sand in the Port Smith Inlet is firm to walk on, and it should be possible to walk to positions from which is possible to scan all exposed tidal flat.

On our ground counts we did not have time to walk extensively on the tidal flats at low tide, and examination of satellite imagery suggested we had not seen into the far ends of the Port Smith Inlets. However, it unlikely that they held many shorebirds, as the aerial survey conducted on 13th May detected only 60 “grey” shorebirds and four Pied Oystercatchers.

The other birds detected from the air were a Black-necked Stork, 2 White Ibis, 10 Little Black Cormorants and 275 unidentified terns at the mouth of Port Smith Inlet. No waterbird species were recorded or seem likely to occur at this site in internationally significant numbers. A local curiosity was the number of Lesser Sand Plovers – this species is greatly outnumbered by Greater Sand Plover in most of north-western Australia, but in Port Smith they were in almost equal numbers.

Figure 9. Google Earth satellite image of Port Smith and the south of Gourdon Bay.

Table 8. Waterbird counts at Port Smith, 12th December 2008.

Species	Count	Species	Count
SHOREBIRDS			
Bar-tailed Godwit	6	GULLS AND TERNS	
Common Greenshank	3	Crested Tern	55
Common Sandpiper	4	Little Tern	1
Eastern Curlew	3	Silver Gull	1
Greater Sand Plover	12	Total	57
Grey-tailed Tattler	7		
Lesser Sand Plover	5		
Red-capped Plover	4	OTHER WATERBIRDS	
Ruddy Turnstone	2	Darter	1
Whimbrel	2	Little Egret	3
Total	48	Total	4

Gourdon Bay

This bay had not appeared especially promising for shorebirds during aerial reconnaissance, but we carried out a ground count nevertheless, as there were no shorebird data for the site and it had been proposed as a potential site for an LNG Hub. It proved to an attractive site, with clear water and gleaming white beaches, but the shores are rather steep and there were no extensive tidal flats.

There was no vehicle access onto the beach of Gourdon Bay, and there were few access points from which we could scan. However, the coastline is very straight and shorebirds stood out boldly from the white beaches when roosting, so we felt we could detect birds from very long range. The aerial survey on 13th December confirmed that few shorebirds were present: only 4 Pied Oystercatchers, 10 “grey” waders and 60 unidentified terns were seen. No waterbird species occurs or seems likely to occur at this site in internationally significant numbers.

Table 9. Waterbird counts at Gourdon Bay, 12th December 2008.

Species	South	North	Total	Species	South	North	Total
SHOREBIRDS							
Bar-tailed Godwit		10	10	GULLS AND TERNS			Total
Common Sandpiper	2		2	Silver Gull	1	1	2
Greater Sand Plover	5		5	UNID terns		20	20
Grey-tailed Tattler	30		30	Total	1	21	22
Lesser Sand Plover	2		2				
Red-capped Plover	5		5	OTHER WATERBIRDS			Total
Red-necked Stint		25	25	Brown Booby		2	2
Sooty Oystercatcher	1	3	4	Pied Cormorant	1		1
Total	45	28	73	Total	1	2	3

Cape Villaret to Jack's Creek

Access to this stretch of white sand beach was made through Eco Beach. Large numbers of shorebirds were seen, almost all at Jack's Creek. Jack's Creek is not far from Bush Point, at the southern end of Roebuck Bay. It is not clear whether the birds found roosting at Jack's Creek were feeding locally, or birds that typically feed on the very broad sandflats of Bush Point. Unfortunately, we have no ground count data for the 6km stretch of beach between Jack's Creek and Yardoogarra Creek (Figure 9), which demarcates the southern boundary of the Bush Point count site. This stretch of coastline is difficult to access, and can only be reached by boat at high tide. An aerial survey of the stretch from Jack's to Yardoogarra Creek on 13th December revealed only 40 unidentified shorebird, suggesting these step white beaches are not an important roost, and that Jack's Creek and Bush Point should be regarded as discrete shorebird sites. However, surveying in a variety of different tide conditions would be needed to confirm this.

Shorebird numbers counted along this coastal stretch are summarised in Table 10. Greater Sand Plovers occurred in internationally significant numbers (2201 seen; 1% of the flyway population = 1,100), and Sanderling numbers approached internationally significant levels (215 seen; 1% of the flyway population = 220).

Numbers of shorebirds seen during aerial surveys of this stretch on 13th December were lower than those recorded on the ground counts of 14th December: 6 Pied Oystercatchers, 9 Eastern Curlew, 770 unidentified shorebirds, 200 unidentified terns, 25 Australian Pelicans and 7 Pied Cormorants.

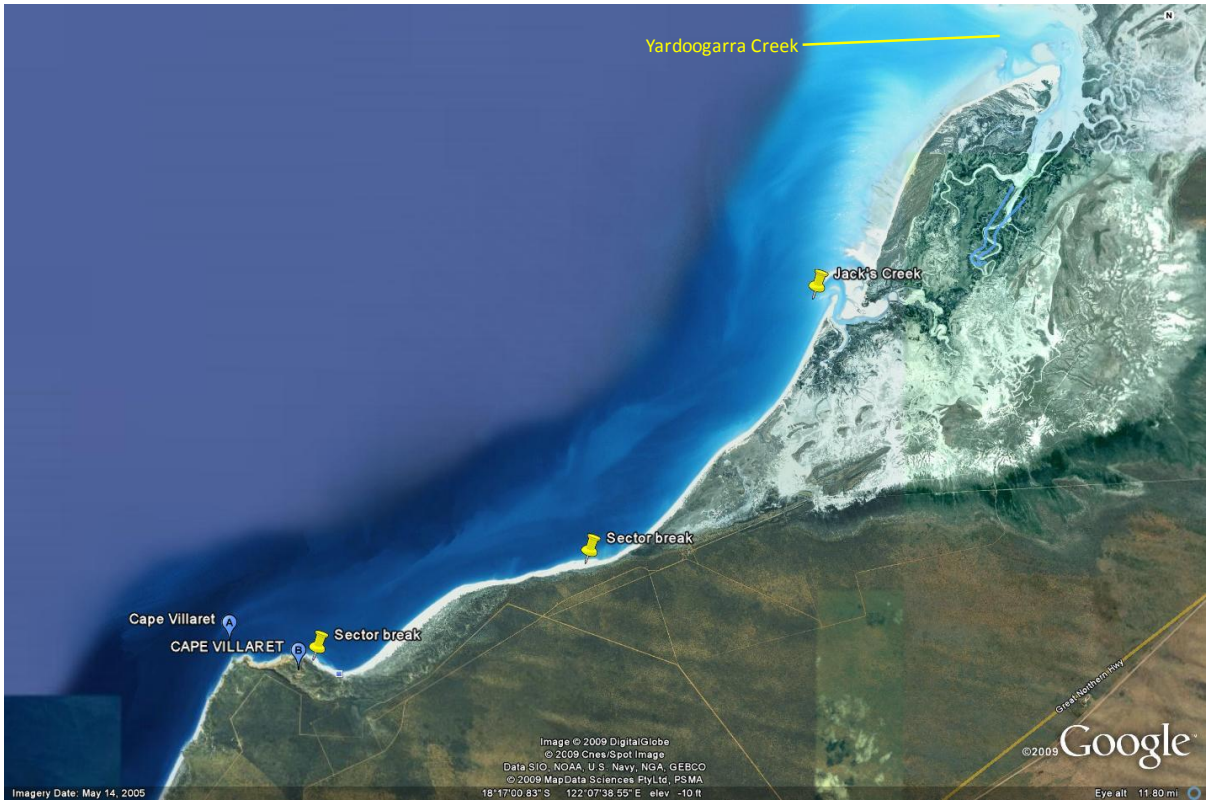

Figure 9. Google Earth satellite image of the coastline between Cape Villaret and Jack's Creek, with Yardoogarra Creek (the southern boundary of the Bush Point Count site) visible in the north-east corner. The yellow map pins indicate breaks between different count sectors tabulated in Table 10.

Table 10. Waterbird counts on the coast between Cape Villaret and Jack's Creek, 14th Dec. 2008.

Species	Cape Villaret	S-sector	Mid-sector	N-sector	TOTAL
SHOREBIRDS					
Bar-tailed Godwit			2	2560	2562
Black-winged Stilt				2	2
Common Greenshank				2	2
Common Sandpiper		1		1	2
Curlew Sandpiper				1	1
Eastern Curlew			1	20	21
Great Knot			21	1125	1146
Greater Sand Plover		44	42	2115	2201
Grey Plover		10	52	71	133
Grey-tailed Tattler		6	51	99	156
Oriental Plover			51	15	66
Pacific Golden Plover		3	3	22	28
Pied Oystercatcher		6	13	4	23
Red-capped Plover		18	47		65
Red-necked Stint		7	3	505	515
Ruddy Turnstone		4	29	132	165
Sanderling			4	211	215
Whimbrel		3	22	69	94
Total		102	341	6954	7397
GULLS AND TERNS					
Common Tern	20	57		176	253
Crested Tern	12	475		92	579
Gull-billed Tern *macrotarsa*		5	1	15	21
Lesser Crested Tern	6	32		18	56
Little Tern	285	36		33	354
Roseate Tern				2	2
Silver Gull		2	3		5
Whiskered Tern	20			292	312
White-winged Black Tern	4			7	11
Total	347	607	4	635	1593
OTHER WATERBIRDS					
Australian Pelican	29		29		58
Great White Egret	1		1		2
Little Egret	3		3		6
Grand Total	33		33		66
Total	380	345	7622	709	9056

Tables 11 and 12 summarise the count totals on the stretch of coastline between Eighty-mile Beach and Roebuck Bay. Overall this region holds internationally important number of six species: Bar-tailed Godwit, Greater Sand Plover, Pied Oystercatcher, Ruddy Turnstone, Sanderling and Little Tern.

Table 11. Summary of shorebird totals between Eighty-mile Beach and Roebuck Bay, 12th-14th December 2008. Based largely on ground-counts, but aerial count data have been included instead, in cases where the species total for a site was higher in aerial surveys than in ground surveys.

Species	Dessault Bay	Geoffrey Bay	Admiral Bay	Bidya-danga	Port Smith	Gourdon Bay	Cape Villaret to Jack's Ck	Grand Total
SHOREBIRDS								
Bar-tailed Godwit	150			686	6	10	2562	3414
Black-winged Stilt	0					0	2	2
Common Greenshank	0		2	3	3	0	2	10
Common Sandpiper	2			2	4	2	2	12
Curlew Sandpiper	0					0	1	1
Eastern Curlew	2			48	3	0	21	74
Great Knot	24			391		0	1146	1561
Greater Sand Plover	528			388	12	5	2201	3134
Grey Plover	43		2	31		0	133	209
Grey-tailed Tattler	42	38		175	7	30	156	448
Lesser Sand Plover	1			1	5	2	0	9
Oriental Plover	0					0	66	66
Pacific Golden Plover	0			1		0	28	29
Pied Oystercatcher	15		4	82	4	4	23	132
Red-capped Plover	461			78	4	5	65	613
Red-necked Stint	368			90		25	515	998
Ruddy Turnstone	174			61	2	0	165	402
Sanderling	200			8		0	215	423
Sharp-tailed Sandpiper	1					0	0	1
Sooty Oystercatcher	0			1		4	0	5
Terek Sandpiper	4	16	10	135		0	0	165
Whimbrel	33	7	23	61	2	0	94	220
Unidentified			158	1821	12			1991
Total	2048	61	199	4063	64	87	7397	13919

Table 12. Summary of numbers of gulls, terns and other waterbirds between Eighty-mile Beach and Roebuck Bay, 12th-14th December 2008. Based largely on ground-counts, but aerial count data have been used in cases where the species total for a site was higher in aerial surveys than in ground surveys.

	Dessault Bay	Geoffrey Bay	Admiral Bay	Bidya-danga	Port Smith	Gourdon Bay	Cape Villaret to Jack's Ck	Grand Total
GULLS AND TERNS								
Caspian Tern	2					0	0	2
Common Tern	145					0	253	398
Crested Tern	436			17	55	0	579	1087
Gull-billed Tern affinis	7					0	0	7
Gull-billed Tern macrotarsa	124			34		0	21	179
Lesser Crested Tern	85			1		0	56	142
Little Tern	1078				1	0	354	1433
Roseate Tern	0					0	2	2
Silver Gull	24	415	6	15	1	2	5	468
UNID terns	0		120	209	275	60	0	664
Whiskered Tern	197					0	312	509
White-winged Black Tern	3					0	11	14
Total	2101	415	126	276	332	62	1593	4905
OTHER WATERBIRDS								
Australian Pelican	10			31		0	58	99
Black-necked Stork	2		1	2	1	0	0	6
Brown Booby	0					2	0	2
Darter	0				1	0	0	1
Great White Egret	0					0	2	2
Little Black Cormorant				10	10			20
Lesser Frigatebird	1					0	0	1
Little Egret	2				3	0	6	11
Pied Cormorant	0					1	0	1
White Ibis					2			2
Egret sp.			4	32				36
Total	15	0	5	75	17	3	66	181
Grand Total (with shorebirds)	4164	476	330	4414	413	152	9056	19005

Roebuck Bay (Northern Beaches and Bush Point)

Roebuck Bay is one of Australia's premier shorebird sites. Counts of the bay have been made fairly regularly since the importance of the site to shorebirds was discovered in the early 1980's, and there have been detailed studies of shorebird movements in the region at high tide (Rogers et al. 2006a, 2006b). These studies have led to a good understanding of the best way to monitor shorebirds in the bay, but it remains a difficult site to count. The bay is large with very extensive tidal flats. Much of its eastern and southern coastline is lined by mangroves and saltmarsh and is very difficult to access. Repeatable surveys are dependent on careful selection of the most suitable tides.

Shorebirds feeding on the northern intertidal flats of Roebuck Bay are now surveyed on "intermediate" high tides between 7.0 and 8.4 m high. On smaller tides many birds roost on inaccessible mudbanks on the eastern shores of the bay (flooded on higher tides); on higher tides many or all shorebirds roost in an inaccessible complex of mangrove clearings and supratidal claypans (only suitable for shorebirds if the tide is high enough to moisten the substrate and lower surface temperatures). On tides of intermediate height when these alternate roosting options are unavailable, the only roosting options for birds at the north end of the bay are on the Northern Beaches between Broome and the Crab Creek mangroves. These sites are easily accessed by birdwatchers, but are still a challenge to count, as birds in these roosts can be very densely packed, and they experience intensive disturbance from birds of prey and humans. Shorebird counts on the northern beaches are often interrupted when birds take flight and settle on other beaches.

Shorebirds feeding on the southern intertidal flats of Roebuck Bay move towards the sandy beaches of Bush Point when the tide is high. On tides lower than *c*. 8m, some of these birds find roosts on narrow, exposed areas of tidal flat just in front of the inaccessible mangroves; on tides higher than c. 8.4 m, tracks through the saltmarshes of Thangoo Station to Bush Point become impassible. Ideally, then, counts of Bush Point should be carried out on tides of 8.0-8.4 m. In practice this can be difficult in the October – December period, when few daytime spring tides reach the required height.

We carried out our count of the northern beaches of Roebuck Bay on 13th December 2009, on a tide of 7.69m. It was a day of high disturbance, and count totals of several species were considered unrealistically low as a result. Accordingly we recounted the northern beaches on 14th December, focussing on the under-counted species, and we have used the higher total from these two counts in the summaries below (Tables 13-14).

The Bush Point count was carried out on 14th December, on a high tide of 7.95 m (the highest available tide during the study period). Extremely hot weather conditions forced unusually large numbers of Oriental Plover and Oriental Pratincole to Bush Point, presumably from the plains of Thangoo Station. As we were concerned that the tide may not be high enough to force all shorebirds from the southern flats of Roebuck Bay onto Bush Point, we also carried out an aerial survey of the southern flats and Bush Point on 13th December, so we could check for major discrepancies between the two count totals. On this flight we also took the opportunity to count shorebirds in the upper stretches of Crab Creek, to check whether all birds from this area moved to the Northern Beaches. While we were reasonably confident that most shorebird species would move to the northern beaches, we thought it possible that some other waterbird species, especially egrets, might spend high tide roosting on mangroves. Although there is a long history of shorebird counts in Roebuck Bay, this was the first year in which a count of all waterbird species had been attempted.

Data for both the ground counts and aerial surveys are summarised in Tables 13 and 14. The aerial survey was carried out on a rising tide when some tidal flats were still exposed. Shorebirds feeding on the eastern waterline of Roebuck Bay are thought to roost either at Bush Point on the Northern Beaches, depending on which is closer (Rogers et al. 2006c). Birds seen on the aerial survey were

therefore treated as "Bush Point" birds if they were seen south of the halfway point (indicated in Figure 10). While this is probably a reasonable overall assumption, it is not known if it applies equally well to all shorebird species.

Bearing this in mind, the correspondence between ground surveys and aerial surveys of Bush Point was reasonably good. The ground count, carried out in the middle of the day at the peak of high tide, resulted in a count of 59,603 shorebirds at Bush Point. However, 26,295 of these were species which do not feed on intertidal flats and are not usually seen at Bush Point in large numbers: Oriental Pratincole, Oriental Plover and Little Curlew. It is believed that these birds were forced to Bush Point by the very high temperatures (low 40's) on 14th December, and in cooler conditions they would have remained on Roebuck Plains. The aerial survey of 14th December took place in cooler conditions, as it was a morning flight, and no Oriental Plovers or Oriental Pratincoles (both species which are reasonable easy to identify from the air) were recorded. Excluding these species, numbers of "grey waders" from the tidal flats were similar: 33,308 were recorded during the ground count, and 35,949 were observed in the aerial survey.

The aerial surveys revealed larger numbers of Brolga, Black-necked Stork, egrets, Royal Spoonbill and White Ibis than were observed during the ground counts. These species are believed to have spent high tide in the mangroves rather than moving into high tide roosts on the northern beaches.

Overall, 11 shorebird species and two species of tern were found in internationally significant numbers. These included the highest counts of Whimbrel ever made in the bay. Seven species previously recorded in Roebuck Bay in internationally significant numbers were not in internationally significant numbers during December 2008 (Grey Plover, Ruddy Turnstone, Eastern Curlew, Black-tailed Godwit, Common Greenshank, Asian Dowitcher and Curlew Sandpiper).

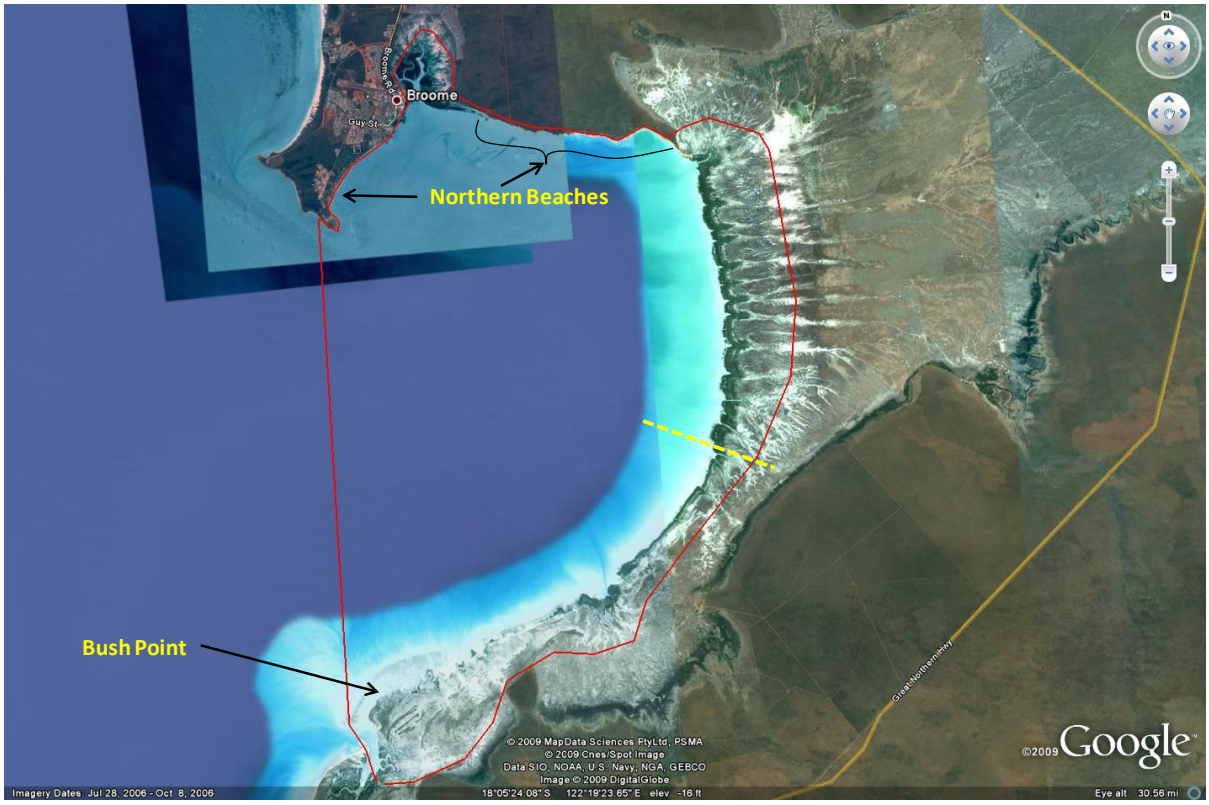

Figure 10. Google earth imagery of Roebuck Bay. The yellow dotted line indicates the halfway point between the Northern Beaches and Bush Point.

Table 13. Summary of shorebird numbers in Roebuck Bay, 13th-14th December 2008. Aerial survey results are shaded grey. Overall Roebuck Bay totals were obtained by adding together the ground counts from Bush Point and the Northern Beaches. However, higher counts of Marsh Sandpiper and Red-necked Avocet were made on the aerial surveys than on the ground-count totals, so the aerial counts for these two species are used in the overall Roebuck Bay totals. Boldface denotes species counts in internationally significant numbers.

Species	Bush Point Ground count	Bush Pt & east coast aerial survey	Northern Beaches	Inner Crab Creek aerial survey	Roebuck Bay total
SHOREBIRDS					
Asian Dowitcher	3				3
Bar-tailed Godwit	**16,541**	150	**4,027**		**20,568**
Black-tailed Godwit	1		469		470
Black-winged Stilt		161	381	71	381
Broad-billed Sandpiper	1		131		132
Common Greenshank	1	185	560	150	561
Common Sandpiper	1		26		27
Curlew Sandpiper	26		1,142		1,168
Eastern Curlew	175	6	134		309
Great Knot	**8,343**		**11,931**		**20,274**
Greater Sand Plover	**3,057**		**3,779**		**6,836**
Grey Plover	127	1	145		272
Grey-tailed Tattler	40	225	**2,765**	300	**2,805**
Lesser Sand Plover	124		34		158
Little Curlew	37		830		867
Marsh Sandpiper				5	5
Oriental Plover	**5,298**		**1,133**		**6,431**
Oriental Pratincole	20,960		81		21,041
Pacific Golden Plover	5		23		28
Pied Oystercatcher	342	281	23		365
Red Knot	27		**2,798**		**2,825**
Red-capped Plover	**1,415**		**1,227**		**2,642**
Red-necked Avocet			25	30	30
Red-necked Stint	1,390		**4,299**		**5,689**
Ruddy Turnstone	24		249		273
Sanderling	**914**				**914**
Sharp-tailed Sandpiper			263		263
Sooty Oystercatcher			33		33
Terek Sandpiper	199	245	**492**	**150**	**691**
Whimbrel	285	215	**855**	**732**	**1,140**
UNID	267	34,480		910	267
Total	59,603	35949	37,855	2648	97,493

Table 14. Summary of numbers of gulls, terns and other waterbirds in Roebuck Bay, 13th-14th December 2008. Overall Roebuck Bay totals were obtained by adding together the ground counts from Bush Point and the Northern Beaches. However, higher counts of Brolga, Black-necked Stork, Egrets, Royal Spoonbill and White Ibis were made on the aerial surveys than on the ground-count totals, so the aerial counts for these species are used in the overall Roebuck Bay totals (the number of egrets identified to species level on ground counts has been subtracted from the number of unidentified egrets counted from the air). Boldface denotes species counts in internationally significant numbers.

	Bush Point	Bush Point aerial survey	Northern Beaches	Inner Crab Creek aerial survey	Roebuck Bay Total
GULLS AND TERNS					
Caspian Tern	34		25		59
Common Tern	146		12		158
Crested Tern	183		8		191
Gull-billed Tern *affinis*	**489**		334		**823**
Gull-billed Tern *macrotarsa*	84		221		305
Lesser Crested Tern	5		5		10
Little Tern	**743**		21		**764**
Roseate Tern	5				5
Silver Gull	118	40	227	30	345
Whiskered Tern	302		4		376
White-winged Black Tern	451		144		595
Unidentified terns		610			
Total	2,560	650	1,001	30	3,631
OTHER WATERBIRDS					
Australian Pelican	91	45			91
Black-necked Stork	4	7	1		7
Brolga		2			2
Eastern Reef Egret			2		2
Great White Egret	1	2	9		10
Egret sp.		111		20	105
Little Black Cormorant	12		1	1	13
Little Egret	2		14		16
Pied Cormorant	35	22	15		50
Royal Spoonbill		1		5	6
Striated Heron			8		8
White Ibis		3	10	16	10
White-faced Heron		3	9	4	9
Total	145	196	69	46	329
Total including shorebirds	62,308	36795	38,925	2724	101,418

Roebuck Plains wetlands (*Taylor's Lagoon, Lake Eda*)

Roebuck Plains becomes a huge complex of freshwater wetlands after heavy wet season rains. The water evaporates during the dry season, but often water remains in several freshwater lakes: Lake Eda, Lake Campion, Taylor's Lagoon and Ungani Lakes. Ungani Lakes does not appear to be a major waterbird site, but is difficult to access and is seldom visited by birdwatchers. In contrast, the remaining three lakes are often visited by birdwatchers, and are known to hold large numbers of freshwater shorebirds and wildfowl when water levels are suitable. However, there is little documentation available of waterbird numbers in these lakes.

Our December surveys were made just before the onset of wet season rains, and rainfall had been relatively low in the preceding wet season. Only Lake Eda and Taylor's Lagoon held any water, and water levels in both wetlands were low, offering only a small amount of waterbird habitat. This made surveying easy, but the resultant counts were low (Tables 15 and 16).

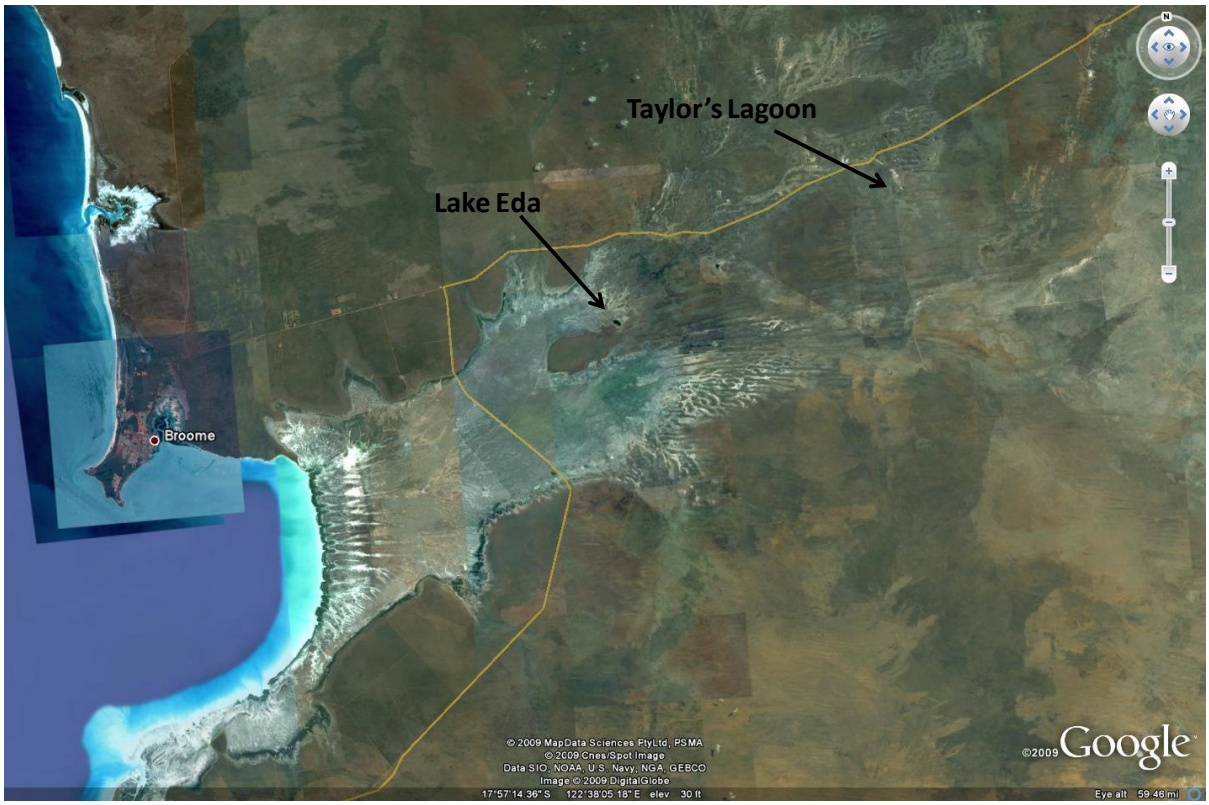

Figure 11. Google Earth image of Roebuck Plains

Table 15. Summary of numbers of shorebirds on lakes of Roebuck Plains, 8th-9th December 2008.

Species	Lake Eda	Taylor's Lagoon	Grand Total
SHOREBIRDS			
Australian Pratincole	31	4	35
Black-fronted Dotterel	11	10	21
Black-winged Stilt	165	87	252
Common Greenshank	14	9	9
Common Sandpiper	1	1	2
Curlew Sandpiper	1		1
Little Curlew	330		330
Long-toed Stint	13	22	35
Marsh Sandpiper	109	68	177
Masked Lapwing		3	3
Oriental Plover		14	14
Oriental Pratincole	180		180
Pacific Golden Plover		1	1
Pectoral Sandpiper	1		1
Red-capped Plover	24		24
Red-kneed Dotterel	3		3
Red-necked Stint	19	2	21
Ruff	1	1	2
Sharp-tailed Sandpiper	270	160	430
Snipe Sp.	1		1
Swinhoe's Snipe		2	2
Wood Sandpiper	73	65	138
Total	1247	449	1696

Table 16. Summary of numbers of gulls, terns and other waterbirds on lakes of Roebuck Plains, 8th-9th December 2008.

Species	Lake Eda	Taylor's Lagoon	Grand Total
GULLS AND TERNS			
Gull-billed Tern *macrotarsa*	6		6
Whiskered Tern	11	3	14
White-winged Black Tern	3	1	4
Total	20	4	24
OTHER WATERBIRDS			
Australasian Grebe	24*	1	25
Australian Wood Duck	5		5
Brolga	98	14	112
Glossy Ibis	27		27
Green Pygmy Goose	5	9	14
Grey Teal		92	92
Pacific Black Duck	14	6	20
Royal Spoonbill	2		2
Wandering Whistling-Duck		6	6
White-faced Heron	7		7
White-necked Heron		1	1
Total	182	129	311
Grand total	1449	582	2031

*Includes one individual which was killed by a White-bellied Sea Eagle just after the count.

Broome

There are a number of small shorebird sites on the Broome Peninsula, within Broome itself (Figure 12). They are largely inhabited by freshwater and grassland species which do not use nearby Roebuck Bay. The Broome Water Treatment Plant, on Clementson Street, provides a year-round freshwater wetland habitat for ducks, and the margins of the treatment ponds are also used by a few shorebird species. It is no longer possible to obtain permission to enter this site, and counts of the site can only be made by scanning from high points outside the fence. The counts made in this site are therefore likely to be underestimates for some species, particularly small shorebirds and cryptic species which feed on the margins of pond and would be concealed by the bunds in the views that can be managed from outside the fences. Wood Sandpipers, Long-toed Stints, Pacific Golden Plover and *Gallinago* snipes are among the species which used to be seen regularly at the Broome Water Treatment Plant; they were not observed on the December 2008 counts, perhaps because of access difficulties rather than their absence.

Broome also has a number of ovals and other lawns, and these are used regularly by Little Curlew before the onset of wet season rains. Few Little curlew were found on most ovals of the town (most

of which have held large numbers of Little Curlew in the past), but almost 700 Little Curlew were found on "new oval", a spots field still under construction at the Broome Recreation Centre. No species of other waterbirds were found on Broome Peninsula in internationally significant numbers (Table 17), but the counts of Plumed Whistling Duck at the Broome Water Treatment Plant were noteworthy.

Table 17. Waterbirds on the Broome Peninsula, 13th Dec. 2008.

Species	Golf Course	Haynes Oval	New Oval	Old Customs House Lawn	Water Treatment Plant	St Mary Oval	Town Oval	Grand Total
SHOREBIRDS								
Black-winged Stilt					23			23
Common Greenshank					4			4
Little Curlew		13	688		26			727
Marsh Sandpiper					2			2
Masked Lapwing	9	16	3	2	2	2	2	36
Oriental Plover			12					12
Silver Gull							46	46
Total	9	29	703	2	57	2	48	850
GULLS AND TERNS								
Silver Gull					51			51
Whiskered Tern					215			215
White-winged Black Tern					315			315
Total	0	0	0	0	581	0	0	581
OTHER WATERBIRDS								
Australian Pelican					54			54
Eurasian Coot					14			14
Grey Teal					45			45
Hardhead					19			19
Hoary-headed Grebe					1			1
Pacific Black Duck					41			41
Plumed Whistling Duck					845			845
Royal Spoonbill					17			17
Straw-necked Ibis	1				3			4
White Ibis					29			29
Total	1	0	0	0	1068	0	0	1069
Waterbirds total	10	29	703	2	1706	2	48	2500

The Indian Ocean beaches of Broome Peninsula and Cable Beach were also surveyed on 13th December. This sandy coastline attracts much more tourism than the adjacent beaches of Roebuck Bay, in part because they are suitable for swimming and in part because they are easier to access from Broome. Unlike Roebuck Bay this stretch of coastline does not have extensive intertidal mudflats, but shorebirds forage along the sandy shoreline of the broad beaches at low tide. Two shorebird species characteristic of sandy shores were counted in internationally significant numbers: Greater Sand Plover and Sanderling. Other highlights of this coastal stretch include a small breeding population of Pied Oystercatcher, and it is of importance as a night-time roost to shorebirds from Roebuck Bay (Rogers et al. 2006d).

Figure 12. Google Earth Satellite imagery of shorebird sites on the Broome Peninsula.

Table 17. Waterbirds on Indian Ocean Beaches of Broome, 13th Dec. 2008.

Species	Riddel Beach to Entrance Pt	Cable to Riddel Beach	Cable Beach Rocks to Coconut Well	Coconut Well to Willie Creek	Grand Total
SHOREBIRDS					
Bar-tailed Godwit		2	16	34	52
Common Greenshank				1	1
Common Sandpiper	7	7	1	2	17
Curlew Sandpiper	15				15
Eastern Curlew			2	3	5
Great Knot			149	62	211
Greater Sand Plover	1042	86	17	99	**1244**
Grey Plover		4	2	25	31
Grey-tailed Tattler	6	2			8
Lesser Sand Plover	51	5	11	6	73
Masked Lapwing			2		2
Oriental Plover				2	2
Pacific Golden Plover	2		5	7	14
Pied Oystercatcher		2	4	23	29
Red-capped Plover	18		29	62	109
Red-necked Stint	153	7	58	84	302
Ruddy Turnstone	12	19		126	157
Sanderling	5	9	230	7	**251**
Sharp-tailed Sandpiper	3				3
Sooty Oystercatcher	6				6
Terek Sandpiper	2				2
Whimbrel	3	8		14	25
Total	1325	151	526	557	2559
GULLS AND TERNS					
Caspian Tern			3	1	4
Common Tern	9	92	36	13	150
Crested Tern	20	2	43	73	138
Gull-billed Tern *affinis*				2	2
Gull-billed Tern *macrotarsa*				10	10
Lesser Crested Tern			6	9	15
Little Tern			5	72	77
Roseate Tern		1			1
Silver Gull	6	6	124	7	213
Whiskered Tern		17			17
White-winged Black Tern		9	24	7	40
Total	35	127	241	194	667
OTHER WATERBIRDS					
Brown Booby	5				5
Darter		1			1
Eastern Reef Egret		3			3
Total	5	4	0	0	9
Waterbirds total	1365	282	767	744	3235

West coast of Dampier Peninsula

This is a rather steep coastline by north-western Australian standards, with sandy beaches meeting low coastal cliffs or steep sand dunes (Figure 13). Birdwatchers visit the area reasonably regularly, and have never found very large concentrations of shorebirds there. One of the drawcards attracting birdwatchers to this coastal stretch is the large flocks of terns which occur there at times, but numbers were reasonably low at the time of our surveys on 13th – 14th December; no species were found in internationally significant numbers.

Figure 13. Google Earth satellite imagery showing shorebird sites on the west coast of Dampier Peninsula.

Table 18. Waterbirds counts on the west coast of Dampier Peninsula, 13th – 14th Dec. 2008.

Species	Barred Creek	James Price Point	Minari (Coulomb Point)	Quondong Pt to 5 km S	Grand Total
SHOREBIRDS					
Black-fronted Dotterel			2		2
Common Greenshank	4		1		5
Common Sandpiper	5			4	9
Curlew Sandpiper	1				1
Great Knot	1				1
Greater Sand Plover	86	21	56	16	179
Grey Plover	18		2	4	24
Grey-tailed Tattler	52	3	29	18	102
Lesser Sand Plover	1			1	2
Pacific Golden Plover	5	2		14	21
Pied Oystercatcher	1	1	5		7
Red Knot		1	26		27
Red-capped Plover	10	9		31	50
Red-necked Stint	9	3	60	11	83
Ruddy Turnstone	24	1	12	2	39
Sanderling	2	5	16		23
Sharp-tailed Sandpiper			5		5
Sooty Oystercatcher		4	27	2	33
Whimbrel	22	8	3	1	34
Total	241	58	244	104	647
GULLS AND TERNS					
Common Tern	6		4	146	156
Crested Tern	19	32	270	25	346
Gull-billed Tern *affinis*	1				1
Gull-billed Tern *macrotarsa*			1		1
Lesser Crested Tern	8	2	35	42	87
Little Tern	24		50	13	87
Roseate Tern			20		20
Silver Gull	8	3	4		15
White-winged Black Tern				7	7
Total	66	37	384	233	720
OTHER WATERBIRDS					
Australian Pelican			2		2
Eastern Reef Egret		1		11	12
Little Pied Cormorant				1	1
White-faced Heron			4		4
Total		1	6	12	19
Waterbird Total	307	96	634	349	1386

CHANGES IN SHOREBIRD NUMBERS

Shorebirds are easier to count in the wild than most animal species, as they live in open settings in which all individuals can be seen. Nevertheless, they are quite difficult to monitor, as they are capable of very substantial movements. Even during the non-breeding season, when they spend several months in one general area, they may make substantial local movements in response to such factors as tide height, water levels, rainfall events, disturbance and changes in distribution of the richest foraging areas. As a result, shorebird count data are often difficult to interpret.

Rappoldt et al. (1985) and Rogers et al. 2006a) identified the following sources of variation in shorebird counts:

(1) Observer error - differences in count totals observed when different observers count the same flock, or even when the same observer counts the same flock twice.

(2) Site-specific error – caused by differences in viewing conditions at different sites – e.g. amount of vegetation cover concealing birds, the density with which birds are packed together ;

(3) Bias – caused by birds that are present not being counted, or being double-counted;

(4) The variation that remains after error and bias has been accounted for; this includes the genuine variation in shorebird numbers that monitoring programs try to identify.

Detailed repeated counts and associated analysis of the first two years of MYSMA data (Rogers et al. 2006a) have been used to develop an approach to estimating the combined amount of observer and site-specific area associated with counts at Eighty-mile Beach and Roebuck Bay. There is no analytical way of dealing with the problem of bias, and our approach in north-western Australia has been to eliminate bias from our data collection, doing our best to collect data in such a way that birds are not overlooked or double-counted.

Breaking down and quantifying the sources of variation in shorebird counts is of considerable importance when attempting to identify population changes over short time frames. The MYSMA surveys were initiated in 2004 with the specific intention of identifying short-term population changes. The impetus for this project was concern about the destruction ("reclamation) of the Saemangeum tidal flats in South Korea, the most important staging area known in the East Asian – Australasian flyway. This site was of particular importance to Great Knot, being used as a staging site on northwards migration by *c*. 30% of the world population. Monitoring at Saeamangeum and adjacent sites on the west coast of South Korea indicated that c. 90,000 Great Knots (23.9% of the world population) disappeared from the Korean study area following closure of the Saemanguem sea wall (Moores et al. 2008). If these birds died, rather than moving to new staging grounds, we would predict a decline of similar magnitude on the non-breeding grounds. Counts on the non-breeding grounds can thus be used to test the claims of reclamation proponents that shorebirds simply find other staging areas if displaced by reclamation.

In this section we examine North-western count data to examine changes in shorebird numbers in those areas that have been surveyed repeatedly over the past few years. As the north-western Australian surveys were designed specifically to monitor shorebirds, we have not attempted to assess changes in tern populations or other waterbirds in this report. We consider Eighty-mile Beach, Bush Point and Roebuck Bay separately at first, as it is possible that numbers at these sites may vary independently from one another. For example, it has been suggested that when a migratory shorebird suffers a global decline, counts on non-breeding grounds will decrease most markedly at marginal sites, with any "vacancies" in preferred sites being filled in by birds that move from marginal sites (Escudero *et al*. 2003).

Eighty-mile Beach

In the results section above (figures 4 and 5), we emphasised that shorebird distribution on Eighty-mile Beach is patchy, with different species concentrating on different areas of the beach. As a result, surveys of the entire beach are needed to assess how many birds are there. Only three such surveys have been carried out in summer. Results from these counts are summarised in Table 19. Table 19 also includes the population estimates available for Eighty-mile Beach at the time it was designated a Ramsar area (Watkins 1993). These estimates were derived from Lane (1987) on the basis of complete aerial surveys (which informed on the total number of shorebirds on Eighty-mile Beach), and partial ground counts which informed on species composition. Extrapolation was used to make estimates of numbers of each species on the beach.

These count data are noteworthy for several of the most abundant species of Eighty-mile Beach:

Bar-tailed Godwit numbers have declined markedly, and the population is now only 46.9% of that in 1999-2001. No complete counts have been anywhere near as low as the estimates made from extrapolations of partial counts made in the 1980's. This is a readily identified species for which we consider our counts to be particularly reliable.

Common Greenshank counts made in 2008 were slightly higher than any in the past. This may have been related to the very dry conditions, preventing this species from dispersing to inland freshwater wetlands.

Curlew Sandpiper counts appear to have declined since 2001. Curlew Sandpiper counts have been declining throughout Australia for some time (Gosbell and Clemens 2006). However it is difficult to assess the significance of the apparent decline at Eighty-mile Beach. Previous counts were made in October and November, and there is banding data indicating that there are Curlew Sandpipers in north-western Australia at this time which are staging *en route* to non-breeding grounds in southern Australia.

Eastern Curlew counts have declined to 59.7% of their levels in 1999.

Great Knot counts have declined since the very consistent counts of 1999 and 2001. The 23.9% decline in numbers (to 76.1% of former levels) corresponds closely with the 23.9% decline in overall non-breeding populations predicted as a result of the loss of 90,000 birds from the former staging grounds in Saemangeum, South Korea.

Greater Sand Plover has declined markedly, and the population is now only 35.4% of that in 1999-2001. This is another species for which we consider our counts to be particularly reliable, as it typically roosts in small scattered flocks on upper beach stretches which are easily found and counted.

Grey Plover counts were 72.3% of their levels in 2001.

Grey-tailed Tattler counts declined to 54.3% of their levels in 2001. However it should be borne in mind that the 1999 and 2001 counts for Grey-tailed Tattler were rather different. In addition, 8km of beach was not counted in 2008, mostly behind headlands between 155-170 km S of the Anna Plains access track. Although this was not a bird-rich region of the beach, headland habitats are more suitable for Grey-tailed Tattlers than they are for most shorebird species.

Counts of **Little Curlew**, **Oriental Plover** and **Oriental Pratincole** were quite different to those made on previous surveys. As noted above, the numbers of these species roosting on Eighty-mile Beach is greatly affected by weather conditions.

Pied Oystercatcher numbers apparently increased slightly between 2001 and 2008. It is not known if this was influenced by the slightly different times of year at which the surveys were made; this species nests in north-western Australia and adjacent off-shore islands, and counts may be influenced by roaming subadult birds.

Red Knot counts have declined to 77.9% of their levels in 2001. No complete ground counts have ever come close to finding the 80,000 Red Knots reported on Eighty-mile Beach following extrapolation of partial counts in the early 1980's. The estimate of 80,000 is still used in estimates of the flyway population of Red Knots (Bamford et al. 2008), and it is in urgent need of review.

Red-capped Plover counts were considerably higher than those in 1999 and 2001. This might have been related to the dry conditions forcing this resident species from inland freshwater wetlands.

Numbers of **Red-necked Stints** and **Sanderling** were higher than in the 1999 and 2001 surveys. For both species, estimates of abundance made in the early 1980's are very different to totals observed during complete ground counts since 1999.

Ruddy Turnstone counts were intermediate between those counted between 1999 and 2001 – the only common migrant species on Eighty-mile Beach for which was the case.

Terek Sandpiper counts have declined to 47.1% of their levels in 2001. This species might have been undercounted in the incompletely surveyed coastal stretch from 155-170 km s of the Anna Plains access point; like Grey-tailed Tattler, this species may find headland roosts to be more suitable than do most shorebird species. Nevertheless, the magnitude of the decline (>5,000 birds) is such that we consider it unlikely that it can be explained solely by these short stretches of incompletely surveyed beach.

Whimbrel numbers have increased, but this species remains uncommon on Eighty-mile Beach.

Overall, the picture from the December 2008 surveys was of a decline in numbers of migratory shorebirds. Excluding species which only forage inland and only roost on Eighty-mile Beach to avoid hot weather (Oriental Plover, Oriental Pratincole, Little Curlew), 12 migratory shorebird species regularly occur on Eighty-mile Beach in their thousands. Of these, three have increased slightly (Common Greenshank, Red-necked Stint, Sanderling); one has remained reasonably consistent numbers (Ruddy Turnstone), and seven have undergone very substantial decreases. The number of shorebirds which feed on the intertidal flats has decreased from 408,037 in 1999 and 430,923 in 2001 to 292,301 shorebirds in 2008.

Table 19. Eighty-mile Beach count totals for shorebirds, 10-12 Dec 2008, compared with previous complete wet-season surveys of this beach, and the Eighty-mile Beach estimates (from Watkins 1993) available at the time Eighty-mile Beach was designated a Ramsar area..

	Watkins (1993)	17-18 Oct 98	12-13 Nov 01	10-12 Dec 08	Maximum	2008 counts as % of 1999-2001 counts
Asiatic Dowitcher	0	1	0	2	2	200.0%
Australian Pratincole	100	9	1	1	9	11.1%
Bar-tailed Godwit	34,300	110,290	97,403	51,719	110,290	46.9%
Beach Thick-knee	0	1	0	0	1	0.0%
Black-fronted Dotterel	0	0	1	0	1	0.0%
Black-tailed Godwit	110	22	7	52	52	236.4%
Black-winged Stilt	0	1	0	10	10	1000.0%
Broad-billed Sandpiper	55	12	3	35	35	291.7%
Common Greenshank	2,440	1,738	2,432	2,534	2,534	104.2%
Common Redshank	0	5	0	0	5	0.0%
Common Sandpiper	0	3	2	6	6	200.0%
Curlew Sandpiper	60,000	2,859	7,984	3,292	7,984	41.2%
Eastern Curlew	480	709	552	423	709	59.7%
Eurasian Curlew	0	0	0	1	1	
Great Knot	160,000	158,082	169,044	128,653	169,044	76.1%
Greater Sand Plover	30,400	63,482	64,584	22,885	64,584	35.4%
Grey Plover	1,650	1,416	1,585	1,146	1,585	72.3%
Grey-tailed Tattler	8,500	10,436	14,647	7,950	14,647	54.3%
Lesser Sand Plover	5	162	0	7	162	4.3%
Little Curlew	12,000	224	215	784	784	350.0%
Marsh Sandpiper	140	76	171	127	171	74.3%
Oriental Plover	18,400	57,619	41,278	17,452	57,619	30.3%
Oriental Pratincole	0	1	0	1,100	1,100	
Pacific Golden Plover	440	24	12	73	73	304.2%
Pied Oystercatcher	190	653	694	809	809	116.6%
Red Knot	80,700	24,891	29,679	23,123	29,679	77.9%
Red-capped Plover	9,600	2,512	3,077	6,752	6,752	219.4%
Red-necked Stint	60,000	16,766	24,005	28,443	28,443	118.5%
Ruddy Turnstone	740	3,480	1,649	2,433	3,480	69.9%
Sanderling	100	2,230	3,219	3,605	3,605	112.0%
Sharp-tailed Sandpiper	25,000	9	193	205	205	106.2%
Sooty Oystercatcher	0	3	13	25	25	192.3%
Terek Sandpiper	3,000	7,989	9,820	4,628	9,820	47.1%
Unidentified	9	0	0	3000	3	
Whimbrel	180	185	148	363	363	196.2%
Total Waders	508,539	465,890	472,418	311,638	514,592	66.0%

It would be very desirable to know when the declines in shorebird numbers occurred on Eighty-mile Beach. This would assist in identifying the causes of the declines and in particular to identify if they coincided with the Saemangeum reclamation. Declines caused by loss of this staging area would be expected to occur suddenly in 2006 or 2007. The Saemangeum sea-wall was closed in April 2006, during northwards migration. Many birds, notably Great Knots, compensated to some extent for the loss of feeding area in Saemangeum in April and May 2006 by feeding on a resultant bivalve die-off which left enormous numbers of bivalves readily accessible on the mud surface (Rogers et al. 2006a). If they were able to complete their migration successfully as a result, and were not dependent on Saemangeum on southwards migration (*c*. August-September 2006) then it is possible that no decline on the non-breeding grounds would have been observed by the time of the December 2006 surveys. By 2007 the available feeding area in Saemangeum was much reduced and there was no major shellfish die-off to compensate for reduced prey abundance (Moores et al. 2006). Accordingly we would expect that if the Saemangeum reclamation reduced survival and hence a decline in the populations on the non-breeding grounds, then this effect would take place by 2007 at the latest. Remaining habitat at Saemangeum continues to deteriorate (Moores et al 2008), so there may be ongoing effects that we cannot yet detect.

We have examined summer count data from the MYSMA project (2004-2008) to assess whether counts declined abruptly in 2006 and 2007. However, interpretation of this dataset is complex. As resources were limited, these surveys only covered 60km of Eighty-mile Beach. In 2008 we confirmed that some shorebirds within this stretch of beach have started to make substantial movement south to a hotspot at the southern edge of the survey area. It is possible that there is now a corresponding northwards movement to the hotspot at the southern edge of the survey area. Such movements could reduce the repeatability of counts, with mobile flocks occurring just inside the survey area during some counts, and just outside it on others.

Figure 12 summarises changes in numbers of the most abundant shorebird in the MYSMA study area on Eighty-mile Beach. We consider the data collected between 0-30 km to be the most repeatable. In 2006, large numbers of waders (especially small to medium-sized species) began to move south from the 30-50km stretch at high tide, and this behavioural change has carried on ever since, reducing the counts for some species in this stretch. Direct observations in 2008 confirmed that many of the birds from 30-50 km S ended up in the stretch of coast 50-60 km south of the Anna Plains access point. Moreover, some birds may have moved into the same area from further south, increasing the difficulty of interpreting these count data. Given these difficulties, significance testing of differences between years is not particularly helpful here. However, looking at the general trends of changes, it would appear that most of the species that had declined at Eighty-mile Beach between the complete surveys of 2001 and 2008 also declined in the MYSMA area between 2004 and 2008: Bar-tailed godwit (including an abrupt decline between 2007 and 2008), Curlew Sandpiper, Eastern Curlew, Greater Sand Plover, Grey-tailed Tattler, and most strikingly, Terek Sandpiper. Great Knot and Red Knot numbers actually increased in the MYSMA survey area in 2008, but this was driven entirely by large numbers between 50-60 km south, suspected to include birds that had moved into the MYSMA area from further south. In the area for which counts were most repeatable (0-30 km S), knot numbers declined, especially in 2006.

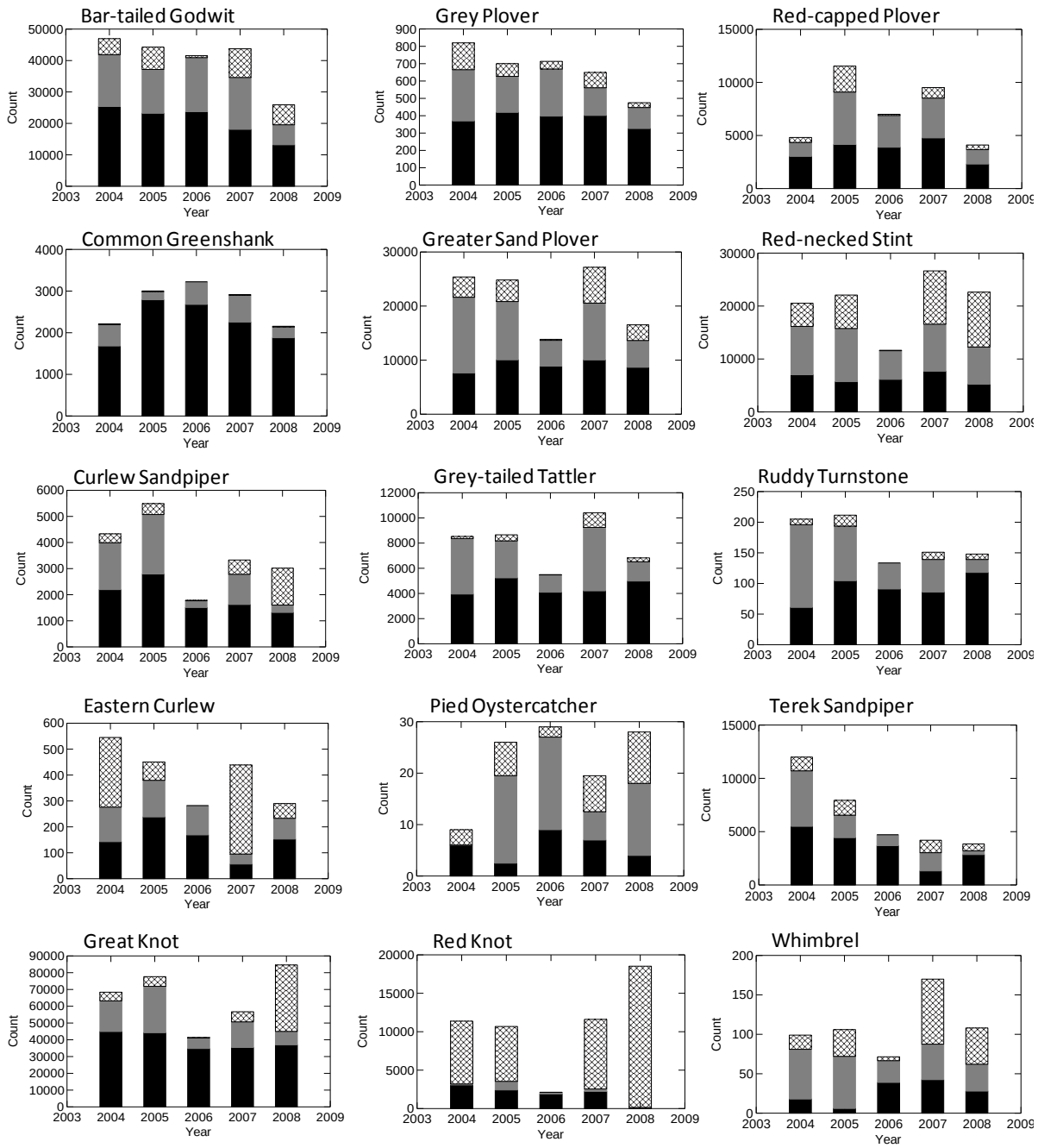

Figure 12. Changes of numbers of the most common shorebird species on the 60km stretch of Eighty-mile Beach immediately south of the Anna Plains access point. Data are presented in stacked bar-charts. Black = birds seen between 0 to30 km s of the Anna Plains access point, Grey = birds seen between 30 and 50km S, and hatched = birds seen between 50 and 60km s. For most years we present the average of two counts carried out between the end of October and mid-December. For 2004 and 2008 we only present data from the December count, as a count section was missed in the November 2004 count, and in October 2008 we suspect some birds were double-counted.

Bush Point

On higher tides and in dry weather, this sandy point is the only potential roost for shorebirds feeding on the vast sandflats of southern Roebuck Bay. At times up to 100,000 shorebirds may roost at Bush Point (Table 20), along a stretch of beach only *c*. 3km long; indeed Bush Point may be the largest single shorebird roost in the world. It is an isolated site, and this has prevented thorough exploration of potential alternative roosts in the area – such as clearings in the mangroves which may be used on very high tides, and upper tidal flats which may not be submerged on smaller tides. As a result we have often been unsure whether substantial variations in species abundance at Bush Point from count to count could be related to some birds in the region being overlooked. However, when we plot the maximum Bush Point counts obtained each summer (Figure 13) there do appear to be consistent changes in numbers over time. These are discussed later in this section, following the section on count variation on the northern beaches of Roebuck Bay

Table 20: Shorebird counts at Bush Point in Nov.-Dec. 2004-2008. We have presented the higher of two counts done between each year between the end of October and early December.

Species	2004	2005	2006	2007	2008
Asian Dowitcher	24	17	1	20	3
Bar-tailed Godwit	22455	31521	34473	20709	26695
Black-tailed Godwit	0	1	0	0	6
Broad-billed Sandpiper	15	33	64	32	3
Common Greenshank	38	22	40	18	3
Common Sandpiper	0	1	0	1	1
Curlew Sandpiper	521	515	311	627	68
Eastern Curlew	241	268	744	517	341
Great Knot	20332	15197	12195	11560	12872
Greater Sand Plover	21136	25943	30529	12567	19213
Grey Plover	861	496	920	476	457
Grey-tailed Tattler	836	410	1078	50	157
Lesser Sand Plover	20	15	2	3	127
Little Curlew	30	2	0	0	37
Oriental Plover	1374	1493	465	133	5298
Oriental Pratincole	0	0	0	0	20960
Pacific Golden Plover	30	96	85	48	20
Pied Oystercatcher	470	741	1150	877	478
Red Knot	1606	1145	377	1351	240
Red-capped Plover	3485	2302	2833	2907	3655
Red-necked Avocet	0	0	0	0	0
Red-necked Stint	18246	14677	7993	8101	16032
Redshank	0	0	0	0	0
Ruddy Turnstone	353	1462	1105	494	294
Sanderling	3031	2908	2950	2712	3537
Sharp-tailed Sandpiper	102	3	6	16	0
Sooty Oystercatcher	0	0	0	0	0
Terek Sandpiper	1065	1134	535	703	634
UNID Waders	0	0	0	0	24367
Whimbrel	175	333	1150	1045	760
Total	96446	100735	99006	64967	136258

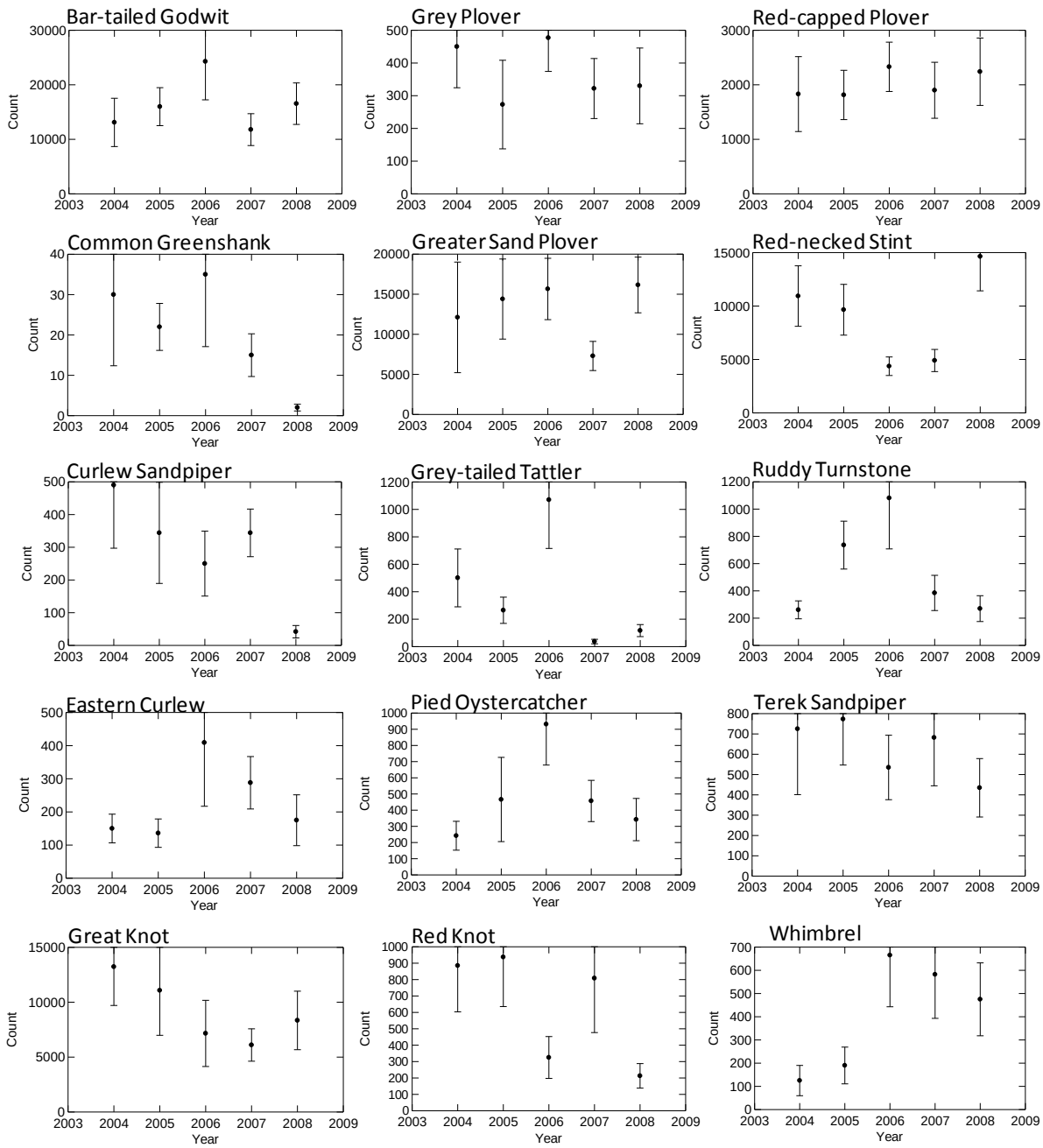

Figure 13. Shorebird counts at Bush Point, between late Oct and early Dec., for all years 2001-2208. Error bars show 95% confidence limits.

Northern Beaches of Roebuck Bay

The northern beaches of Roebuck Bay used to be counted annually in January or February, in keeping with the convention for national shorebird counts in Australia. Roost choice studies carried out in 2000 demonstrated that counts made after the onset of wet season rains were not very repeatable, as they produced an alternate roosting habitat (flooded saltmarsh) to which an unpredictable number of birds moved from the northern beaches. The timing of population monitoring counts was therefore shifted to the November-December period, before the onset of wet season rains.

Counts obtained since monitoring shifted to November-December are summarised in Table 21, and these data are presented graphically for selected common species in Figure 14. In general the count data from the northern beaches are very well behaved, and in many species gradual changes from year to year form a coherent pattern.

Since 2004, we have recorded all component counts during surveys of Roebuck Bay, and following the approach of Rogers et al. (2006a) we can use these data to calculate count variance at this site. In figure 21 error bars are presented for recent counts, showing the 95% confidence limits of counts. Using this significance level, there were few changes in abundance from one year to the next that were statistically significant, but over longer time frames significant changes occurred in numbers of several species. Mostly strikingly, numbers of Common Greenshank and Red-capped Plover seem to have increased steadily since 2001 (perhaps related to lower wet-season rainfalls since 2001), while numbers of Pied Oystercatcher seem to have declined equally steadily during the same period (Figure 14). For most other species, counts on the northern beaches of Roebuck Bay have remained reasonably steady over the past eight years, often both increasing and decreasing at different times within that period.

Between them, the northern beaches and Bush Point hold nearly all the roosting shorebirds of Roebuck Bay at high tide. Radio-telemetry studies in 2000 confirmed that the sites are discrete: birds feeding on tidal flats in northern Roebuck Bay do not use Bush Point as a roost. However, resightings of leg-flagged and colour-banded individuals have shown that there is some movement between the northern beaches and Bush Point, presumably caused by birds shifting feeding grounds, and changing their roosts as a result. Whether this might influence counts is unclear. We have found no indication of negative correlations between counts at Bush Point and the northern Beaches, but this cannot be tested rigorously yet, as we only have five years data. Nevertheless, we have examined combined data from the northern Beaches and Bush Point (maximum count obtained in a single tide series each year; Table 22 and Figure 15). Treating the data in this way brings order to the counts of several species: e.g. Bar-tailed Godwits have been declining in number since a peak in 2005; Red-necked Stints have been declining steadily since 2004; numbers of Grey Plover, Greater Sand Plover, and Eastern Curlew began to decline between 2006 and 2007.

Table 21: Shorebird counts on northern beaches of Roebuck Bay, Nov.-Dec. Data from 2001 were collected before the MYSMA project began; count methodology was similar, but component counts were not recorded, so standard deviations of counts cannot be calculated. For MYSMA counts from 2004-2008, we have provided the higher of two counts done between the end of October and early December.

Species	2001	2002	2003	2004	2005	2006	2007	2008
Asian Dowitcher					1	1		
Bar-tailed Godwit	11955	7275	16635	11927	9909	12216	8696	5121
Broad-billed Sandpiper	2	26	101	52	328	53	199	131
Beach Stone-Curlew					2		1	1
Black-tailed Godwit	6780	1785	2120	1076	1975	435	944	469
Black-winged Stilt	0	0	218	25	162	66	141	658
Common Greenshank	128	140	166	261	295	362	371	560
Common Sandpiper	14	3	19	17	15	23	19	26
Curlew Sandpiper	1076	930	1829	1392	1543	1403	1207	1142
Eastern Curlew	221	332	460	492	363	638	261	348
Great Knot	12450	15935	11071	15233	13094	11228	16278	12664
Grey Plover	168	207	80	119	288	458	133	145
Greater Sand Plover	4470	1956	4334	3150	3903	5562	6026	3779
Grey-tailed Tattler	1690	1180	807	1475	1908	1558	1500	2765
Little Curlew	229	115	15	31	1	500		830
Lesser Sand Plover	15	7	49	147	78	21	32	34
Marsh Sandpiper					5			
Oriental Plover	2	406	305		122	28		1133
Oriental Pratincole	0	11	40	1				81
Pacific Golden Plover	14	3	28	12	28	39	37	24
Pied Oystercatcher	25	54	48	54	45	36	28	23
Red-capped Plover	457	600	912	1157	1145	1682	1752	1227
Red Knot	1881	855	1102	1348	1230	1071	1222	2798
Red-necked Avocet					1	30		25
Red-necked Stint	3705	4875	3899	4935	5127	4384	3967	4299
Ruddy Turnstone	417	115	387	361	433	334	345	350
Sanderling	0	0	1		6		3	
Sooty Oystercatcher	17	20	28	23	28	32	23	33
Sharp-tailed Sandpiper	0	0	4	9	9	2	7	611
Terek Sandpiper	432	805	1840	578	1248	588	570	492
Whimbrel	360	245	100	415	456	353	200	855
Total	46508	37880	46598	44290	43748	43103	43962	40624

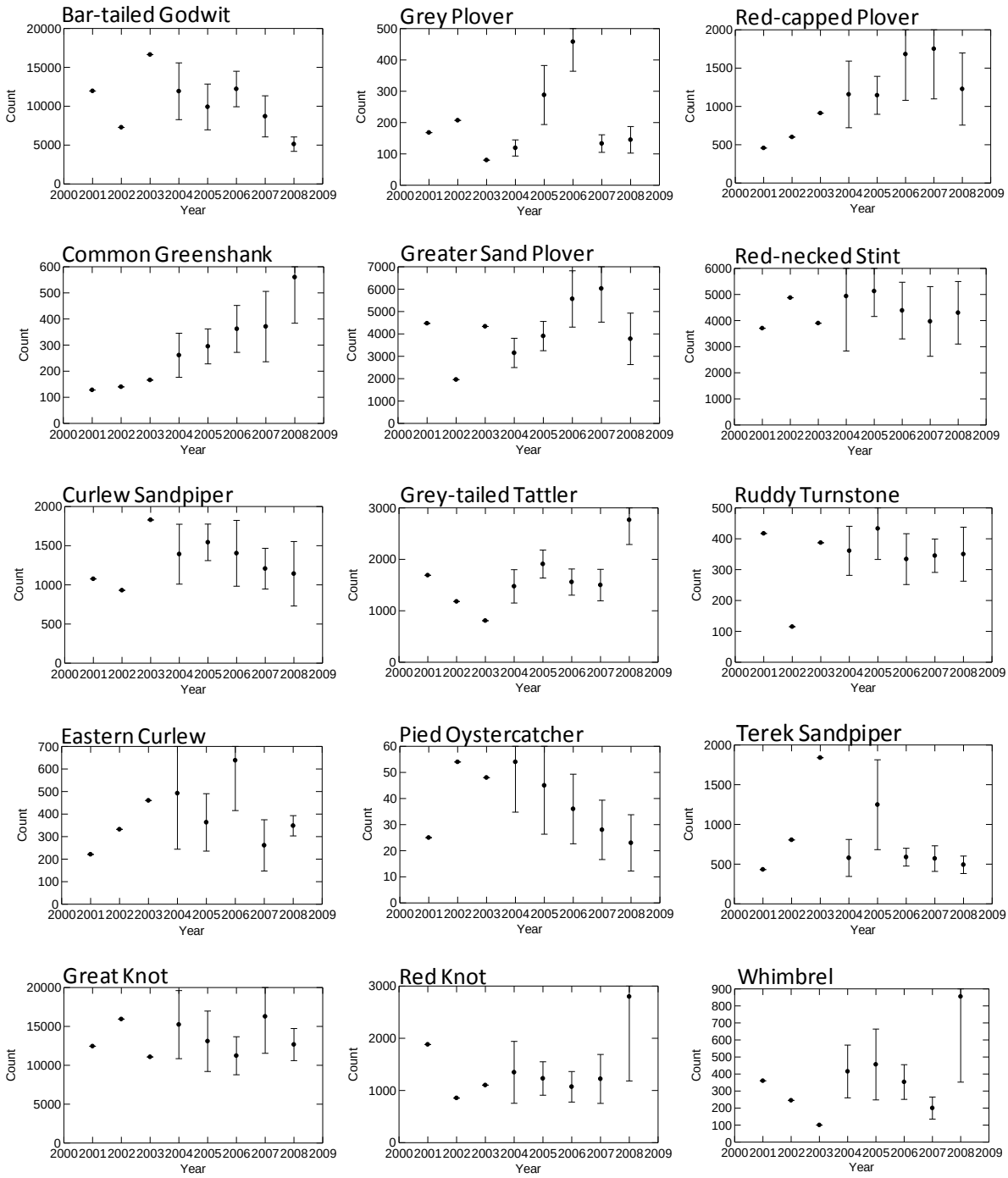

Figure 14. Shorebird counts on the northern beaches of Roebuck Bay, between late Oct and early Dec., for all years 2001-2208. Error bars show 95% confidence limits. Confidence limits could not be calculated for 2001, 2002 or 2003.

Table 22: Maximum shorebird counts in Roebuck Bay (at Bush Point and the Northern Beaches) during a single tide cycle, between the end of October and early December.

Species	2004	2005	2006	2007	2008
Asian Dowitcher	1	2	1	9	3
Bar-tailed Godwit	21277	22309	20077	16447	15275
Beach Stone-Curlew		2		1	1
Black-tailed Godwit	641	1246	341	116	285
Black-winged Stilt	25	159	3	55	381
Broad-billed Sandpiper	27	85	53	121	32
Common Greenshank	268	253	274	264	355
Common Sandpiper	5	12	12	9	13
Curlew Sandpiper	1213	1601	772	1490	670
Eastern Curlew	563	359	776	468	243
Great Knot	22335	14323	16263	19369	17193
Greater Sand Plover	12071	15444	20169	9574	6836
Grey Plover	524	446	697	287	272
Grey-tailed Tattler	1646	1992	1566	1428	1822
Lesser Sand Plover	71	35	17	14	14
Little Curlew	61	1	500		302
Marsh Sandpiper		5			
Oriental Plover	377	549	81	34	6431
Oriental Pratincole	1				21041
Pacific Golden Plover	22	29	58	47	28
Pied Oystercatcher	245	282	222	433	137
Red Knot	2069	1438	198	756	2131
Red-capped Plover	2064	1120	2185	2436	2642
Red-necked Avocet		1	30		3
Red-necked Stint	11447	9474	6493	6275	5689
Ruddy Turnstone	192	1044	311	426	273
Sanderling	1333	1385	1196	760	914
Sharp-tailed Sandpiper	11	2	3	7	263
Sooty Oystercatcher	21	18	24	6	10
Terek Sandpiper	918	1522	588	255	639
UNID Waders					24367
Whimbrel	201	560	733	599	1100
Total	79629	75698	73643	61686	109365

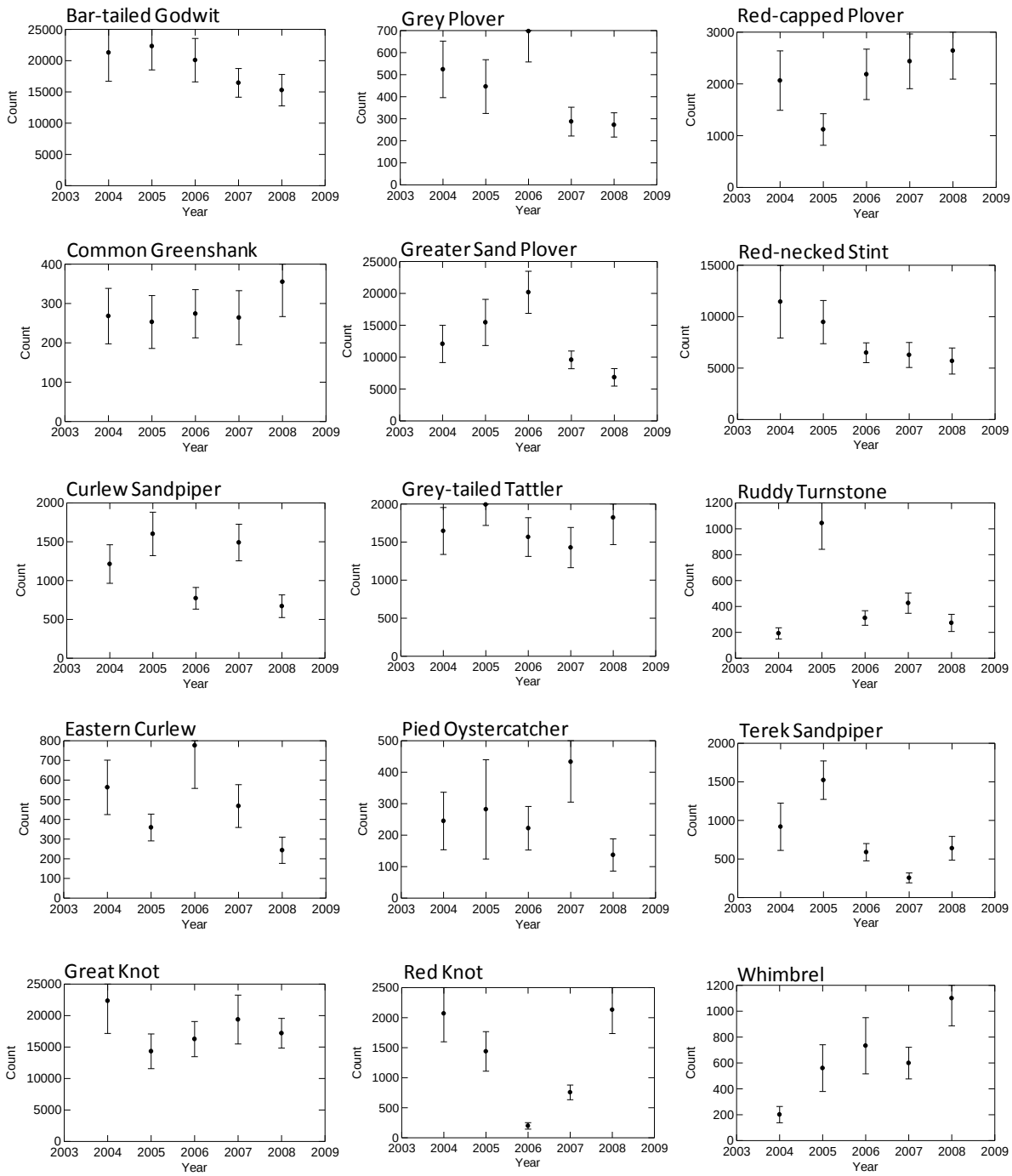

Figure 15. Shorebird counts from Northern Beaches and Bush Point combined (maximum count in a tide series for Roebuck Bay overall), 2001 – 2008. Error bars show 95% confidence limits.

Discussion

We consider the workshops held immediately before these surveys to have been a success. The participants absorbed a lot of information during the workshops, and in the field over the following week, we were able to see first-hand how much they had learned about counting shorebirds, and how well they applied it: they did a very good job. Moreover, the workshop had the effect of drawing the participants more deeply into the shorebird world; the Shorebirds 2020 volunteers, for example, have since been increasingly active in their roles as regional organisers.

Much of this report describes the numbers of birds seen during the 2008 surveys. In a nutshell, Eighty-mile Beach and Roebuck Bay (both the northern beaches and Bush Point) remain internationally significant sites for many shorebird species. They are also internationally important sites for at least two species of tern. No other waterbird species were found at these sites in internationally significant numbers. Too little surveying of other waterbird species in the region has been carried out to fully understand how these birds use the area. Nevertheless, it is clear that the ornithological highlight of these coastal sites is their large shorebird populations.

Ground surveys were carried out for the first time on the stretch of coastline between Eighty-mile Beach and Roebuck Bay. It is not as rich in shorebirds as Eighty-mile Beach or Roebuck Bay, but this overall the region does hold a lot of birds, including internationally significant numbers of Bar-tailed Godwit, Greater Sand Plover, Pied Oystercatcher, Sanderling, Ruddy Turnstone and Little Tern. Specific sites within this region with internationally significant numbers of birds were Dessault Bay (Little Tern, probably Sanderling), and Jack's Creek (Greater Sand Plover, Sanderling); we also suspect that more detailed surveying of LaGrange Bay will reveal internationally significant shorebird numbers there. Greater Sand Plovers and Sanderling were also found in internationally significant numbers on the ocean beaches (Riddell Beach, Cable Beach) immediately adjacent to Broome, despite the popularity of these areas as tourism venues.

The over-riding purpose behind the MYSMA surveys has been to assess changes in shorebird numbers. Table 23 summarises the information on population changes over the study area, and Box 1 provides some notes on changes for each species. It is a reasonably simplistic analysis, in that it simply compares shorebird numbers in 2008 with those recorded in 1999 & 2001 (full Eighty-mile Beach surveys) and 2004 (the first year of the MYSMA surveys). There was no particular biological significance to those starting years, and we do not have the historical information to tell whether they were "normal" years, years in which certain species rose to an unusually high peak, or whether they represented counts of populations tha5 had been in decline for several years. In addition, it should not be assumed that shorebird populations are naturally stable in number: breeding success of arctic-breeding shorebirds varies considerably from year to year (e.g. Soloviev and Tomkovich 2008), and their non-breeding populations fluctuate as a result.

Even with these caveats in mind, the compilation in Table 23 is disturbing. Of the 15 most common shorebird species of the north-western Australian coast, we believe that 12 have declined in abundance since 2004; moreover, many of these declines have been very substantial indeed, with several species having declined to about half of their previous levels. It is unlikely that the cause of most of these declines lies in Australia. North-western Australia is sparsely populated, and most of the sites where we counted shorebirds were remote and almost pristine. We believe the declines reflect global declines, which are likely to be a direct result of habitat loss in staging areas used on migration. In particular, most north-western Australian migrants refuel on the tidal flats of the Yellow Sea during migration, and these areas are being lost to land creation projects at an alarming rate; somewhere between 30-50% of the former tidal flat area of the Yellow Sea has been destroyed in the last three decades.

A noteworthy feature of Table 22 is that declines have not occurred uniformly across all sites. Pied Oystercatchers, for example, increased in numbers along Eighty-mile Beach and (slightly) at Bush Point, but the small population of northern Roebuck Bay showed steady decline. For this particular species we suspect there may be local explanations: (1) There is some evidence that the majority of Pied Oystercatchers on the northern beaches of Roebuck Bay are immature, so their abundance may be more strongly influenced by recent breeding success than in sites like Eighty-mile Beach where territorial, breeding adults predominate; (2) Pied Oystercatchers in Roebuck Bay prey heavily on a large cockle (*Anadara granosa*) which is harvested recreationally by humans and is now declining in northern Roebuck Bay (de Goiej *et al*. 2008). We cannot provide parallel explanations for varying rates of decline between sites in other species, as we do not have enough information on fluctuations in their prey ability. Nevertheless, it does seem striking that declines at Eighty-mile Beach (a remarkably pristine site) were generally greater than those along the northern beaches of Roebuck Bay, a site which is close to the town of Broome and experiences a lot of disturbance. We suspect that Roebuck Bay is a naturally superior feeding site for shorebirds; for most shorebird species, biomass of prey is higher in Roebuck Bay than it is along Eighty-mile Beach (Rogers 2005). Perhaps as numbers of shorebirds decline, survivors move into newly opened vacancies in preferred sites such as northern Roebuck Bay, buffering local shorebird declines in these sites but increasing the apparent rate of decline at more marginal sites.

A particular impetus for the MYSMA program was to identify effects of loss of the staging site at Saemanguem (South Korea) on shorebird populations in Australia. Several species could be predicted to decline in north-western Australia as a result of this reclamation project, as there is evidence that (1) they used to stage in large numbers at Saemangeum); (2) there is evidence from leg-flag or colour-band resightings that these migrants included birds from north-western Australia; (3) there has been a decline in the Saemangeum area since the sea-wall was closed in 2006). The six species that meet all these criteria are Bar-tailed Godwit, Common Greenshank, Eastern Curlew, Great Knot, Grey Plover and Terek Sandpiper. Our MYSMA data indicate that all of these species except Common Greenshank declined in at least some sites in north-western Australia in 2006 or 2007, immediately following sea-wall closure.

The coincidence in timing of these population declines in north-western Australia with closure of the Saemangeum sea-wall is fairly compelling, but it is not wholly conclusive. Ideally we would like to know the fate of a large number of individual birds, but this level of detailed information is not available (see Burton *et al*. 2006 for an example of a reclamation study for which data were available for a large colour-banded population). However, we can make progress with further analysis. It would be desirable to assess whether the population changes observed in north-western Australia can be explained by variation in breeding success. A measure of breeding success is available, as the AWSG has been measuring juvenile ratios in November catches of north-western Australian waders regularly in recent years, and another measure of breeding success can be extracted from the MYSMA counts carried out each June by the AWSG. It would also be desirable to assess whether changes in annual adult survival are related to declines in north-western Australia. The data for such an analysis does exist, as Chris Hassell (Global Flyways Network) and Alice Ewing (Melbourne University and AWSG) have been carrying out independent studies of individually-marked shorebirds in Roebuck Bay; both have accumulated very large resightings databases that are suitable for demographic analyses.

Another analysis which is needed is re-examination of count data for Red Knots on Eighty-mile Beach in the early 1980's. Extrapolation from partial counts at the time suggested that Eighty-mile Beach had a population of 80,000 Red Knots. This is still the "official" figure for Eighty-mile Beach used in assessing the flyway population of Red Knots (Bamford et al. 2008). However complete counts of Eighty-mile Beach since 1999 have all resulted in very much lower counts of between 20,000 to

30,000Red Knots. It is a matter of some urgency to assess whether Red Knot numbers on Eighty-mile Beach in the 1980's were overestimated (this is possible, as the patchy distribution of this species on Eighty-mile Beach was not understood at the time), or whether the species has indeed declined to some 30% of its former numbers. The most important staging area known for Red Knots in the EAAF is in the northern Bohai Bay, an area under immediate threat from ongoing, very extensive reclamation projects.

Not all of the declines in shorebird numbers in north-western Australia can be attributed to the reclamation of Saemanguem. Perhaps the most striking example is Greater Sand Plover, one of the more easily counted shorebirds of the region; its numbers on Eighty-mile Beach have declined to only 35.4% of their 2001 levels. As the species has always been a rarity on the west coast of Korea, reclamation of Saemangeum should not have affected its flyway population. It is however, quite possible that the species has declined as a result of other reclamation projects. The staging strongholds of Greater Sand Plover appear to lie on the coastline from northern Vietnam to the southern half of China, and much of this tidal flat region is also being reclaimed.

The declines in shorebird numbers in north-western Australia highlight the need for further, more detailed monitoring of the region. In addition to fulfilling Australias's obligations to monitor waterbirds in the Ramsar sites of Roebuck Bay and Eighty-mile Beach, shorebird surveys in this region can act as a barometer of the status of flyway populations for the East Asian – Australasian Flyway. Annual summer surveys in north-western Australia should be continued.

Much of the existing MYSMA strategy for monitoring coastal shorebirds in north-western Australia seems adequate. However, there is an urgent need to increase coverage of Eighty-mile Beach, which holds more shorebirds than the rest of north-western Australia combined. Behavioural changes on this beach have reduced the repeatability of counts on the 60km section of beach currently monitored by MYSMA; very large numbers of shorebirds now roost at the extreme southern end of the count section, and minor movements may now influence whether enormous flocks roost inside or outside the count area. Expanding the survey area to 80 km would solve this problem in the short term. However, as we cannot anticipate future changes to Eighty-mile Beach and the behaviour of the shorebirds that live there, we think it would be wiser to carry out complete counts of Eighty-mile Beach every year.

Box 1 – Notes on population changes in the numbers of the most common North-western Australian shorebirds and their potential causes.

Bar-tailed Godwit – Much of the decline observed at Eighty-mile Beach since 2001 seems to have occurred after MYSMA surveying began in 2004. The species has been declining both along Eighty-mile Beach and the northern beaches of Roebuck Bay since c. 2006; at both sites there was a conspicuously abrupt decline between 2007 and 2008. Breeding success was low in 2008 (AWSG unpubl. data) and this contributed to the effect, but is unlikely to be a complete explanation, given that first-year birds rarely exceed 20% of the population in Roebuck Bay during the wet season, and that the declines were of larger magnitude.

Common Greenshank - Increasing steadily in Roebuck Bay, slightly at Eighty-mile Beach; declining at Bush Point, but this is not a major site for the species. These trends may be related to rainfall, as the species also makes use of inland wetlands, and wet-season rains have declined since the very heavy rains in the wet seasons from 1997 to 2001.

Curlew Sandpiper – Has declined declined considerably on Eighty-mile Beach since 2001. MYSMA counts since 2004 have also shown a decline, but to a lesser extent, suggesting that the decline was also in progress between 2001 and 2004; however it is possible that counts of this species are influenced by timing of the surveys, as some Curlew Sandpipers stage in north-western Australian during southwards migration. Curlew Sandpiper numbers have been declining in Australia since the early 1990's, apparently because of low breeding success; the decline may now be levelling off (Rogers and Gosbell 2006).

Eastern Curlew – This species has declined in the MYSMA area since 2004, but not by as much as the 2001-2008 decline shown on complete Eighty-mile Beach surveys. A substantial population of Eastern Curlew stage at Saemanguem. Non-breeding decline in Eastern Curlew as a result of the Seamangeum reclamation would probably be first observed in 2007; this species migrates early, and most birds had already migrated through Saemanguem by 21st April 2006 when the sea-wall was closed. In Roebuck Bay, both at Bush Point and on the northern beaches, Eastern Curlew counts declined abruptly between 2006 and 2007, in keeping with the predictions from Saemangeum. This was not the case in the 60-km MYMSA stretch of Eighty-mile Beach, due to an unusually high count in 2007 in the stretch between 50-60km south. As explained previously in the report, counts of this 10km stretch of beach appear to have been influenced by a substantial influx of birds from other stretches of Eighty-mile Beach; in the 0-30 km stretch of Eighty-mile Beach where counts are considered to have been more repeatable, Eastern Curlew declined abruptly between 2006 and 2007.

Great Knot – The magnitude of decline in numbers shown by complete Eighty-mile Beach surveys (23.9%) closely matches the decline in non-breeding population predicted by the reclamation of Saemanguem. In Roebuck Bay, both at Bush Point and on the northern beaches, numbers of Great Knots declined between 2004 and 2008, with declines being observed in 2006 on the northern beaches, in 2006 and 2007 at Bush Point. In the MYSMA area of Eighty-mile Beach, counts in the stretch of beach considered most repeatably surveyable (0-30km) numbers also declined between 2004 and 2008, mostly in 2006. However, counts for the full 60km MYSMA area increased, due to an influx in the difficult stretch from 50-60km south.

Grey Plover – Another species that staged in large numbers in Saemanguem. It declined sharply in all MYSMA areas between 2006 and 2007.

Greater Sand Plover – Never abundant at Saemanguem. The species, which we consider to be one of the most easily counted species on Eighty-mile Beach, declined alarmingly between 2001 and

2008, to only 35.4% of its former levels. Declines of smaller magnitude occurred in the MYSMA area between 2004 and 2008, suggesting that much of a continuing decline had occurred between 2001 and 2003.

Grey-tailed Tattler – Numbers counted declined at Eighty-mile Beach between 2001 and 2008. Declines through the MYSMA period (2004-2008) were less marked, and the species indeed increased in on the northern beaches of Roebuck Bay. This species was never abundant at Saemanguem.

Pied Oystercatcher – A resident species. Increased at Eighty-mile Beach between 2001 and 2008, and in the MYSMA area between 2004 and 2008 – with the exception of a steady decline in numbers of the small population on the northern beaches of Roebuck Bay.

Red Knot – Never an abundant species at Saemanguem. Numbers on Eighty-mile Beach declined between 2001 and 2008. Data from the MYSMA area are too messy to draw firm conclusions. They are heavily skewed by the patchy distribution of this species on Eighty-mile Beach, with nearly all of that population occurring in the stretch of beach 50-65 km south of the Anna Plains access track; it seems that sometimes these birds occurred in the MYSMA area and at other times they did not.

Red-capped Plover - A resident species. Increased at Eighty-mile Beach between 2001 and 2008, and in Roebuck Bay between 2004 and 2008. However, numbers declined in the MYSMA area of Eighty-mile Beach between 2004 and 2008. As in Common Greenshank, numbers counted on beaches may be related to rainfall history.

Red-necked Stint – Stages in reasonably large numbers at Saemangeum, but has shown little decline there (it is a species that can use freshwater wetlands as well as tidal sites). Numbers have increased at Eighty-mile Beach since 2001, as they have through much of Australia, apparently because of a series of consecutive years of high breeding success (Rogers and Gosbell 2006). The population now appears to be declining again (Rogers and Gosbell 2006), and numbers in the MYSMA area declined slightly between 2004 and 2008.

Ruddy Turnstone – Declining at Saemanguem, which had a population of less than 1000 birds. Has declined at Eighty-mile Beach between 2001 and 2008. Also declined during the MYSMA period.

Terek Sandpiper – Declined rapidly at Eighty-mile Beach, with the number present in 2008 only 47.1% that counted in 2001. This species also declined at all MYMSA sites, with very strong declines on Eighty-mile Beach and Bush Point, smaller declines on the northern beaches of Roebuck Bay. Saemanguem was an important staging site for this species and its reclamation may have had some effect on the decline, but MYSMA data suggests the decline of this species began before closure of the Saemanguem sea-wall in 2006.

Whimbrel – Increasing at all sites. In Roebuck Bay this species is difficult to count (it sometimes roosts in inaccessible mangrove clearings if tides have been high enough to moisten them),but it is one of the easier species to count at Eighty-mile Beach. The Whimbrel population staging in Saemangeum has declined by *c*. 500 birds since sea-wall reclamation (Moores et al. 2008), but as counts in adjacent estuaries in Korea have increased, there may not yet have been any global decline in numbers as a result.

Table 23. Changes in numbers of the most abundant shorebird species in north-western Australia. Counts in 2008 are expressed as a percentage of previous counts. The previous complete surveys of Eighty-mile Beach (first data column) were made in 1999 and 2001. All other columns report on changes in the MYSMA area, expressing the December 2008 counts as a percentage of the total seen in the first series of MYSMA surveys in 2004. For faster interpretation by the reader, declines are coloured red; increases are coloured black.

Site	Eighty-mile Beach			Roebuck Bay			Full MYSMA area
Survey region	Complete Surveys	MYSMA: 0-30 km S	MYSMA: 30-60 km S	MYSMA: Bush Point	MYSMA: N Beaches	All bay	Roebuck Bay and 0-60 km of EMB
Species	2001 to 2008	2004-2008	2004-2008	2004-2008	2004-2008	2004-2008	2004-2008
Bar-tailed Godwit	46.9%	55.2%	52.0%	118.9%	42.9%	71.8%	65.2%
Common Greenshank	104.0%	97.4%	111.7%	7.9%	214.6%	132.5%	109.5%
Curlew Sandpiper	41.0%	69.7%	60.2%	13.0%	82.0%	55.2%	67.4%
Eastern Curlew	59.7%	53.2%	107.0%	141.5%	70.7%	43.2%	72.1%
Great Knot	76.1%	73.4%	123.8%	63.3%	83.1%	77.0%	109.5% (79.2%)
Greater Sand Plover	35.4%	65.1%	113.6%	90.9%	120.0%	56.6%	62.4%
Grey Plover	72.3%	57.9%	88.1%	53.1%	121.8%	51.9%	53.8%
Grey-tailed Tattler	54.3%	80.0%	126.1%	18.8%	187.5%	110.7%	91.6%
Pied Oystercatcher	116.0%	311.1%	66.7%	101.7%	42.6%	55.9%	154.7%
Red Knot	77.9%	162.9%	3.7%	14.9%	207.6%	103.0%	158.8% (86.2%)
Red-capped Plover	219.4%	85.3%	76.3%	104.9%	106.1%	128.0%	86.5%
Red-necked Stint	118.5%	110.3%	74.6%	87.9%	87.1%	49.7%	77.8%
Ruddy Turnstone	69.9%	72.2%	193.4%	83.3%	97.0%	142.2%	50.9%
Sanderling	112.0%	262.5%	259.0%	116.7%		68.6%	81.9%
Terek Sandpiper	47.1%	32.1%	51.9%	59.5%	85.1%	69.6%	34.4%
Whimbrel	196.0%	109.1%	155.6%	434.3%	206.0%	547.3%	416.0%

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Expedition participants. Standing, left to right: Nial Moores, Rob Clemens, Park Jong-Gil, Maruice O'Connor, Adrian Boyle, Kim Soek-Yi, Allan Gillanders, Trevor Cowie, Bai Quinquan, Phil Straw, Arthur Keates, Gavin O'Brien, Ashley Herrod. Squatting, left to right: Danny Rogers, Chris Hassell. Sitting, left to right: Cai Yinting, Liz Rosenburg, Kim Hyang-ja, Kimberley Onton, Sara Pearson, Joanne Oldland.

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APPENDIX 1. Geographical co-ordinates of count sites

Datum = GDA-94.

Shorebird Area	Count Area	Longitude	Latitude
Anna Plains	Anna Plains, WA	121.50530	-19.22040
80 Mile Beach	80MB Negative 20+K	121.52043	-19.04551
80 Mile Beach	80MB Negative 20-15K	121.51743	-19.07537
80 Mile Beach	80MB Negative 15-10K	121.49673	-19.11638
80 Mile Beach	80MB Negative 10-5K	121.46893	-19.15335
80 Mile Beach	80MB Negative 5-0K	121.44457	-19.18618
80 Mile Beach	80MB 0-5km	121.41696	-19.22409
80 Mile Beach	80MB 5-10km	121.38630	-19.26323
80 Mile Beach	80MB 10-15km	121.35829	-19.29849
80 Mile Beach	80MB 15-20km	121.32953	-19.33397
80 Mile Beach	80MB 20-25km	121.29948	-19.36746
80 Mile Beach	80MB 25-30km	121.26675	-19.40163
80 Mile Beach	80MB 30-35km	121.23540	-19.43504
80 Mile Beach	80MB 35-40km	121.20059	-19.46421
80 Mile Beach	80MB 40-45km	121.16290	-19.49108
80 Mile Beach	80MB 45-50km	121.12768	-19.52045
80 Mile Beach	80MB 50-55km	121.08976	-19.54795
80 Mile Beach	80MB 55-60km	121.05419	-19.57501
80 Mile Beach	80MB 60-65km	121.04450	-19.58700
80 Mile Beach	80MB 65-70km	121.01167	-19.60081
80 Mile Beach	80MB 70-75km	120.97499	-19.62222
80 Mile Beach	80MB 75-80km	120.93263	-19.64234
80 Mile Beach	80MB 80-85km	120.88476	-19.66231
80 Mile Beach	80MB 85-90km	120.83111	-19.68393
80 Mile Beach	80MB 90-95km	120.77831	-19.70667
80 Mile Beach	80MB 95-100km	120.73404	-19.72574
80 Mile Beach	80MB 100-105km	120.69127	-19.74494

Shorebird Area	Count Area	Longitude	Latitude
80 Mile Beach	80MB 105-110km	120.64827	-19.76297
80 Mile Beach	80MB 110-115km	120.60806	-19.77660
80 Mile Beach	80MB 115-120km	120.56552	-19.79011
80 Mile Beach	80MB 120-125km	120.52000	-19.80429
80 Mile Beach	80MB 125-130km	120.47549	-19.82060
80 Mile Beach	80MB 130-135km	120.43218	-19.83832
80 Mile Beach	80MB 135-140km	120.38772	-19.85293
80 Mile Beach	80MB 140-145km	120.34297	-19.86812
80 Mile Beach	80MB 145-150km	120.29773	-19.88409
80 Mile Beach	80MB 150-155km	120.25203	-19.89747
80 Mile Beach	80MB 155-160km	120.20479	-19.91085
80 Mile Beach	80MB 160-165km.a	120.16235	-19.91408
80 Mile Beach	80MB 160-165km	120.13520	-19.91359
80 Mile Beach	80MB 165-170km	120.10738	-19.91553
80 Mile Beach	80MB 170-175km	120.07475	-19.92250
80 Mile Beach	80MB 175-180km	120.03914	-19.92993
80 Mile Beach	80MB 180-185km	119.99560	-19.93059
80 Mile Beach	80MB 185-190km	119.94833	-19.93771
80 Mile Beach	80MB 190-195km	119.89767	-19.95311
80 Mile Beach	80MB 195-200km	119.85754	-19.96345
80 Mile Beach	80MB 200-205km	119.81727	-19.97021
80 Mile Beach	80MB 205+km	119.78272	-19.96488
Broome	Cable Beach - rocks to Coconut Well S Lagoon	122.21083	-17.88245
Broome	Riddel Beach to entrance point	122.19376	-17.99464
Broome	Cable Beach to Riddel Beach	122.20489	-17.95022
Broome	Croc Well Sth lagoon to Willie Creek	122.20399	-17.79926
Broome	Sewage Ponds	122.22128	-17.97461
Broome	Catalinas	122.23867	-17.96413
Broome	Old Customs House Lawn / Catalinas	122.24051	-17.95674

Shorebird Area	Count Area	Longitude	Latitude
Broome	New Oval	122.22418	-17.95130
Broome	Haynes Oval	122.22993	-17.95559
Broome	Town Oval	122.24200	-17.95428
Broome	St Mary Oval	122.22268	-17.95997
Broome	Golf Course	122.21559	-17.97780
Bush Point (south end of Roebuck Bay)	Cape Villaret to Jack's Creek (N section)	122.14724	-18.28720
Bush Point (south end of Roebuck Bay)	Cape Villaret to Jack's Creek (S section)	122.07145	-18.32424
Bush Point (south end of Roebuck Bay)	Cape Villaret to Jack's Creek (mid-section)	122.09578	-18.31699
Cape Gordon to Cape Villaret	Cape Gordon to Cape Villaret	122.02852	-18.36600
Coast north of 80 Mile	Dessualt Bay 0 - 5 km	121.53234	-19.02330
Coast north of 80 Mile	Dessualt Bay 5 - 10 km	121.55585	-18.98422
Coast north of 80 Mile	Port Smith	121.79753	-18.49860
Coast north of 80 Mile	Gourdon Bay North	121.96589	-18.42332
Coast north of 80 Mile	Gourdon Bay South	121.84807	-18.45508
Coast north of 80 Mile	Bidyanga	121.77282	-18.66210
Dampier Peninsula	James Price Point	122.15050	-17.44230
Dampier Peninsula	Minari (Coulomb Point)	122.15109	-17.37385
Dampier Peninsula	Barred Creek	122.19007	-17.66203
Dampier Peninsula	Quondong point and beach to 5 km south	122.16829	-17.58735
Dampier Saltworks	Dampier Saltworks	116.73611	-20.71922
Roebuck Bay	Quarry Beach	122.28626	-17.96804
Roebuck Bay	Nick's Beach	122.29887	-17.97299
Roebuck Bay	Eagles Roost	122.30305	-17.97364
Roebuck Bay	Boat Ramp	122.34285	-17.97898
Roebuck Bay	One Tree Point / Sandy Blowout	122.98406	-17.98406
Roebuck Bay	Wader Spit	122.33609	-17.97999
Roebuck Bay	Crab Creek	122.35413	-17.97668

Shorebird Area	Count Area	Longitude	Latitude
Roebuck Bay	Boiler	122.35803	-17.98035
Roebuck Bay	Stilt Viewing	122.36037	-17.98141
Roebuck Bay	Terek Rocks	122.34882	-17.97574
Roebuck Bay	Greenshank Corner	122.35096	-17.97542
Roebuck Bay	Town Beach to Port (Simpsons Beach)	122.21336	-17.98755
Roebuck Bay	Richard's Point	122.33074	-17.97705
Roebuck Bay	Tattler Rocks	122.31947	-17.97550
Roebuck Bay	Boat Ramp 2	122.34352	-17.97882
Roebuck Bay	2 Dog	122.29370	-17.97097
Roebuck Bay	Campsite	122.30830	-17.97461
Roebuck Bay	Wader Beach	122.33363	-17.97841
Roebuck Bay	Fall Point	122.33720	-17.98041
Roebuck Bay	Crab Creek beaches	122.36136	-17.98237
Roebuck Bay	Fishheads	122.32434	-17.97628
Roebuck Plains Lakes	Lake Eda	122.65058	-17.88842
Roebuck Plains Lakes	Taylors Lagoon	122.89203	-17.78142

APPENDIX 2: MYSMA Count Log, Dec. 2008.

During the fieldwork we maintained a count log to document the day to day challenges in carrying out the survey. It was written late in the evenings, and the prose is far from elegant! Nevertheless it is included here as it includes useful information on survey conditions and logistics.

10 Dec 2008 High tide of 6.24m at 9:20

Eighty-mile Beach counts, done by three separate squads. One squad (with 4 teams) was based at Anna Plains Station, one (with two teams) at Wallal and one (with two quad bikes) at Cape Keraudren.

The four Anna Plains team counted from 0-30 km S, and 0 to 10 N of the beach access point at Anna Plains. Good weather – overcast, and quite cool, so the light was excellent with no haze. Cool weather conditions meant Oriental Plover had no reason to fly onto the beach, as is usually the case during the December counts. Birds were spread over much of the beach from the tide edge to the base of the dunes between 0 and 30 km, rather than being split cleanly into sea-edge and upper-beach flocks. This situation may have slowed down the counting, but most teams had no serious problems. The CJH team from 20-30 km S only had 3 hours of counting time as the tide took a long time to reach the beach.

0-5 N and 5-10 N. Team: Jan Lewis (leader & scribe), Arthur Keates (lead counter), Allan Gillanders. A number of smallish flocks which all flew north when disturbed making for an easy count. Allan counted godwits and small species up the beach; Arthur counted the rest.

0-5 S and 5-10 S. Team: Danny Rogers (leader), Jo Oldland, Phil Straw, Trevor Cowie (scribe). Danny counted knots and curlew sands, Phil counted godwits, Jo counted small plovers and stints, and then we picked up the remaining species between us. In general this stretch was more bird-rich than usual, with big numbers of Common Greenshank. Birds were a bit more spread out on the beach than usual, presumably because of the cool conditions. It slowed counting down a bit, but not too much.

10-15 S and 15-20 S. Adrian Boyle (leader), Sarah Pearson (scribe), Kim Soek-yee and Park Jong-Gil. Noted one Great Knot with oil around right flank. Between 15-20 km, note that some of the counts of 13 and 12 affinis might have been macrotarsa.

20-25 S, 25-30 S Chris Hassell (leader), Nial Moores, Kim Hyang Ze, Liz Rosenberg (Scribe). Between 20-25 km, noted that zero Red Knot seen in 3300 Great Knot. Similar to the 0-10 km section birds were more spread out than usual, presumably because of the cool conditions. As a result, the count was a bit hurried in kms 20-25, and it was necessary to count some flocks by proportion in flight – Nial counting totals, Chris estimating species proportions. For the last 1.6 kms of the 25-30km stretch, the mud was beginning to be exposed, and it is possible that some birds moved south out of the section.

The teams based at Wallal had mixed fortunes:

Maurice O'Connor (driver), George Swann (leader), Gavin O'Brien (scribe) and Cai Yinting. Started by going north from Wallal Beach; did four complete 5 km stretches, and then half of a 5th stretch before reaching the uncrossable Mandora creek. They then turned round, returned to Wallal Beach,

and then started counting their way south, completing 4 more 5-km stretches (so during the day they counted some 42.5 km of Eighty-mile Beach).

Grant Morton (leader), Clare Morton (scribe), Rob Clemens and Bai had a very frustrating day. They had been scheduled to count the beach north of Mandora Creek, but it turned out that beach access there is no longer possible. They spent a lot of time trying to find a way on (finding a fisherman's track which once worked, but is now covered by dunes), and eventually concluded that only quad bike access was possible. In the course of the day they only counted 2 km of Eighty-mile Beach, the sector immediately north of Mandora Creek.

The Cape Keraudren team – two quad bikes driven by Ash Herrod and Kimberly Onton had no major complications – first they counted the bay immediately south of the Cape Keraudren boundary fence, and then they worked their way north, getting to 15 km north of Cape Keraudren. Fuel consumption was around 70-80 km per tank (so they needed to cache fuel the next day). There was a creek some 10km north of Cape Keraudren that couldn't be crossed at the mouth at high tide, so they had to go half a km inland to cross it and a tributary. At low tide on the return trip, they could cross this creek at its mouth.

Sand bags on the front baskets of the bikes enabled easy scope use, and dividing the species between observers before the counts began saved a lot of time. Birds, especially terns, were reasonably wary of the bikes, so they wound up being counted by scope from longish range before they manoeuvred round the groups. In general birds were quite spread out, making the counts easy but time-consuming.

11 Dec. 2008 High tide of 6.79m at 10:15

All teams based at Eighty-mile Beach for a second day. Warmer weather than on the previous day, but it wasn't too uncomfortable.

The sections from 50-60 km S have become increasingly difficult to count in a single high tide in recent years, so this year we decided to give them doubled effort, one team counting from 50-55 km S during a high tide, one team counting from 55 to 60 km S.

50-55 km S – Danny Rogers (leader), Jo Oldland, Phil Straw and Trevor Cowie (scribe). Danny counted knots and curlew sands, Phil counted godwits, Jo counted small plovers and stints, and then we picked up the remaining species between us. Not an easy count, with waders very unsettled on the rising tide and huge clouds of birds to the north. We had to wait for them to settle and nearly all landed in our block, so we didn't start counting until the tide had peaked. The weather was already very hot by this stage, so we counted Oriental Plovers in addition to the grey waders. The final 2.5 km were very rushed so we could beat the ebbing tide, and usually we were counting the common species in blocks of 100's. We may have undercounted uncommon species as result, but as birds seemed quite settled by this stage, the counts of the major species seemed pretty solid.

55-60 km S. Chris Hassell (leader), Nial Moores, Kim Hyang Ze, Liz Rosenberg (Scribe). Slow but good count. CJH not sure how he ever manages to do 10 km with just himself and one inexperienced observer. It will be very interesting to compare counts from year to year for this section and 50-55. Few birds flying behind. Diversity less as we went south so easier and quicker counting.

40-45 km S, 45 – 50km S. S. Adrian Boyle (leader), Sarah Pearson (scribe), Kim Soek-yee and Park Jong-Gil. No real problems – there weren't that many bird in this stretch, many having flown into the

50-60km stretch before counts began. An oddity was a leucistic Red-necked Stint in the 45-50 km stretch, white with brown areas restricted to wings. An unfamiliar sea snake (*Hydrophis czeblukovi*) was collected at 47km S and will be sent to the WA museum.

The Wallal teams again had mixed fortunes:

Km 120-125, 125-130, 130-135, 135-140, 140-145, 150-155. Maurice O'Connor (driver), George Swann (leader), Gavin O'Brien (scribe) and Cai Yinting – covered a lot of ground with no major complications.

Km 155 to 170. Grant Morton (leader), Clare Morton (scribe), Rob Clemens and Bai had another frustrating day. The idea was that they would count their way south until they met the team (Ash and Kim) coming north from Cape Keraudren. However there was very little beach access and driving on the beach was not possible, so they did a lot of walking and scanning from long range. Overall they estimate that they counted about 7km of beach, and 8km were uncounted.

Km 170-175, km 175-180, km 180-185. Ash Herrod, Kimberley Onton. Fairly straightforward when done on quad bikes. The beach was narrow between 20-25 N of KC, and there was no way to pass birds without flushing them, with many birds (especially terns) flying ahead and therefore being likely to be double-counted. In this section counts were made by scope, and then the counters accelerated quickly to outpace those birds that were trying to fly ahead. This section of beach also had a large sand spit with a large concentration of birds; otherwise the birds were quite spread out.

Km 10- 20 N of Anna Plains to Cape Missiessy was counted by Jan Lewis, Arthur Keats and Allan Gillanders. Few flocks until the Cape was reached. Larger flocks very well hidden amongst the rocks of the Cape ie invisible when roosting; flushing was the only way to get an accurate count. To get onto the Cape continue along the beach above the high tide line, between the fence line and the dead mangrove roots and then take a sharp right turn at the fence line which brings you up onto a more solid track leading from the gate marking the Anna Plains boundary. Take a left turn for the Cape – or, to be most effective, park and walk round the rocky headland as near to the tide edge as possible.

Dessault Bay was also counted by Jan Lewis, Arthur Keats and Allan Gillanders, the first time this bay has been counted. Access was from the southern end at Cape Missiessy by driving from the end of the track to the Cape along the high tide line and onto the beach; Dessault Bay was fairly quiet; it was drivable, though with soft sand which often required first gear. We were able to cross the first creek half way down the beach as the tide had fallen by the time we reached there. At high tide it might not be so easy. A few more kms were covered until the second creek which was not crossed – and probably can not be crossed by a car at high tide. This is an active creek that the tide pushes up to create several pools that remain once the tide has fallen. Some sections are mangrove lined. Little Terns were nesting on the sand bank on the north side of the creek mouth. A very large mixed flock of terns was roosting at the mouth of the creek.

<u>12 Dec. 2008 High tide of 7.29 at 11:04</u>

Hot, no cloud; easterly winds. It was uncomfortable, especially on 80 Mile Beach where flies were in record numbers. Two teams from the Anna Plains squad remained at 80 Mile Beach to count "missing" sections from the previous two days, while the remaining Anna Plains vehicles returned to Broome, counting at previously unexplored sites (e.g. Bidyanga, Port Smith, Gourdon Bay) on the

way. Further south, a big effort to get the quad bikes onto the beach north of Mandora Creek, where Grant and George did a long run to meet up with Chris's team.

60-65 km South. Chris Hassell (leader), Nial Moores, Kim Hyang Ze, Liz Rosenberg (Scribe). Seemed low on bird numbers, no birds gathering up the beach as is usually the case possibly due to very hot conditions and very strong easterly wind. Previous night's tide of 7.77 m made driving very difficult on very soft sand high up beach or very soft and damp lower.

65-66 km south Chris Hassell (leader), Nial Moores, Kim Hyang Ze, Liz Rosenberg (Scribe). Met Grant at 66km. The only birds seen in this km were in a creek line.

30-35 km south, and 35-40 km South. Adrian Boyle (leader), Sarah Pearson (scribe), Kim Soek-yee and Park Jong-Gil. These stretches were counted on the third day because we had agreed to use two teams to count the troublesome 50-60 km stretch the previous day. As a result it wasn't possible to carry out counts at Admiralty Bay as originally planned, but this area had looked birdless and difficult of access in an aerial survey three weeks earlier.
The 30-40km stretch was easy to count, as it was almost devoid of birds – only some 4000 in a four km stretch. The team therefore finished their count early, and continued south to look for the missing birds, especially Great Knots. Numbers proved to be low in the next 16 km – results by km are summarised below (component counts and times are available on the datasheet, but haven't been entered into the database):

Location	Great Knot	Red Knot	Bar-tailed Godwit
Km 40-41	0	0	Several hundred
Km 41-42	< 100	0	c. 200
Km 42-43	0	0	0
Km 43-44	0	0	130
Km 44-45	1	0	85
Km 45-46	2	0	110
Km 46-47	0	0	0
Km 47-48 (11:40)	15	0	470
Km 48-49 (11:42)	10	0	280
Km 49-50 (11:47)	405	0	110
Km 50-51	0	0	160
Km 51-52 (12:00)	35	0	615
Km 52-53	290	0	170
Km 53-54	160	6	310
Km 55-56 (13:00)	5900	25	1640

This is the lowest count we've ever had in the 30-40 km stretch, and probably also for the 40-50km stretch. In one respect it is consistent with the observations made on the 11th Dec, when huge clouds of large shorebirds flew into the 50-55km stretch from further north (though we don't know exactly where from, other than that many were from 45-50km). However, on the 11th we saw far more birds in the 50-55km stretch than were present on the 12th. (particular Red Knot) Most likely explanation may be that they flew further south? Yet the counts from 60km south to Mandora were not particularly large.

Bidyadanga. Jan Lewis, Arthur Keats and Jo Oldland. Apparently the first ground count at this site? Permission to enter the community had been previously arranged by phone. On the day no-one in the community office knew of our visit. We advised the person in the office we would be able to

find our own way and drove through the community to the far end which brings you through paperbark onto a salt marsh area. Initially we headed left/south. The road follows the edge of the paperbark and finally brought us to the south side of the creek which feeds the saltmarsh. This is all rocky cliffs with the tide right at the base several hours before high tide. There were no birds on that side, but we could see flocks on the north bank. We returned on the track round the edge of the paperbark continuing to the north instead of returning to the community. Several tracks lead off to fishing spots inland on the creek, but eventually we reached sand dunes which mark the coast. There are several entry points to the beach which we used to count the whole lower edge of the huge bay. There was quite a large flock on the actual creek mouth and then smaller flocks on each of the rocky platforms jutting out into the ocean. It may have been possible to drive onto and north along the beach but we preferred to stay on the track and look from vantage points. A large (1000+) flock of knots and godwits was found in the corner of the Bay. We decided to try and follow the Bay north. There were many tracks and junctions to chose; we stuck to the widest and made forays off to the west at intervals. By now the tide had fallen considerably exposing a wide, beautifully coloured, but virtually empty mudflat, with whimbrel and pelicans the main occupants. The main track continued to Port Smith joining the Port Smith entry track just by the edge of the caravan park.

Port Smith, Gourdon Bay. Danny Rogers (leader), Phil Straw, Allan Gillanders, Trevor Cowie (scribe). Port Smith – arrived on a rising tide, and started by talking to Frank from the bird park, for local advice on how to get into Port Smith and Gourdon Bay. It is a fairly small, sandy inlet fringed by mangroves. At high tide when the flats are covered there isn't any roosting habitat visible from the most easily accessible entrance, at the end of Port Smith Road. Following Franks advice we skirted the inlet and mangroves to the north, circling round to get to the northern head of the inlet. The track has some soft sandy patches in the last two km, and we got bogged in one of them (not hard to get out, but it was very hot!). We could get to some narrow beaches and rock outcrop from this point, and some waders were seen, but they were scattered and were in small numbers.
Later in the day we returned to Port Smith after the tide had ebbed, and attempted a low tide count from the entrance point at the end of Port Smith Road. At the time we thought we could see a nice large proportion of the inlet – an attractive place with very sandy flats on which small numbers of shorebirds were feeding. We have treated these as separate birds from those seen on the western banks of Port Smith at high tide, as the species composition was different; there seemed to be a fair bit of habitat to the west beyond our line of sight and it seemed logical that birds from the channel entrance would have fed there.

Port Smith seemed a good place for Lesser Sand Plovers by NWA standards. Examination of aerial photos later suggested that we had in fact only seen 30-40% of the flats of the inlet from our vantage point. Nevertheless, we suspect that low tides would be the ideal time to do counts of Port Smith, as walking over the sandy flats or through the sandy mangroves poses no major complications; it should be relatively easy to wade to a small number of points from which the entire bay can be scanned.

Gourdon Bay – A pretty area – a large, deep bay with steep white sand beaches. At high tide the water was very clear – enabling us to watch shoals of fishes, plus sharks moving in to hunt them – and there seemed to be little or no tidal flat for birds to feed on at low tide. We found two small roosting flocks of waders, one on a rocky headland at the south end of the bay, and another on sandy beaches some 4km north which moved onto rocky islands as the tide ebbed. It's impossible to drive onto the beach of Gourdon Bay, so we were unable to count turtle tracks. Instead we scanned most of it by telescope, from the southern end and from a vehicle accessible dune about half-way along; it is probably only possible to get to the northern end on foot (not practical in really hot weather as it would involve a 10km walk). Given the heat haze it's possible that we missed scattered

waders, but the only beach flock we did see contrasted strongly with the white sand, and we could see it from 4km. We therefore doubt that we missed large numbers of waders.

Access to Gourdon Bay was via Port Smith Road. We used two tracks, both visible in the Google Earth Images of the area and easily seen from Port Smith Road. One went north from the Port Smith Road about 5km short of the caravan park – it wasn't signposted, but had the approximate GPS co-ordinates 18° 31.003' S 121° 50.965 E. The road goes north until you reach a fork – go left and you wind up at Saddle Hill (a high point from which you can see all of Gourdon Bay, but too distant for wader counting), go right and you get to the southern edge of the bay, and a rocky headland which had a few tattlers and sand plovers, at 18° 27.669 S 121° 50.846 E.

The other access point was reached by a second road north, about 12 km short of Port Smith (this distance is a guess) – the junction is labelled "Port Smith Junction" on our Google Earth Images, with co-ordinates of 18° 30.985 S, 121° 54.666 E. The track is signposted to a place with a name saying "Nyah Nyah" or some such (can't read my handwriting), and also says no admission without permission. It ends in a locked gate and rubbish tip at 18° 27.960S 121° 54.595E, and from here it's easy to climb over the dunes to the shores of Gourdon Bay.

It was very hot (40°+) on the day of our visit, so conditions weren't good for assessing wildlife highlights in the woodlands behind Gourdon Bay. However it seemed to be a fairly lush and tall area of woodland, and might merit more careful assessment at some stage.

<u>13 Dec. 2008 High tide of 7.69m at 11:49</u>

Stinking hot, strong easterlies. Counted the northern shores of Roebuck Bay (Quarry Beach to One Tree Mangroves and Simpson's Beach as usual). In addition we had teams counting sites in and near Broome, including The Port, Riddel Beach, Gantheaume Point, Cable Beach, Coconut Well and Willie Creek. A separate team also went to the Dampier Peninsula (James Price Point and Minari). The team that counted waterbirds from in front of the Crab Creek mangroves looking over Little Crab Creek and towards Crab Creek also went in to Broome Town and counted the Water Treatment Palnt and Broome Ovals. Adrian and Nial also did a flight from just south of Crab Creek along the eastern shore of Roebuck Bay, over Bush Point and the down the coast to Cape Missiessy. This helped to ensure we hadn't missed any large numbers of birds during our ground counts there. The plane took off 10 minutes earlier than planned and the tide covered the mud flats a little later than expected so some birds may have been missed during the early part of the flight.

James Price Point and Minari (Coulomb Point) – counted by Ash Herrod, Kimberly Onton, Maurice O'Connor and Liz Rozenberg. The two sites were separated by geography – the northern limit of James Price Point was treated as the end of the cliff-face, and the beach north of that was treated as Minari (at the northern end, stopped where the creek meets the beach).

James Price Point – Start 17° 29' 12.4", 122° 08' 41.1". Finish 17° 23' 56.4", 122° 08' 59.3".

Minari – Start and finish 17° 21' 22.8", 122° 09' 12.4"

<u>14 December 2008 High tide of 7.95m at 12:31</u>

Northern Roebuck Bay – Danny Rogers, Liz Rosenberg, Jo Oldland and Trevor Cowie.

Frustrating count. We were only counting selected species: Great Knot, Red Knot, Bar-tailed godwit, Grey Plover, Ruddy Turnstone and Terek Sandpiper (because totals seemed low on the 13th). Stinking hot at first, but a westerly sprang up about half-way through the count.

Started at One-tree. Not huge numbers of birds feeding there and many of the birds from the flats turned out to be strays from the plains – Little Curlew, Oriental Plover and Oriental Pratincole.

We only got as far as Campsite. We'd been going slowly, and at Campsite we were refining the count of the main flock (>13,000 Knots), when fishermen came and disturbed the lot; they scattered and there wasn't time to revise counts. We counted a few extra birds at Eagles's Roost as we were sure they had been in the rocks there originally, but it was too late to count by the time we got to Nick's Beach and sites further west. The count is therefore incomplete – only use totals if they increase those from 13th Dec.

Barred Creek, Quondong. Arthur Keats, Rob Clemens, Kim Hyang-Gee and Kim Soek-Yee. All pretty straightforward.

Bush Point – Everyone else. Split into three teams: AB in south, CJH in mid-section and GM on the island. Seems to have gone smoothly but bird numbers seemed very low and the count included a flock of several thousand birds that flew out of mangroves half-way through the count; it seems likely that birds were therefore missed from the inacessable roosts to the north of BP.
GS and MOC went on to the beach south of BP at the tourist resort of Eco Beach. They were able to count birds until Jack's Creek, there were good numbers around Jacks Creek. The creek was impossible to cross and birds may well have been missed between Jacks Creek and the south side of Yardogarra Creek.