



Technical Appendix C3

Avifauna

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GORGON DEVELOPMENT ON BARROW ISLAND

TECHNICAL REPORT

AVIFAUNA

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1 Introduction

The Gorgon Venture proposes to develop a terrestrial gas processing facility and associated marine infrastructure at Town Point on the east coast of Barrow Island. The proposed development area near Town Point includes littoral and terrestrial habitats used by shorebirds, seabirds and landbirds. Direct loss of some of these habitats and disturbance to surrounding areas is likely to affect local avifauna.

Formal assessment of the impacts of the proposed development requires information on the significance of the impacted areas to avifauna. Protected and migratory species are known to occur on Barrow Island, however, quantitative data on the distribution and abundance of avifauna around the Island are scarce.

Field surveys and literature reviews were conducted on behalf of the Gorgon Venture for the earlier Environmental, Social and Economic (ESE) Review of the proposal (Bamford 2002, Astron Environmental 2002). The ESE Review process identified gaps in existing knowledge concerning the distribution and seasonality of birds in potential impact areas.

Most shorebirds and some other species are listed as migratory and are known to be abundant on the Island (Sedgwick 1978), but it is not clear for which species the Island is of particular importance, nor how the species vary in abundance during the year or across the Island. Previous studies indicated that the Bandicoot Bay area in the south of Barrow Island is the main area of importance for migratory shorebirds (Sedgwick 1978), but little was known of the importance of beaches near Town Point in relation to the rest of the Island.

Bamford Consulting Ecologists were engaged to redress this lack of information, by surveying avifauna in the development area in 2003/2004 and assessing the significance of this area to regional and local populations. This report presents the findings of the current study and provides assessment of the importance of the proposed development area in relation to other areas of Barrow Island for avifauna.

The current study addresses three aspects of the avifauna of Barrow Island:

- littoral avifauna (waterbirds that utilise coastal environments)
- landbirds
- Double Island seabirds

The littoral avifauna surveys aimed to identify the importance of the Town Point area for avifauna and to contribute to an understanding of the importance of Barrow Island for these species.

Landbird surveys were designed to compare the abundance of landbirds in the vicinity of the proposed gas processing facility with abundances in surrounding areas and with data from other studies on Barrow Island. The importance of different habitat and landform types for landbirds was investigated to facilitate estimates of the wider distribution of these birds on the Island.

Double Island, about four kilometres north-east of the project area, is known to support breeding populations of the wedge-tailed shearwater and bridled tern (Astron Environmental 2002). Although some distance from the proposed development area, it was suggested that lights might affect the breeding colony of shearwaters, particularly

through mortality of young birds attracted to the proposed development's lights. Preliminary surveys of this colony were carried out in October and November 2003.

2 Methods

2.1 Field Program

Field surveys were undertaken monthly between September 2003 and September 2004. Dates of surveys and activities undertaken during each survey are presented in Table 2-1. Most survey work was undertaken by Dr Mike Bamford and Dr Mike Craig (Bamford Consulting Ecologists). This report presents the results of all surveys, September 2003 to September 2004.

Table 2-1 – Barrow Island Sampling Program, September 2003 to September 2004

Sampling period	Littoral birds	Landbirds	Double Island seabirds
8-12 Sept 2003	*	*	
1-7 Oct 2003	*	*	*
22 Nov – 2 Dec 2003	*	*	*
11-16 Dec 2003	*	*	
9-14 Jan 2004	*	*	
6-11 Feb 2004	*	*	
11-17 March 2004	*	*	
21 – 28 April 2004	*	*	
21 – 24 May 2004	*	*	
18-21 June 2004	*	*	
16-19 July 2004	*	*	
18 –22 August 2004	*	*	
15-19 September 2004	*	*	

2.2 Littoral Avifauna Surveys

Surveys of littoral avifauna involved monthly counts around as much of the Island as possible and detailed observations on the coastline north and south of Town Point. Monthly counts were carried out during high tide periods, usually within two hours of the high tide, when most littoral avifauna were concentrated on beaches and headlands. Surveys were conducted at times when the maximum tide was at least 2.7 m (WAPET Landing datum). Surveys were carried out on foot by experienced observers, who identified birds with binoculars (10 x) and spotting telescopes (20 x to 60 x). Birds were counted individually, where possible, but when large flocks were encountered, standard approaches of estimation were used, such as block counting and using the proportion of each species determined from a detailed count to estimate the number of that species present in a mixed flock.

For the purposes of littoral avifauna counts, Barrow Island was divided into regions and sites, the sites consisting of individual bays, beaches and headlands (Figure 2-1). Within each site, birds were recorded as being either located at a roost, where ten or more birds

were concentrated, or outside of roosts. The co-ordinates of each roost (WGS84 datum) were recorded using a hand-held GPS unit. Survey coverage was not the same on each field trip and is summarised in Attachment 1.

Nearly the whole coastline of Barrow Island was surveyed from January to September 2004, most of the coast was surveyed from October to December 2003 and over half the coastline was surveyed in September 2003 (Attachment 1). To facilitate comparison of island-wide abundance between months, abundances at sites that were not surveyed were estimated for September to December 2003.

Population estimates for the whole island for September to December 2003 were derived by adding the abundances of birds at surveyed sites to the estimated abundance of birds at unsurveyed sites. Abundances of birds at unsurveyed sites was estimated from the proportional distribution of birds around the island in surveys from January to March 2004, when numbers were high and virtually all the island was counted.

The proportion of the island-wide total abundance of birds that was present at each of the beaches surveyed in January to March 2004 was used to scale up island-wide abundances for September to December 2003. This assumes that the proportion of birds using various sites was constant between September and December 2003 and between January and March 2004.

Littoral avifauna foraging in intertidal habitats in the vicinity of Town Point were counted at low tide. Waterbirds were counted on Terminal Beach (between Town Point and the pipeline to the north) and on Bivalve Beach (between Town Point and the first rocky point to the south). All birds within this area were counted using a spotting scope and classified as either within 200 m of Town Point or 200 m to 400 m from Town Point.

2.2.1 Double Island Seabird Surveys

Double Island is known to support breeding colonies of the wedge-tailed shearwater and bridled tern, and was visited in October and November 2003. Both islands were surveyed in October, but only the South Island was revisited in November because it supported the most accessible breeding areas for shearwaters. During the visits, observations were made on activity in some burrows and estimates were made of numbers of burrows present in the main breeding areas.

2.2.2 Landbird Surveys

Landbirds were surveyed along six transects in the vicinity of the proposed gas processing facility (Figure 2-2). Each transect was one kilometre long and sampled twice (once by each observer) during each monthly survey. All surveys occurred between 0600 and 0800 hours, when landbirds are most active and their densities can be most accurately estimated. The start and finish coordinates of each transect are shown in Table 2-2.

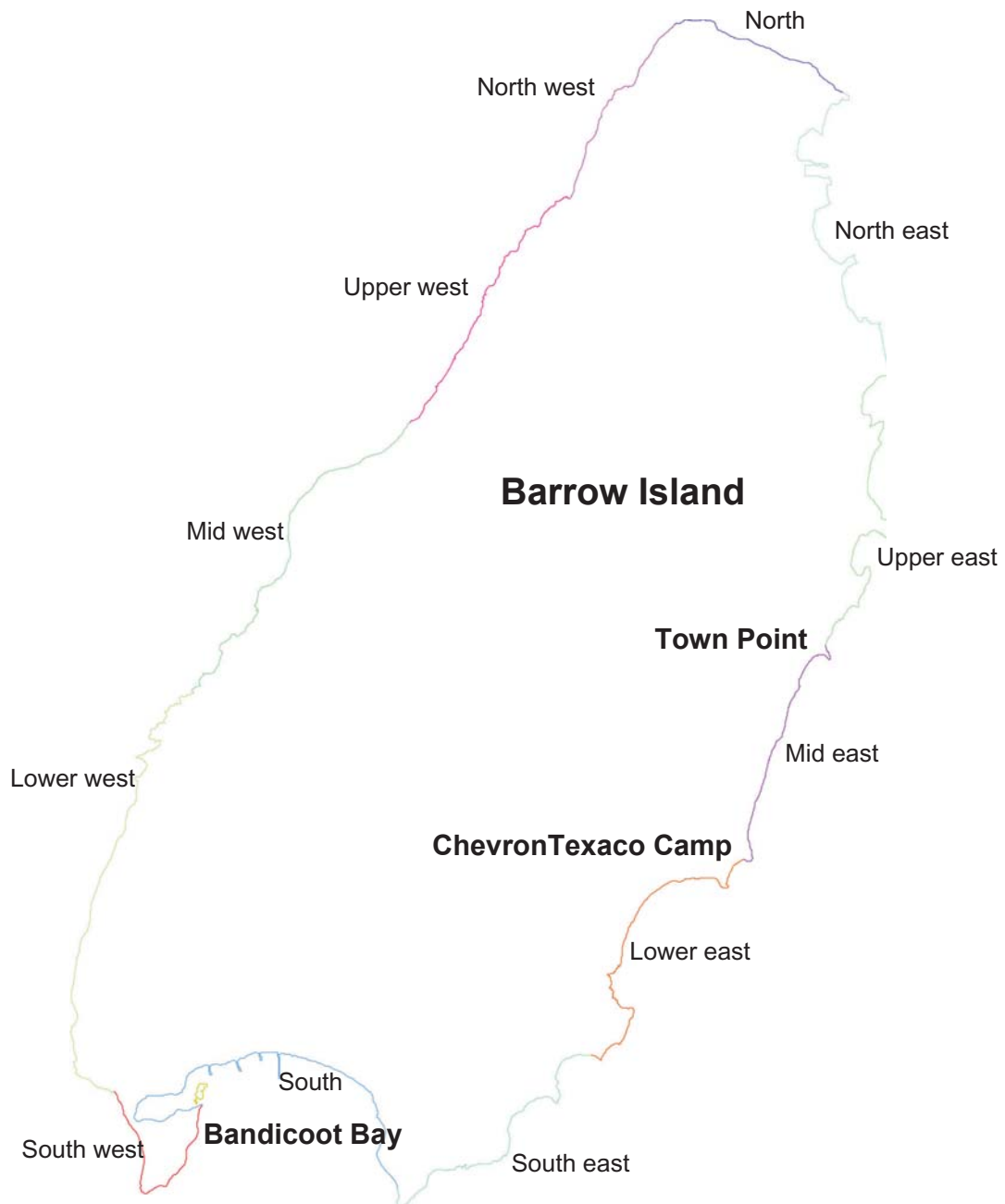


Figure 2-1 - Littoral Avifauna Survey Regions Around Barrow Island

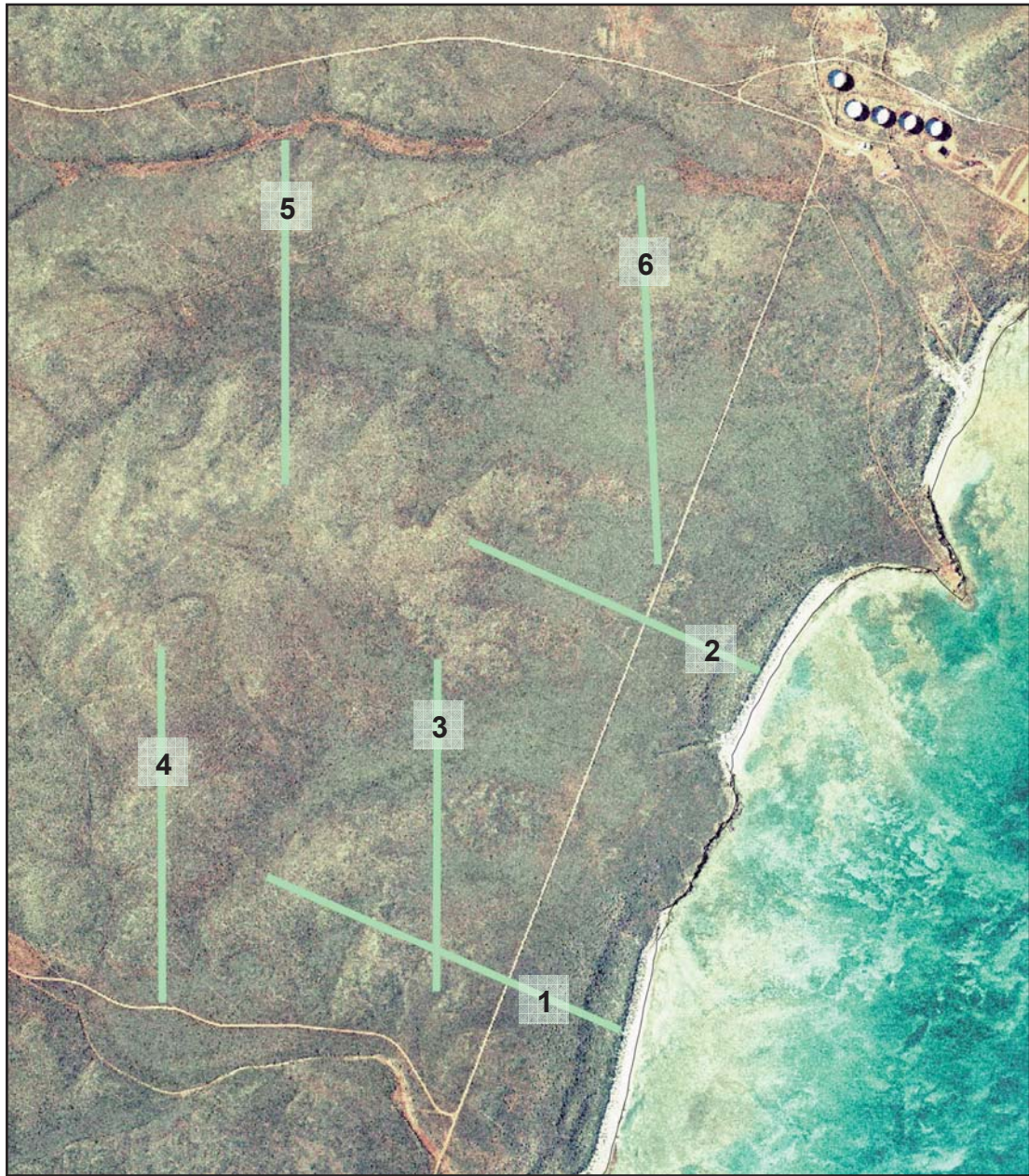


Figure 2-2 - Landbird Survey Transects

Table 2-2 - Landbird Transects within the Proposed Development Area - Coordinates: WGS84 (GDA94) Datum, Zone 50

Transect No.	Start	Finish
1	339170E, 7699045N	338156E, 7699495N
2	339527E, 7700100N	338748E, 7700460N
3	338645E, 7700115N	338645E, 7699155N
4	337855E, 7699146N	337850E, 7700149N
5	338210E, 7700618N	338210E, 7701615N
6	339234E, 7701482N	339283E, 7700387N

Surveys along the landbird transects involved walking slowly along each transect, recording landbirds within 25 m either side and beyond 25 m of each transect. Only records from within 25 m of each transect were used for the calculation of density estimates. The locations where birds within 25 m were first observed were recorded with a handheld GPS unit. Birds were identified and counted and some observations were made, such as the presence of male white-winged fairy-wrens in breeding plumage.

Each transect was 50 m wide and one kilometre long and therefore covered an area of five hectares. Within each transect, bird counts were related to vegetation type by recording the principle type of vegetation in 100 m units along each transect. The number of 100 m units in which each of the six main vegetation types was represented is presented in Table 2-3.

Details of landbird surveys conducted in October 2004 can be found in Attachment 5.

Table 2-3 - Vegetation Types on the Landbird Transects. F = Number of 100 m Units in Total Dominated by Each Vegetation Type

Vegetation code	Vegetation type	F
1	<i>Acacia coriacea</i> over <i>Triodia angusta</i> on coastal red, sandy dunes	4
2	<i>Acacia bivenosa</i> over mixed <i>Triodia</i> spp. on red sandy-loam plain	17
3	<i>Melaleuca</i> over mixed <i>Triodia</i> spp. on shallow soils of limestone rises and ridges	26
4	<i>Triodia angusta</i> forming dense stands with or without emergent shrubs in red sandy-loam valleys	2
5	<i>Triodia wiseana</i> occasionally with shrubs <1 percent cover on shallow soils of limestone ridges	3
6	Low <i>Acacia bivenosa</i> over mixed <i>Triodia</i> spp. on shallow soils of limestone slopes	8

3 Results

3.1 Littoral Avifauna

3.1.1 Barrow Island Total Counts

Monthly and maximum counts of each littoral avifauna species on Barrow Island are presented in Attachment 2.

A minimum of 32 119 littoral avifauna were counted on Barrow Island during the period September 2003 to September 2004. The highest monthly count of all birds was 20 428 in September 2004. Monthly counts of some species qualify Barrow Island as an internationally-significant migratory shorebird site, under the Ramsar Convention for supporting >1 % of a species' population in the East Asian-Australasian Flyway. Population estimates for migratory shorebirds in the East Asian-Australasia Flyway have been calculated by Bamford *et al.* (in press) and have been calculated for non-migratory shorebirds and terns by Wetlands International (2002).

Barrow Island is a regionally significant site for grey-tailed tattlers (6.6 % of known population), ruddy turnstones (5.5 % of known population), red-necked stints (2.4 % of known population) and fairy terns (8.3 % of known population).

In addition, counts of sanderlings, greater sand plovers and lesser sand plovers during southward migration period (September to November), met the staging criterion (0.25 % of a species' population) of the Ramsar Convention. Counts of roseate terns over adjacent waters in August 2002 (Astron Environmental 2002) and of bridled terns around Double Island in November 2003, may also be significant for these species. Population estimates for common terns in the north-west of Australia are uncertain and therefore the significance of over 1708 common terns in November 2003 is unknown. The maximum count of the sooty oystercatchers (83) represents 1.1 % of the known population of the distinctive northern race (*ophthalmicus*) of the species (Wetlands International 2002).

The total counts from January to March are based on surveys covering nearly all of the shoreline of Barrow Island, whereas coverage varied from September to December (see Attachment 1). Total Island-wide estimates based on the subset of sites surveyed in September, based on the sites surveyed between January and March and extrapolated to all sites (total) are presented in Figure 3-1. Total littoral avifauna abundances around Barrow Island increased during the southward migration in September to November 2003, dropped slightly in December and then peaked again in January to March 2004. Total island-wide abundances decreased following the northward migration and remained low between April and August 2004. The southward migration in 2005 appeared to start earlier than previously, with the highest total abundances counted in September 2004.

Monthly counts of the most abundant species are presented in Figure 3-2, Figure 3-3 and Figure 3-4, to examine monthly patterns for the main species. Several of the most abundant species are migrants that showed a peak during southward migration and during the non-breeding season. These included the red-necked stint (Figure 3-3), and greater and lesser sand plovers (Figure 3-4). The common tern (Figure 3-3) contributed significantly to the overall spring peak while the silver gull and fairy tern (Figure 3-2) contributed to the summer non-breeding season peak. In contrast, grey-tailed tattler and ruddy turnstone abundances (Figure 3-3) displayed little variation during the spring-

summer period (September 2003 to March 2004). Numbers of the bar-tailed godwit were constant over the non-breeding period but peaked slightly during the northward migration in March 2004 (Figure 3-2).

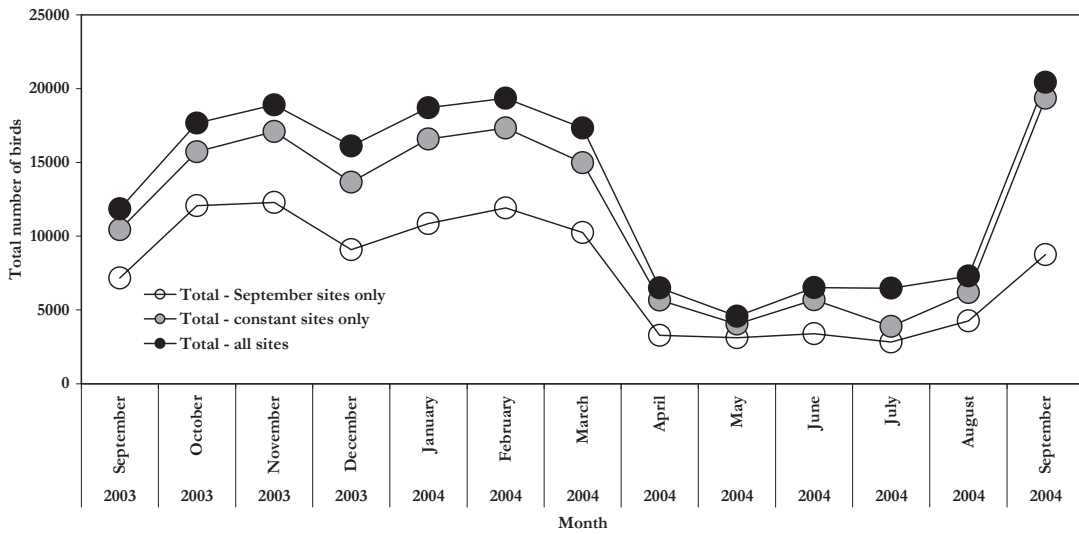


Figure 3-1 - Total Numbers of Waterbirds from September 2003 to September 2004. September 2003 to December 2003 Counts are Estimates

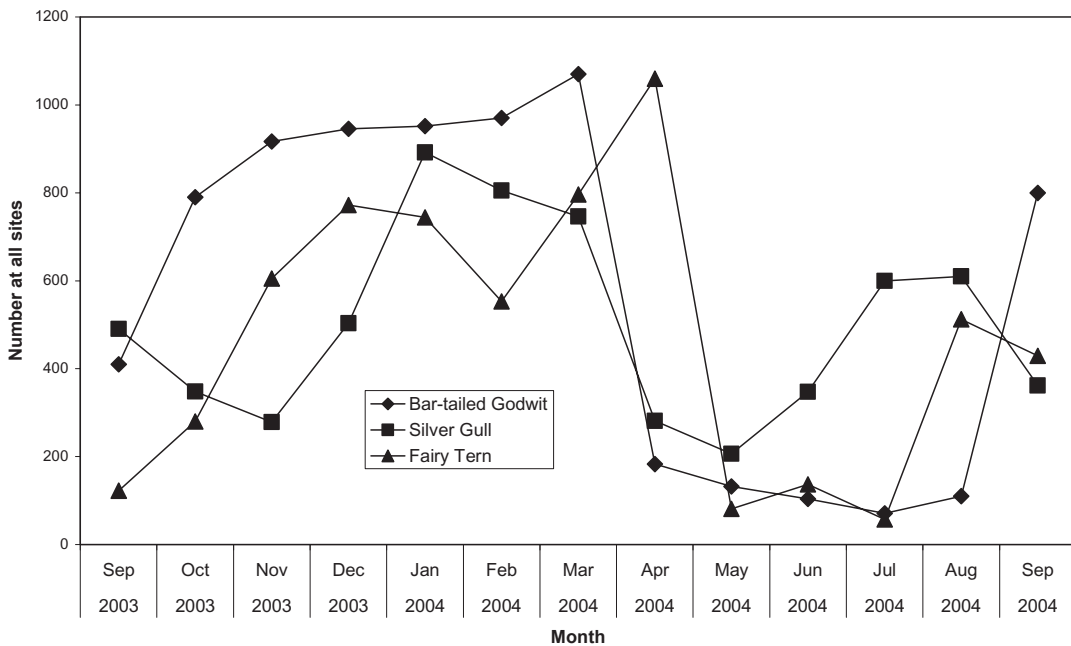


Figure 3-2 - Total Numbers of Bar-tailed Godwits, Silver Gulls and Fairy Terns from September 2003 to September 2004. September 2003 to December 2003 Counts are Estimates

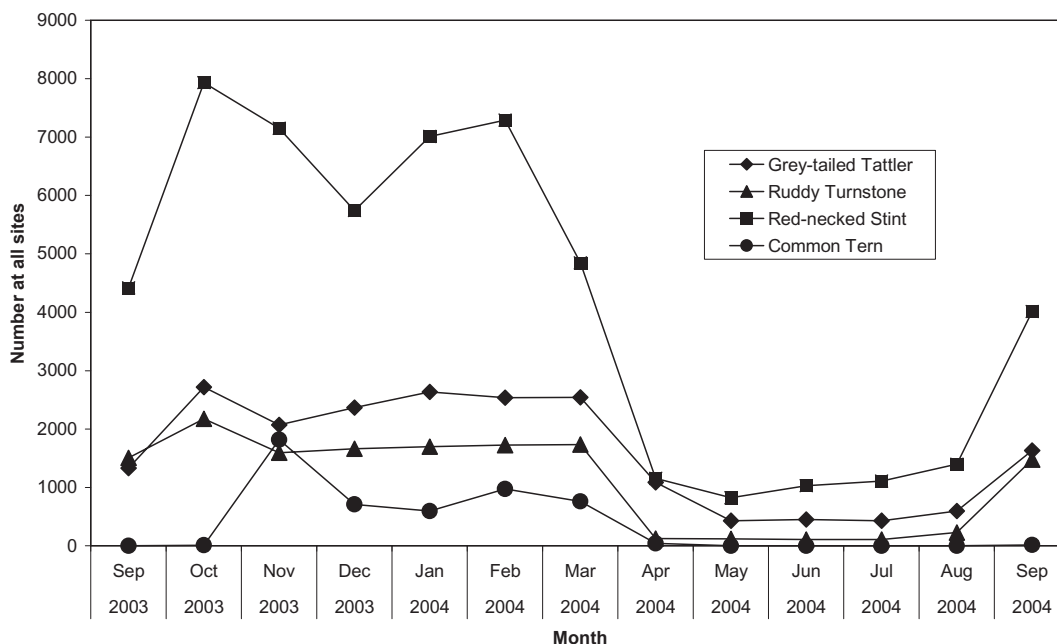


Figure 3-3 - Total Numbers of Grey-tailed Tattlers, Ruddy Turnstones, Red-necked Stints and Common Terns from September 2003 to September 2004. September 2003 to December 2003 Counts are Estimates

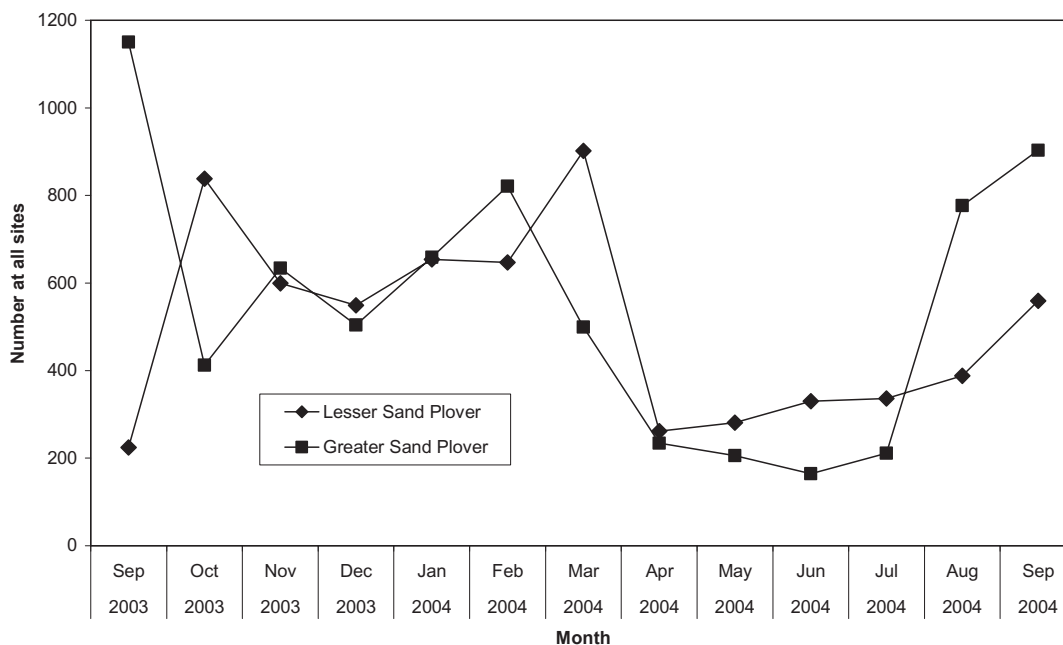


Figure 3-4 - Total Numbers of Lesser Sand Plovers and Greater Sand Plovers from September 2003 to September 2004. September 2003 to December 2003 Counts are Estimates

3.1.2 Distribution of Littoral Avifauna on Barrow Island

The abundances of all littoral avifauna pooled, and of the most abundant species in different sections of the shoreline around Barrow Island, are presented in Figure 3-5 to Figure 3-14. All of the monthly count data for various sections of the Barrow Island shoreline (regions) for all species pooled and for the most abundant species are presented in Attachment 3.

Littoral avifauna in general were concentrated in the south-east and south of Barrow Island (Figure 3-5) along beaches from the existing camp to the Bandicoot Bay area. This pattern was common to the majority of the most abundant species (Figure 3-6 to Figure 3-12). Silver gulls were more evenly distributed around the Island (Figure 3-13). Grey-tailed tattlers were also abundant in the North-East (Figure 3-7). Among less commonly observed species, the sanderling was recorded mainly in the South-West region but most other species were concentrated in the Lower East, South-East and/or South. There was little evidence of seasonal variation in distribution amongst regions of the Barrow Island shoreline.

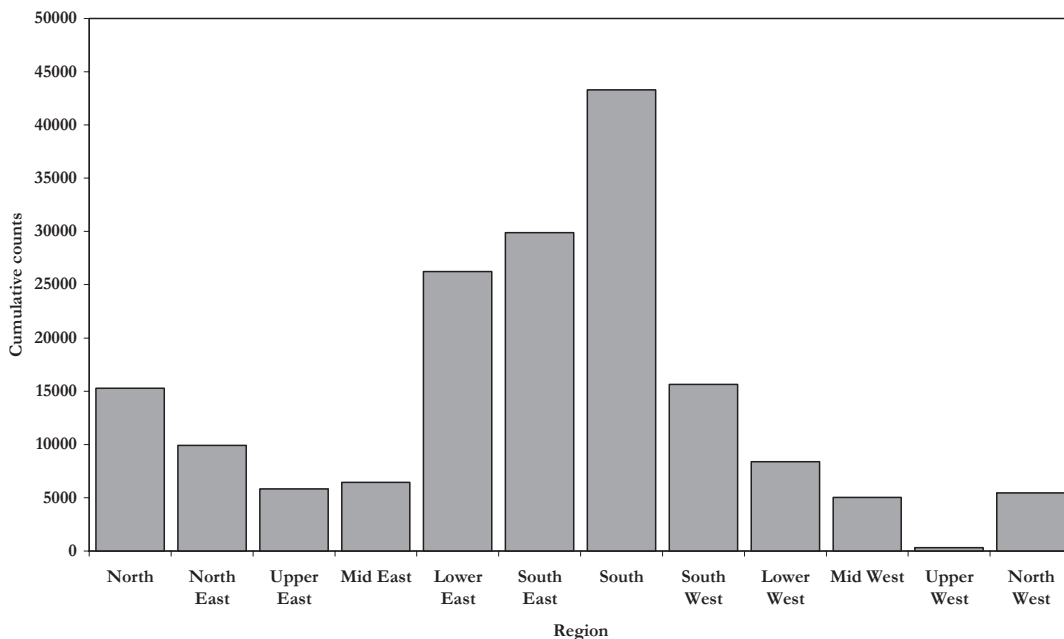


Figure 3-5 - Regional Distribution of all Waterbird Species Pooled from all Surveys, September 2003 to September 2004. Counts include Estimated Values for September to December 2003

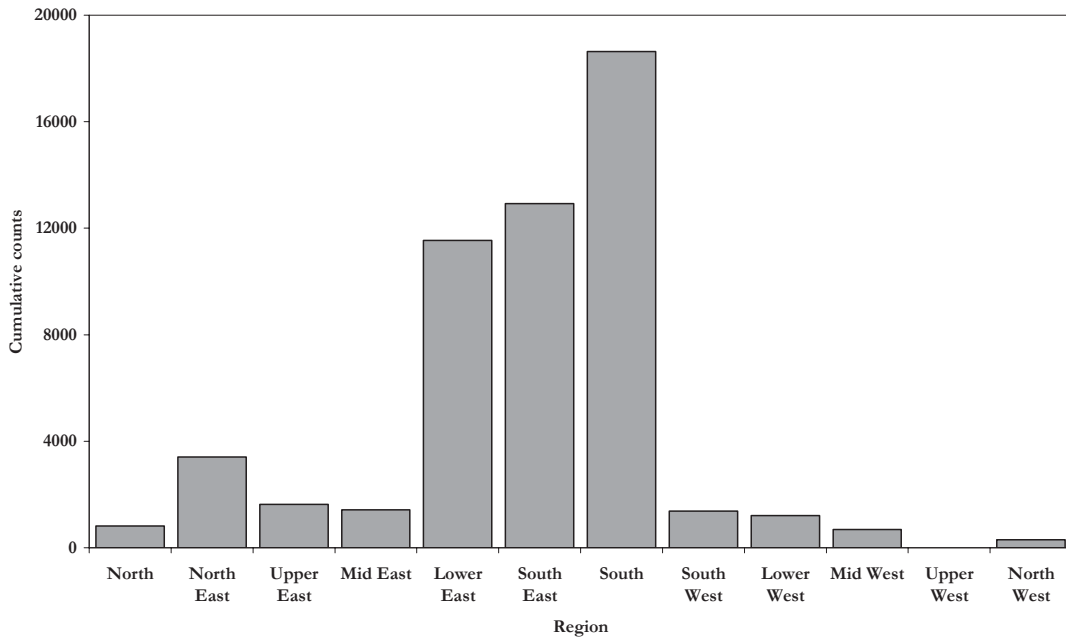


Figure 3-6 - The Regional Distribution of Red-Necked Stints on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

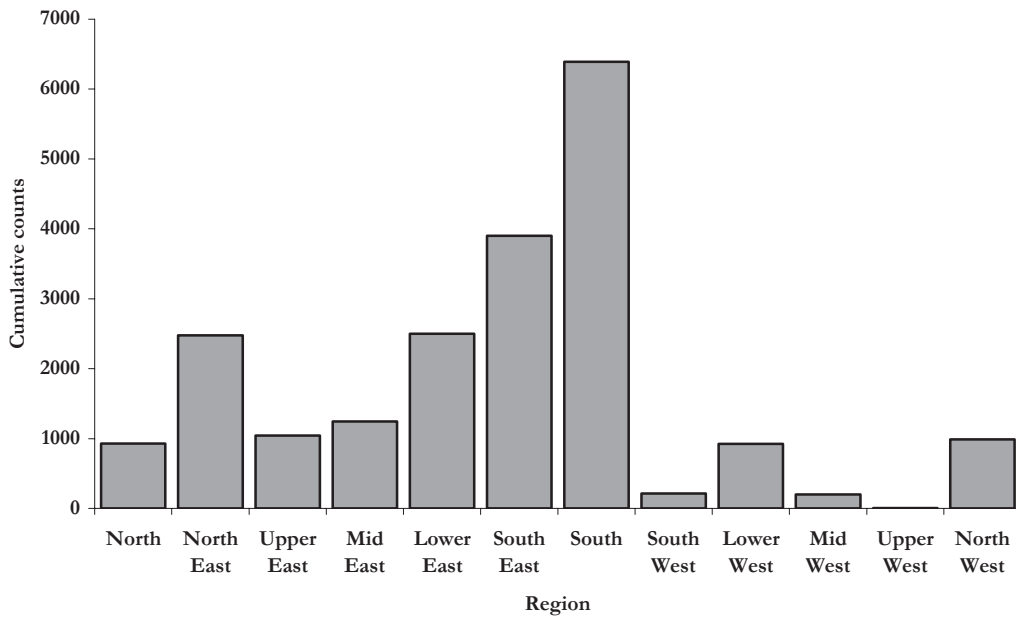


Figure 3-7 - The Regional Distribution of Grey-Tailed Tattlers on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

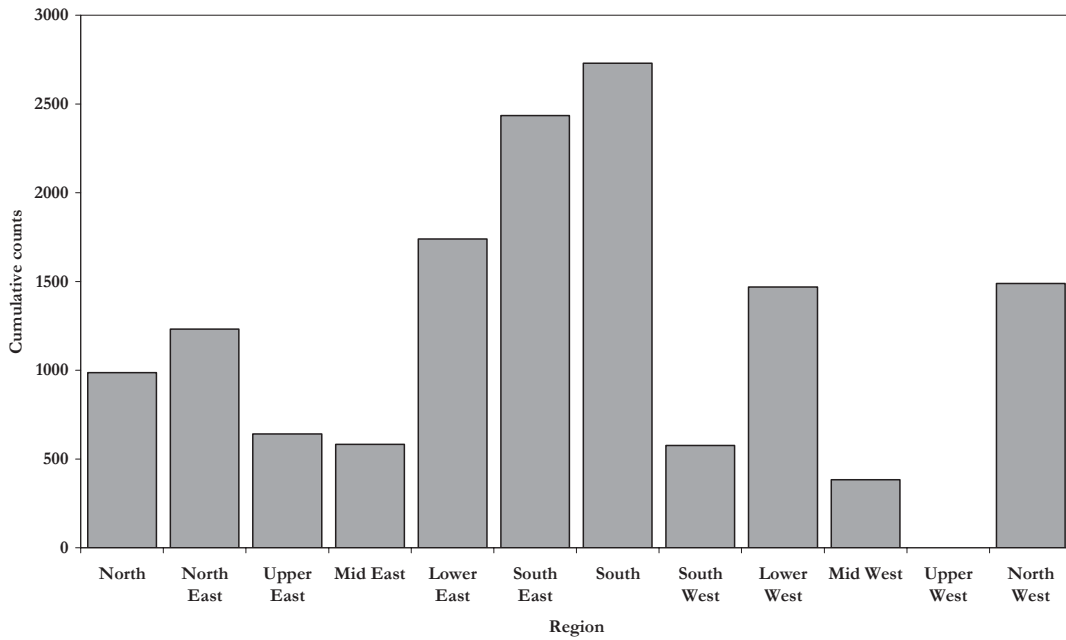


Figure 3-8 - The Regional Distribution of Ruddy Turnstones on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

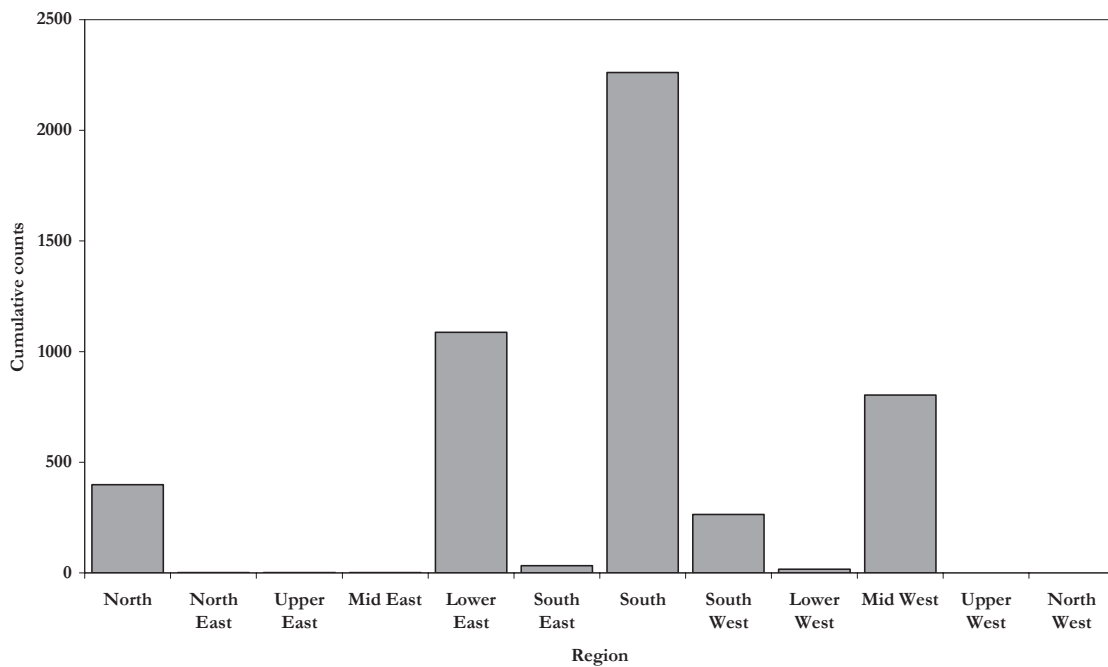


Figure 3-9 - The Regional Distribution of Common Terns on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

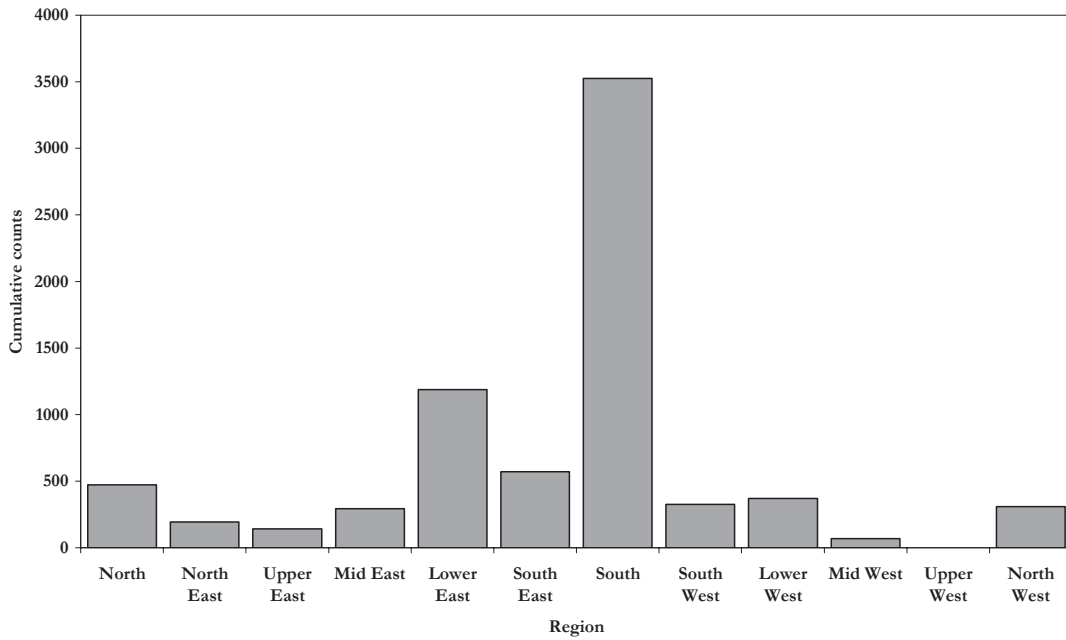


Figure 3-10 - The Regional Distribution of Bar-Tailed Godwits on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

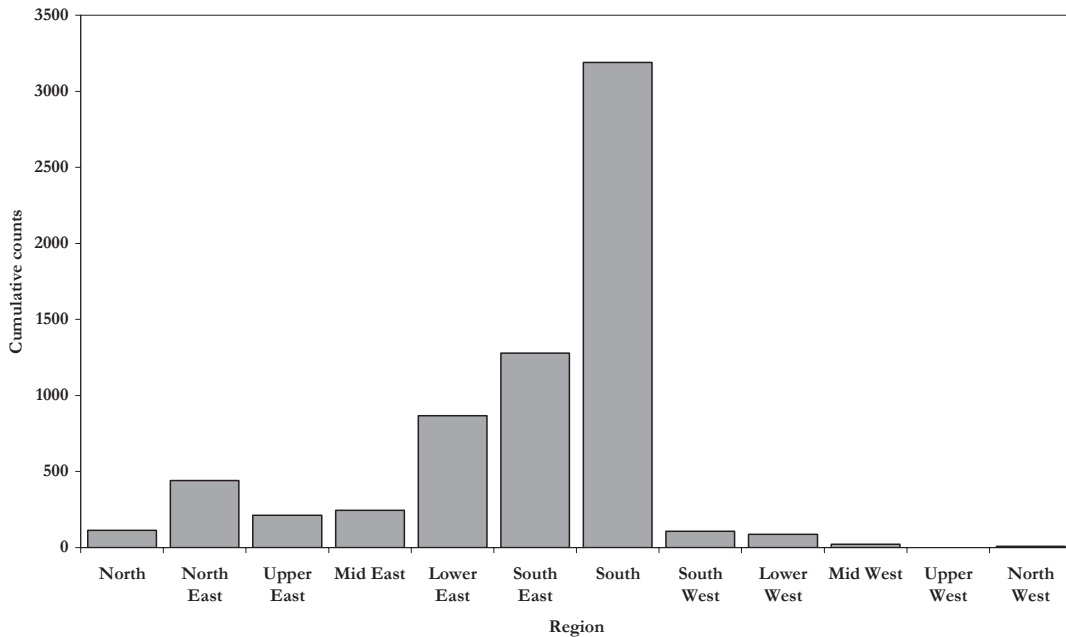


Figure 3-11 - The Regional Distribution of Lesser Sand Plovers on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

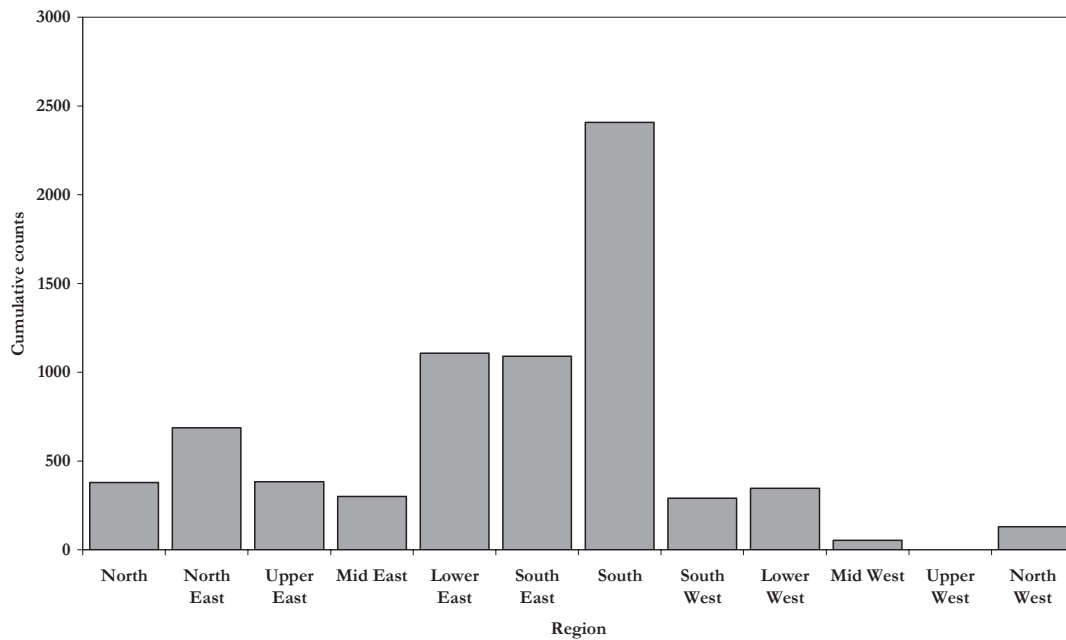


Figure 3-12 -The Regional Distribution of Greater Sand Plovers on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

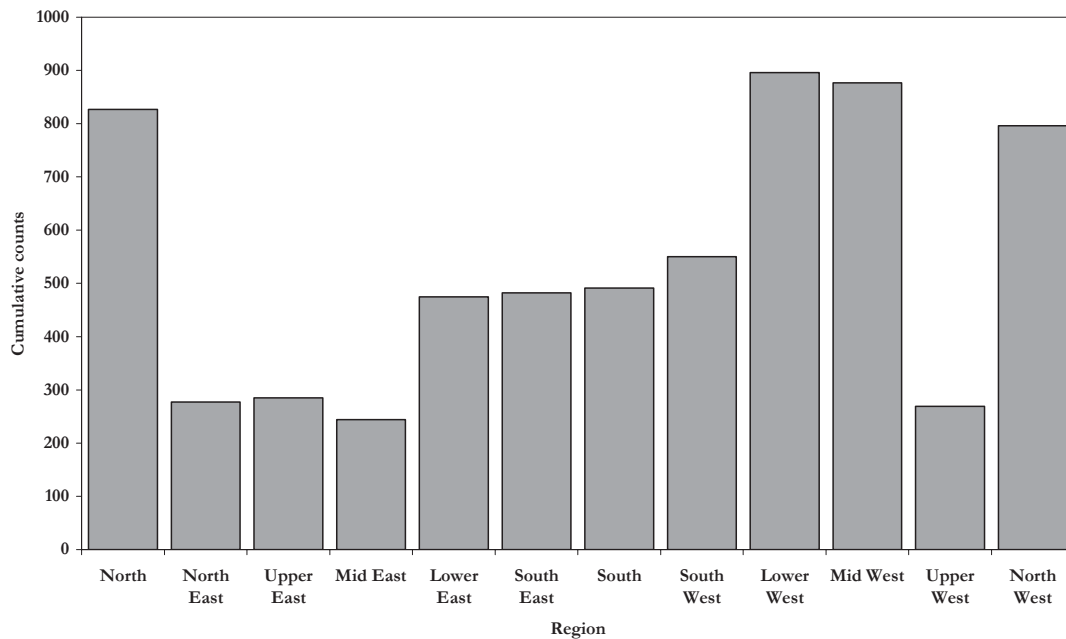


Figure 3-13 - The Regional Distribution of Silver Gulls on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

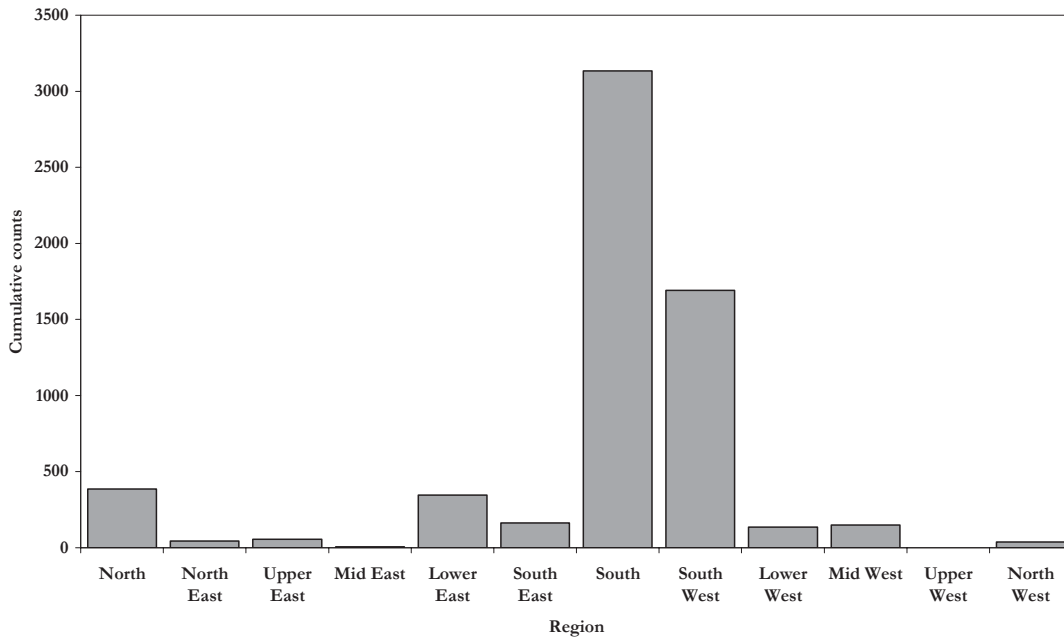


Figure 3-14 - The Regional Distribution of Fairy Terns on Barrow Island for all Months Combined. Counts include Estimated Values for September to December 2003

3.1.3 Littoral Avifauna of the Town Point Area

The distribution of littoral avifauna roost sites along the east coast shoreline adjacent to the proposed development at Town Point is presented in Figure 3-15.

At high tide, small numbers of cormorants, eastern reef egrets, silver gulls and oystercatchers roost on the rocks at Town Point. Favoured roost sites on the adjacent shoreline were consistently used between months. Data collected between April and September 2004 further supported these observations. Sooty oystercatchers successfully nested on the rocky cliff top at Town Point during spring 2003 and 2004. Other nests of this species were observed at Cape Dupuy on the north coast of Barrow Island.

The proposed Development at Town Point lies between the upper east and mid east regions that span approximately 11 km of the shoreline that was visited by 7.1 % of all littoral avifauna during the surveys. For the most abundant species, the percentage of island-wide records from the Town Point area (upper east and mid east regions) is presented in Table 3-1.

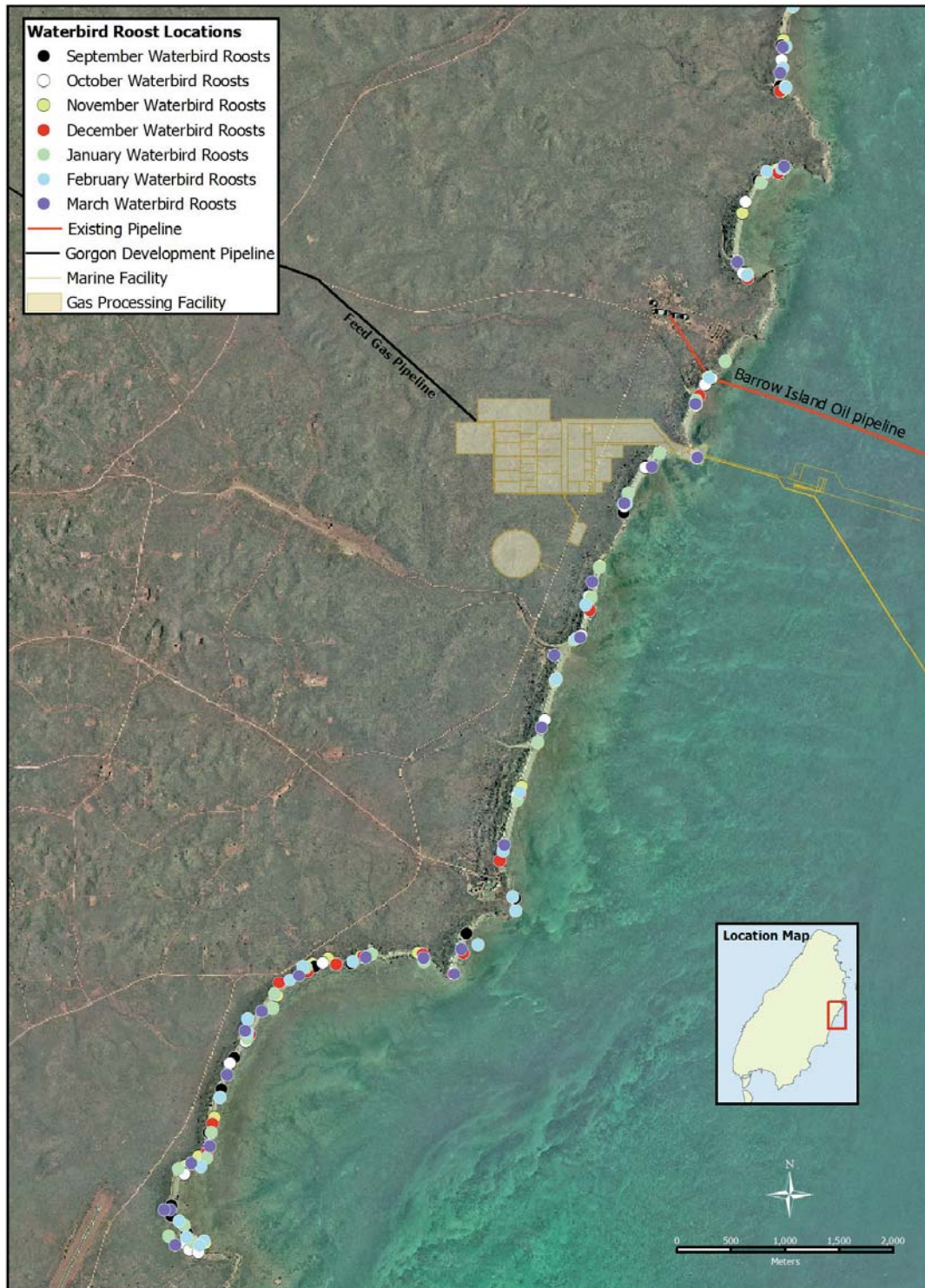


Figure 3-15 -East Coast of Barrow Island, Indicating Locations of all Roost Sites Recorded during Surveys from September 2003 to March 2004

Table 3-1 - Percentage of Waterbird records on Barrow Island in the Upper East and Mid East Regions, North and South of Town Point, between September 2003 and September 2004. Values are for abundant species only

Species	Total N records on Island (all months pooled)	Percentage present at Town Point
Red-necked stint	53 930	5.7
Grey-tailed tattler	20 818	11.0
Ruddy turnstone	14 261	8.6
Bar-tailed godwit	7 454	5.8
Lesser sand plover	6 569	6.9
Greater sand plover	7 175	9.5
Silver gull	6 469	8.2
Common tern	4 919	<0.1
Fairy tern	6 149	1.0
Caspian tern	1 031	27.8
Crested tern	8 620	13.5

The crested and Caspian terns are not abundant on Barrow Island, but have been included because they are the only regularly observed species with a distribution that is biased in favour of the north-east and mid-east regions.

Foraging

Only a small proportion of the littoral avifauna on Barrow Island forage on the reef platforms around Town Point. Twenty-two species and a maximum abundance of 249 waterbirds were observed foraging at Town Point between October 2003 and September 2004. Approximately one percent of the littoral avifauna on Barrow Island foraged on the surveyed section of shoreline up to 400 m north and south of Town Point (Table 3-2).

Table 3-2 - Total Number of Birds Foraging on Reef Platforms Adjacent to Town Point at low tide and the Percentage of the Total Number Present on the Island Observed at Town Point

Month	Northern reef platform	Southern reef platform	Total	Percentage of Island total
October 2003	77	90	167	1.06
November 2003	21	47	68	0.39
December 2003	74	104	178	1.24
January 2004	78	129	207	1.11
February 2004	75	132	207	1.07
March 2004	75	174	249	1.44
April 2004	28	32	60	0.92
May 2004	23	10	33	0.72
June 2004	26	35	61	0.94
July 2004	21	15	36	0.56
August 2004	19	35	54	0.74
September 2004	33	57	90	0.44

While approximately one percent of the waterbirds on the Island foraged at Town Point, the proportion was higher for some species (Table 3-3). These tended to be the less abundant species. The Town Point area was important for eastern reef egrets in January 2004, Australian pelicans in February 2004, and for Caspian and crested terns in March 2004. For all other species, less than seven percent of the individuals present on Barrow Island foraged at Town Point (Table 3-3).

Table 3-3 - The Maximum Number, Including Month Recorded, of Each Species Foraging on the Reef Platforms Around Town Point. Maxima are Presented as a Percent of the Total Island Population in that Month

Species	Maximum count	Month of count	Percentage of Monthly Total for Barrow Island
Australian pelican	3	February	15.0
Eastern reef egret	11	January	20.4
Osprey	1	October/December	4.8
Bar-tailed godwit	4	January	0.4
Whimbrel	3	January	3.2
Common greenshank	5	December	2.0
Common sandpiper	1	October/December	4.5
Grey-tailed tattler	32	October	1.4
Ruddy turnstone	30	October/March	2.0
Red-necked stint	62	October	0.8
Pied oystercatcher	9	February/April	3.1
Sooty oystercatcher	5	April	5.3
Grey plover	3	February	2.3
Red-capped plover	10	December/June	3.7
Greater sand plover	23	September	2.5
Lesser sand plover	1	March	0.1
Silver gull	45	January/February	5.6
Caspian tern	57	March	24.6
Crested tern	73	March	9.0
Lesser crested tern	3	March	22.8

Between 16 % and 65 % of the waterbirds on the reef platforms adjacent to Town Point were foraging within 200 m of the point (Table 3-4). These data indicate that the area immediately adjacent to Town Point is not of high significance to foraging waterbirds.

Table 3-4 - Abundance of Waterbirds Foraging in Intertidal Habitats within 200m of Town Point and the Proportion of All Waterbirds Foraging in this Area

Month of survey	Waterbird count <200 m	Waterbird count >200 m	Percentage waterbirds <200 m
October	57	110	34.0
November	14	54	20.6
December	53	125	29.8
January	56	151	27.1
February	52	155	25.1
March	40	249	16.1
April	18	42	42.8
May	13	20	65.0
June	12	49	24.5
July	9	27	33.3
August	13	41	31.7
September	27	63	42.9

3.1.4 Shearwaters and other Waterbirds on Double Island

Active shearwater burrows were found on both islets of Double Island in October 2003, with most activity across the top of the islands where the limestone is so deeply weathered by solution pipes that it resembles giant honeycomb. Burrows in this landscape are hard to examine because they start in small caverns that the birds access through solution pipes. These caverns lie approximately one metre below the surface of the ground. The solution pipes act as a common entrance to several burrows and make it very difficult to estimate the number of burrows present in this landscape.

Wedge-tailed shearwaters and eggs were present in the burrows on South Double Island in November 2003. North Double Island was not surveyed in November 2003. On the western side of South Double Island, there were approximately 500 burrows within an area of less than two hectares of sandy soil. Although these burrows were accessible and discrete, the sandy soil meant that there was a high risk of the burrows collapsing under the weight of the observers and the survey was curtailed. On the basis of this number of burrows in a small area and the area of limestone in which nests were located, the colony is probably used by 5000 to 10 000 pairs.

In November 2003, an estimated 4000 bridled terns were circling the islands and inspecting crevices in the limestone, presumably preparing to nest in these areas. Bridled terns were also observed in, or leaving, the caverns under the solution pipes. The islands are also important sites for other waterbirds. A pair of white-bellied sea-eagles with a recently-fledged chick was observed on South Double Island in November 2003. Approximately 165 pied cormorants and 24 eastern reef egrets were roosting on North Double Island in October 2003. The reef egret count was the highest single count for this species on Barrow Island. A reef egret nest with two eggs was found in October. Small numbers (<10 of each species) of ruddy turnstones, grey-tailed tattlers and greater sand-plovers were observed during both visits to Double Island.

3.2 Landbirds of the Gorgon Development Study Area

Abundances of landbirds in the proposed development area from September 2003 to August 2004 are presented in Table 3-5, 3-6 and 3-7. Results from landbird transects from October 2004 can be found in Attachment 5.

The abundance of landbirds in the study area appears to vary seasonally. The main bird species (white-winged fairy wren, singing honeyeater and spinifexbird) were recorded more often in late winter and early spring than in hotter months, with a slight increase in March, April and May 2004 in some species following cyclone Monty (Table 3-5). This almost certainly relates to changes in detectability due to the behaviour of the birds. Birds are more cryptic when sheltering from the sun and this behaviour is more critical in summer. Spinifexbirds also called more frequently in spring than in summer and were therefore easier to detect. In addition, there was some evidence to suggest that the fairy wren and honeyeater particularly may have been attracted to the observer in spring. These effects may have biased results in all months.

Table 3-5 - Total Abundance of Each Bird Species from September 2003 to August 2004. Data Pooled Across the Six Transects in Each Month

Species	Sep	Oc	No	De	Jan	Fe	Ma	Ap	My	Jn	Jl	Au	Total
Bar-shouldered dove	0	0	7	0	0	3	0	0	0	0	0	0	10
White-winged fairy wren	50	27	17	21	23	6	28	15	26	19	18	31	281
Singing honeyeater	7	3	0	0	0	0	1	7	9	2	2	3	34
Welcome swallow	0	1	0	0	0	0	1	0	2	1	1	0	6
Spinifexbird	10	13	5	4	8	5	8	14	14	5	7	28	121
Spotted harrier	0	0	0	0	0	0	0	1	0	0	0	0	1
Nankeen kestrel	0	0	0	0	0	0	0	0	0	0	0	1	1
White-breasted woodswallow	0	0	0	0	0	0	0	0	0	0	0	1	1
Total	67	44	29	25	31	14	38	37	51	27	28	64	455

Densities of each landbird species were calculated for each transect (Table 3-6) and for each of the vegetation types (Table 3-7), as defined in Table 2-3.

There were trends in landbird densities between transects for most species (Table 3-6). For example, the bar-shouldered dove was confined to Transect Two and the white-winged fairy wren tended to be more abundant on Transect Five. The spinifexbird densities tended to be lower on Transect Four. The singing honeyeater was not recorded on Transect Five and was recorded at low densities on the other transects.

Table 3-6 - Mean Densities (per hectare) for Bird Species along Six Transects in the Vicinity of the Development Area, September 2003 to August 2004. There were 24 surveys in each transect

Species	Landbird Transect						
		1	2	3	4	5	6
Bar-shouldered dove	Mean	0.00	0.10	0.00	0.00	0.00	0.00
	SE	-	0.07	-	-	-	-
White-winged fairy wren	Mean	0.42	0.22	0.30	0.48	0.84	0.27
	SE	0.09	0.07	0.06	0.09	0.16	0.07
Spinifexbird	Mean	0.24	0.13	0.23	0.13	0.18	0.13
	SE	0.05	0.04	0.05	0.03	0.05	0.03
Singing honeyeater	Mean	0.16	0.06	0.03	0.01	0.01	0.04
	SE	0.06	0.02	0.02	0.01	0.01	0.02

Landbird distributions showed close affinities to vegetation types (Table 3-7) as described below:

- Bar-shouldered doves were confined to vegetation type one (coastal *Acacia coriacea*).
- White-winged fairy wrens were least abundant in coastal vegetation types one and two, but particularly abundant in vegetation type five (low *Triodia* over limestone). Vegetation type five was poorly represented, however, so in general the fairy wren was associated with *Triodia* with or without shrubs but growing in shallow soil on limestone rises.
- Singing honeyeaters were largely confined to coastal vegetation types one and two (*A. coriacea* and *A. bivenosa* over *Triodia* on red sandy-loam).
- Spinifexbirds were found across all vegetation types, but were most abundant in types one, two and six. These were near-coastal and inland sites, but consisted of *Acacia* over *Triodia*.

Table 3-7 - Mean Densities (per hectare) of Landbirds in Each Vegetation Type. Data Pooled over the Six Transects, September 2003 to August 2004 2004. (n = 24)

Species	Vegetation Type (see Table 2-3)						
		1	2	3	4	5	6
Bar-shouldered dove	Mean	0.15	0	0	0	0	0
	SE	0.15	-	-	-	-	-
White-winged fairy wren	Mean	0.02	0.23	0.52	0.29	0.81	0.38
	SE	0.02	0.06	0.07	0.22	0.31	0.11
Spinifexbird	Mean	0.10	0.19	0.15	0.12	0.16	0.25
	SE	0.05	0.04	0.03	0.09	0.09	0.06
Singing honeyeater	Mean	0.29	0.03	0.03	0	0	0.04
	SE	0.12	0.01	0.01	-	-	0.02

4 Discussion

4.1 Littoral avifauna

Between September 2003 and September 2004, Barrow Island supported large numbers of littoral avifauna, with migratory shorebirds and terns being the most abundant. While the migratory species had the expected peaks in abundance in spring, most remained abundant throughout the survey period, indicating that Barrow Island is not only a staging post during southward migration, but is used through the summer non-breeding season by migrant species and during the winter by at least some birds. Sedgwick (1978) also noted migratory shorebirds in August 1978, before most species would have returned from migration, suggesting that many birds 'over-winter' on the Island. High counts of migratory shorebirds during the breeding season (winter in the southern hemisphere) have been recorded for a number of other sites in northern Australia (Bamford *et al.* in press).

The monthly patterns of variation in the abundance of migratory shorebirds on Barrow Island in 2003/2004 were unexpected, as sites on the north-west coast of Australia tend to be most important for such species during southward migration (Bamford *et al.* in press). Southward migration was evident for some species, for example greater sand plovers in September and red-necked stints, sanderlings and lesser sand plovers in October. However, the abundance of other species, for example the grey-tailed tattler and ruddy turnstone, varied little from September 2003 to February 2004. This suggests that many birds stayed upon the Island following their arrival on southward migration in September. Migrating bar-tailed godwit appear to arrive and simply stay on the Island. Even among those species with the expected southward migration peak, there was an increase in abundance in January and February. This may have been due to local movements of birds from the mainland to Barrow Island. The slightly lower numbers in December may reflect a gap between the southward migration period and this possible phase due to local movements. Barrow Island is unusual compared with other sites in the north-west of Australia in effectively acting as a terminus for migratory species.

Sites in the north-west of Australia tend to be less important during northward than southward migration, and on the basis of March data (early northward migration), this also seems to be the case for Barrow Island. The two sand plover species and the bar-tailed godwit increased slightly in abundance in March, but most species declined in numbers; some sharply. This decline may have been influenced by the passage of Cyclone Monty prior to the March survey.

The November peak in the abundance of common terns, also a migratory species, is consistent with southward movement through Barrow Island, whereas the fairy tern (subject to local movements but not an international migrant) seemed to congregate on the Island during its breeding season. However, fairy terns were not observed to breed on Barrow Island and a substantial proportion of the birds were immature or in non-breeding plumage. Numbers of silver gulls increased steadily from November to January and then remained at a high level up to March, possibly in response to the emergence of turtle hatchlings.

Barrow Island is an internationally significant littoral avifauna site because it meets the Ramsar criterion of supporting >1 % of a species population for the ruddy turnstone, red-necked stint, grey-tailed tattler, sanderling, greater sand-plover, lesser sand-plover, fairy tern and for the *ophthalmicus* race of the sooty oystercatcher. All these species are

trans-equatorial migrants, except for the fairy tern, which undergoes only local movements and the sooty oystercatcher, which is a resident.

On the basis of the importance of the Island for six migratory waders (grey-tailed tattler, ruddy turnstone, red-necked stint, sanderling, greater sand-plover and lesser sand-plover), Barrow Island is equal tenth among the 147 important sites for migratory waders in Australia (Bamford *et al.* in press). For the grey-tailed tattler and ruddy turnstone, it is the fifth and fourth-most important site in Australia, respectively.

Ruddy turnstones, grey-tailed tattlers and red-necked stints were present on Barrow Island in August 1978 (Sedgwick 1978) at similar proportions to the current study. It is not clear how comprehensive the 1978 surveys were, but counts of most migratory shorebirds were much lower even than those recorded in September 2003. However, 36 black-tailed godwits, a species not seen during the current study, were recorded. Among non-migratory shorebirds and other littoral species, counts were broadly similar to those obtained in the present study.

The highest abundances of littoral avifauna on Barrow Island (over two-thirds of records of most species) are associated with the extensive tidal mudflats in the south and south-east of the Island, from Bandicoot Bay to the existing ChevronTexaco Camp. These areas are important for roosting and foraging and the birds appear to roost close to their foraging sites. The littoral avifauna habitats in Bandicoot Bay are recognised as being a key area for shorebirds and are proposed as a nature conservation area (CALM 2004). However, the current study has shown that the area of importance is greater than previously suggested.

Littoral avifauna were widely distributed around Barrow Island, usually associated with tidal mudflats or rocky intertidal pavements. However, littoral avifauna numbers were generally low in the vicinity of Town Point and the proposed development area, despite the extensive pavement reef and sand flats in this region. The grey-tailed tattler and the greater sand plover were the most abundant birds in the Town Point area. While the 12 km stretch of shoreline between Mattress Point and the ChevronTexaco Camp represents about 20 % of Barrow Island's coastline, less than nine percent of all littoral avifauna occurred in this area.

Town Point is a nesting site for the *ophthalmicus* race of sooty oystercatchers. Other nests were observed at Cape Dupuy on the northern coast and pairs of birds demonstrated mating behaviour at a number of other sites.

The reef platform around Town Point is not a major feeding site on Barrow Island. The number of birds that utilised the area was always less than 1.5 % of the Island total and was remarkably consistent between months, except for November 2003. Both the abundance of littoral avifauna and the proportion of the Island total in the Town Point area were much lower in November than in other months. This is probably due to the fact that the tide was much lower in November than in the other months. This would have resulted in more reef platform being exposed and, as a consequence, the birds being more widely dispersed and at lower density than at other times. It is also possible that the low tide meant that many foraging birds were feeding in depressions in the reef platform and, therefore, were missed by the count. It is recommended that all future counts be conducted at a standard low tide of 0.45 m (above chart datum) to remove any confounding effect of tide height.

When individual species were examined, the proportion of the Barrow Island total that foraged or roosted at low tide within 400 m of Town Point was generally low, but in March 2004 it was moderately high for two species common on the Island: Caspian terns (24.6 %) and crested terns (9.0 %). It is not clear why so many terns were present on the reef platform at Town Point in March.

Of all the littoral avifauna on Barrow Island, approximately one percent foraged within 400 m of Town Point, and less than 0.35 % foraged within the immediate vicinity of the Point (< 200 m). Habitat loss associated with construction of the landing and causeway will therefore directly affect approximately 0.35 % of littoral avifauna foraging habitat on Barrow Island.

4.2 Wedge-tailed Shearwaters on Double Island

The visits to Double Island confirmed the presence of a breeding colony of wedge-tailed shearwater with at least 500 nests in one small area on the South Island and a total colony size of 5000–10 000 pairs. There are hundreds of thousands of pairs of wedge-tailed shearwaters nesting on islands off the north-west and western coasts of Western Australia (Johnstone & Storr 1999).

Long-term monitoring of wedge-tailed shearwater breeding colonies elsewhere in the region has shown that breeding success varies from year-to-year amongst colonies, due to prevailing oceanographic conditions, even in years when breeding success is generally poor (Dunlop *et al.* 2002). Wedge-tailed shearwaters are reported to be tolerant of disturbance and human activities close to their breeding colonies (Marchant & Higgins 1990), but juvenile birds are sometimes attracted to lights and are injured or killed by flying into buildings and structures (Lane 1991). From a colony of 6000 pairs on Muttonbird Island (New South Wales), 176 juveniles were collected on the nearby mainland in the 1987 breeding season, some injured but most simply confused by the land and unable to find their way back to sea. Some of these birds came from resorts seven kilometres north of the breeding colony. Note that the Muttonbird Island colony itself appears unaffected by nearby commercial activities and low levels of human visitation.

4.3 Landbirds

The present investigations focussed on determining the density of the main landbird species in relation to different vegetation types within the proposed Development area. These data were used to calculate the importance of the Development area to landbirds by comparison with existing information, such as whole-of-island population estimates and densities of particular species, including relationships with vegetation type (Sedgwick 1978, Pruett-Jones & O'Donnell unpubl. and Pruett-Jones & Tarvin 2001).

Across the proposed Development area, the coastal *Acacia* shrublands supported the highest species richness and high densities of singing honeyeaters and spinifexbirds, but the inland habitats including *Melaleuca* shrublands over *Triodia* are important for the white-winged fairy wren, with inland *Acacia* shrublands over *Triodia* being important for the white-winged fairy-wren and spinifexbird.

The landbird assemblage of Barrow Island is depauperate. Of the 128 birds recorded on Barrow Island, 51 are landbirds and only 16 of these species are residents or regular migrants (Attachment 4). In an intensive study during September and October 2001,

Pruett-Jones & O'Donnel (unpubl.) found five landbird species to be common. These were the spinifexbird, white-winged fairy-wren, singing honeyeater, white-breasted woodswallow and welcome swallow. Of these, the spinifexbird, white-winged fairy-wren and singing honeyeater were the only species recorded regularly in the present study, with the addition of the bar-shouldered dove in near-coastal *Acacia* shrubland. There was a suggestion by Pruett-Jones & O'Donnel (unpubl.) that white-breasted woodswallows may have declined in abundance since the surveys of Sedgwick (1978).

The spinifexbird has an estimated Island population of 17 800 (Sedgwick 1978) to 24 623 (Pruett-Jones & O'Donnel unpubl.), with the latter value based on density estimates in excess of one bird/ha; much greater than the 0.13 to 0.24 birds/ha determined in the present study and the 0.33 birds/ha from the October 2004 transects. The low values obtained in 2003/2004 are probably due to poor detectability of the species outside the breeding season, when most surveys took place. Numbers of spinifexbirds recorded in transects in September and October 2003 and August 2004 were up to three times the numbers seen at other times of the year and therefore suggest densities at least broadly similar to those obtained by Pruett-Jones & O'Donnel (unpubl.). Despite this, the proportional abundance of spinifexbirds in different vegetation types can be expected to be reasonably accurate. Pruett-Jones & O'Donnel (unpubl.) found densities of the spinifexbird to be highest where there was a shrub stratum emergent through the *Triodia*, and this trend also emerged in the proposed development area, with high numbers in *Acacia coriacea* over *Triodia* in coastal areas and in *Acacia bivenosa* over *Triodia* in inland areas. There was an exception to this trend, however, as spinifexbirds were recorded at only low densities in vegetation type three, *Melaleuca* over *Triodia* on limestone rises and ridges. This is a widespread habitat in the proposed development area and was well-sampled, so it would appear that it is of low suitability for spinifexbirds. Spinifexbirds may favour more openly branched shrubs such as *Acacia*.

The white-winged fairy wren has an estimated Island population of 8150 (Sedgwick 1978) to 7519 (Pruett-Jones & O'Donnel unpubl.), with densities found by the latter authors in the range 0.25 to 1.75 birds/ha. In the proposed development area, densities fell within this range in vegetation types three to six, but densities were much lower in coastal *Acacia* shrublands. Estimates from the October 2004 transect data (1.05 birds/ha) also fell within the above range of values (Attachment 5). Pruett-Jones & O'Donnel (unpubl.) found that the white-winged fairy-wren was associated with complex vegetation structure. In the proposed development area it appeared to be associated with inland vegetation types in general, with a tendency to favour formations with complex vegetation structure. Unlike the spinifexbird, it was notably abundant in areas of *Melaleuca* over *Triodia*. The very high density in vegetation type five (*Triodia* with very low shrub densities on limestone ridges) may have been an artefact of small sample size.

Population estimates of singing honeyeaters on Barrow Island range from 3050 (Sedgwick 1978) to 3920 (Pruett-Jones & O'Donnel unpubl.). This species is generally associated with coastal *Acacia* shrublands. This was clear in the proposed development area but the mean density of 0.16 and 0.11 birds/ha in the September 2003 – August 2004 and October 2004 studies, respectively, is much lower than the 2.5 birds/ha reported by Pruett-Jones & O'Donnel (unpubl.) in coastal *Acacia* shrublands. The low values in the proposed development area are partly related to seasonal variations in detectability, as very few singing honeyeaters were detected within transects from November to March. Despite this, a density of 2.5 birds/ha appears higher than any observed even in September and October.

Population densities of singing honeyeaters on Barrow Island may be suppressed due to several years of below-average rainfall. Alternatively, singing honeyeaters are sometimes attracted to the observer, so the use of two observers by Pruett-Jones & O'Donnel (unpubl.) may have led to an over-estimation of the species' density.

The population densities and approximate extent of vegetation types in the proposed development area can be used to estimate population sizes of the three most abundant bird species. Populations in the proposed development area compared with Island estimates from Pruett-Jones & O'Donnel (unpubl.) or Sedgwick (1978) are outlined in Table 4-1.

Table 4-1 - Landbird Populations in the Proposed Development Area.

Species	Population in Gorgon study area (300 ha)	Current Barrow Island total population estimate	Percentage of total Island population
Bar-shouldered dove	6	180	3
Spinifexbird	48	24 623	0.2
White-winged fairy wren	141	7 519	1.9
Singing honeyeater	10	3 920	0.3

The results from the October 2004 survey (Attachment 5) suggest that the numbers of white-winged fairy-wrens on Barrow Island may be slightly greater than those listed in the table above. The density of white-winged fairy-wrens in October 2004 was approximately 1.05 birds/ha. Their preferred shrubland habitat covers about 8926 ha or approximately 40% of the island. Assuming that the density of wrens is consistent in their preferred habitat across the island, the total population is approximately 9336.

As the area of the proposed Gorgon Development is 300 ha, the number of white-winged fairy-wrens in the entire development area is probably about 315 birds, or 3.3 % of the total population.

For both the white-winged fairy-wren and bar-shouldered dove, the proposed Development area probably has good representation of their preferred habitat. The area does not appear to be as favourable for the spinifexbird and the singing honeyeater.

The white-winged fairy-wren on Barrow Island is an endemic race that has recently been identified as the most genetically-distinct of the white-winged fairy wren races (Driskell *et al.* 2002). These birds are abundant on Barrow Island. Other non-migratory avifauna on Barrow Island, although not recognised as distinct taxa, are assumed to be genetically distinct from mainland populations, as a result of their long period of isolation.

5 Conclusions

5.1 Littoral Avifauna

A minimum of 32 119 littoral avifauna of 50 species used the Barrow Island shoreline during the period September 2003 to September 2004, with the highest monthly count of all birds being 20 428 (September 2004). Barrow Island is of international significance for six migratory species: grey-tailed tattler, ruddy turnstone, red-necked stint, sanderling, greater sand plover and lesser sand plover. It is also significant for two non-migratory birds: fairy tern and the northern race of the sooty oystercatcher.

The littoral avifauna was dominated by migratory species that were expected to use Barrow Island mainly during their southward migration (October-November), as is the case elsewhere in the north-west of Australia. However, some species were more abundant in January and February, contributing to overall higher counts in summer than in spring. For most migratory species, Barrow Island appears to act as a destination rather than as a staging site.

Littoral avifauna in general were concentrated in the south-east and south of Barrow Island, from the existing ChevronTexaco Camp to the Bandicoot Bay area. Over half of the littoral avifauna each month were found in these parts of the Island.

The coastline in the vicinity of Town Point and the proposed Development area is of relatively low importance for littoral avifauna compared with other parts of Barrow Island. Town Point was not generally an important waterbird foraging or roosting site during the 2003/2004 summer, reflected by the low abundances in this area in relation to other parts of the Barrow Island shoreline. The only waterbird breeding observed near Town Point was a pair of sooty oystercatchers that nested on Town Point in September 2003 and 2004 and a pair of ospreys with a nest (not used in 2003) on Latitude Point.

5.2 Shearwater Rookeries on Double Island

Wedge-tailed shearwaters nest on both islets of Double Island, beneath limestone slabs and in sandy soil. The sandy rookery on the north-western corner of the southern island comprises about 500 burrows across an area of approximately two hectares. The total colony may contain 5000–10 000 pairs.

The Double Island rookery is of regional significance as these migratory birds are protected under international conventions.

5.3 Landbirds

The proposed Development area is not locally or regionally significant for landbirds. The abundance of landbirds in the Town Point hinterland is similar to the abundance in other parts of Barrow Island as reported in earlier studies. The proposed Development area has no unique features that might constitute critical habitat.

The landbird fauna of Barrow Island is depauperate but is notable for the presence of an endemic race of the white-winged fairy-wren listed under the EPBC Act and as Schedule One (Vulnerable) under the Wildlife Conservation Act. The Barrow Island white-winged fairy wren generally inhabits low shrubland (*Acacia*, *Melaleuca*) over *Triodia* on limestone hill slopes away from the coast within the proposed Development area. About 3.4

percent of Barrow Island's total population of white-winged fairy wren occurs within the 300 ha of the proposed development area.

White-winged fairy-wrens are the second most abundant landbird on Barrow Island (Pruett-Jones & Tarvin 2001) and their population status is unlikely to be affected by small changes in available habitat.

Bar-shouldered doves, singing honeyeaters and spinifexbirds also inhabit the proposed Development area. The Island populations of these birds are probably genetically distinct from populations on the nearby mainland, due to the long period of isolation and should be treated as endemic taxa.

The bar-shouldered dove and singing honeyeater were largely confined to *Acacia* over *Triodia*, particularly near the coast. Spinifexbirds were widespread, with some bias in favour of areas of emergent *Acacia* amongst *Triodia*.

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Attachment 1 - Regions, Sites and Months for Littoral Bird Surveys. Constant sites are those surveyed in every month from October 2003 to February 2004.

Region	Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Constant site
North East	Surf Point		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Sponge Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Pungens Head		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Oystercatcher Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Square Head North		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Square Bay		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Square Head South		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Pillow Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Pillow Head		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Ant Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Ant Point		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Bed Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Lucky's Head		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Lucky's Bay		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Barge Landing		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Bob's Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
North East	Boomerang Beach		X	X	X	X	X	X	X	X	X	X	X	X	X
Upper East	Mattress Bay	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Upper East	Mattress Point	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Upper East	Dove Bay	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Region	Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Constant site
Upper East	Dove Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Upper East	Mushroom Rock Bay	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Upper East	Latitude Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Upper East	Pipeline Beach	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mid East	Town Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mid East	Yacht Club Beach	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Mid East	Camp Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lower East	Camp Beach	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lower East	Unnamed Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lower East	Shark Beach	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lower East	Shark Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South East	Perentie Two Bay	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South East	Perentie Two Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South East	Perentie One Bay	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South East	Perentie One Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South East	Stokes Bay	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South East	Stokes Point	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South	Bandicoot Bay	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South	Bandicoot Lagoon	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South West	South East Beach	x	x	x	x	x	x	x	x	x	x	x	x	x	x
South West	Sanderling Beach	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lower West	Eagle's Nest Beach South	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Region	Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Constant site
Lower West	Eagle's Nest Beach North					x	x	x	x	x	x	x	x	x	
Lower West	Eagle's Nest Beach Point					x	x	x	x	x	x	x	x	x	
Lower West	West Point					x	x	x	x	x	x	x	x	x	
Lower West	Satellite Beach					x	x	x	x	x	x	x	x	x	
Lower West	Whale Beach					x	x	x	x	x	x	x	x	x	
Lower West	Whale Point					x	x	x	x	x	x	x	x	x	
Lower West	Groper Beach			x	x	x	x	x	x	x	x	x	x	x	
Lower West	Groper Point					x	x	x	x	x	x	x	x	x	
Lower West	The Ledge					x	x	x	x	x	x	x	x	x	
Mid West	Bogg's Beach			x	x	x	x	x	x	x	x	x	x	x	
Mid West	Bogg's Point					x									
Mid West	Biggada Creek			x	x	x	x	x	x	x	x	x	x	x	
Mid West	Turtle Bay		x	x	x	x	x	x	x	x	x	x	x	x	x
Mid West	John Wayne Beach			x	x	x	x	x	x	x	x	x	x	x	
Mid West	Petal Beach		x	x	x	x	x	x	x	x	x	x	x	x	x
Upper West	Flacourt Bay		x	x	x	x	x	x	x	x	x	x	x	x	x
Upper West	Butler's Bridge					x	x	x	x	x	x	x	x	x	
Upper West	Y Beach					x	x	x	x	x	x	x	x	x	
Upper West	Cape Malouet							x	x	x	x	x	x	x	
Upper West	Obe's Beach					x	x	x	x	x	x	x	x	x	
North West	White's Beach					x	x	x	x	x	x	x	x	x	
North West	White's Point					x	x	x	x	x	x	x	x	x	

Region	Site	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Constant site
North West	Max's Beach					x	x	x	x	x	x	x	x	x	
North West	Max's Point					x	x	x	x	x	x	x	x	x	
North West	Tortuga Beach					x	x	x	x	x	x	x	x	x	
North	Tortuga Point					x	x	x	x	x	x	x	x	x	
North	Perched Beach					x	x	x	x	x	x	x	x	x	
North	Cape Dupuy		x			x	x	x	x	x	x	x	x	x	
North	Dupuy Beach		x			x	x	x	x	x	x	x	x	x	
North	First Beach		x			x	x	x	x	x	x	x	x	x	
North	Second Beach		x			x	x	x	x	x	x	x	x	x	
North	Oyster Rock		x			x	x	x	x	x	x	x	x	x	
North	Lighthouse Beaches		x			x	x	x	x	x	x	x	x	x	
North	Surf Point Beach		x	x	x	x	x	x	x	x	x	x	x	x	x
Number of sites:		18	52	50	50	76	75								46

Attachment 2 - Monthly Total Counts of Littoral Avifauna on Barrow Island. Species marked with an asterisk are recognised as migratory under state and federal legislation.

Species	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Max
Little pied cormorant	0	0	0	0	2	0	11	1	2	2	2	2	0	11
Pied cormorant	306	19	135	60	81	135	398	146	280	518	250	659	332	659
Little black cormorant	0	0	0	0	0	11	0	0	0	0	0	0	0	11
Australian pelican	0	14	14	12	24	24	18	0	1	20	20	19	16	24
White-faced heron	0	8	5	0	7	5	1	0	3	2	2	0	0	8
Little egret*	0	0	0	0	0	0	0	0	0	0	0	0	10	10
Eastern reef egret*	42	30	17	21	54	40	73	63	45	40	56	48	46	73
Great egret*	0	0	0	0	1	0	0	0	1	0	0	0	0	1
Striated heron	7	5	5	2	5	2	7	6	7	9	6	4	12	12
Nankeen night heron	1	4	5	17	30	20	8	14	33	33	23	20	8	33
Osprey*	12	21	22	22	33	29	33	35	28	41	32	32	25	41
Brahminy kite	9	6	1	7	6	2	8	10	6	6	8	6	11	11
White-bellied sea-eagle*	4	7	2	5	3	4	3	9	5	11	6	1	6	11
Bar-tailed godwit*	251	660	766	790	952	970	1070	183	132	104	71	110	800	1070
Little curlew*	0	0	1	1	0	0	0	0	0	0	0	0	0	1
Whimbrel*	20	52	64	30	93	77	97	55	37	44	26	27	84	97
Eastern curlew*	3	8	3	3	6	2	5	2	1	1	0	1	3	8
Marsh sandpiper*	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Common greenshank*	54	188	203	255	224	227	108	49	33	20	34	59	188	255
Terek sandpiper*	1	8	15	2	16	13	9	8	3	0	1	1	7	16

Species	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Max
Common sandpiper*	20	30	26	22	36	41	20	3	0	0	8	30	36	41
Grey-tailed tattler*	830	2368	1805	2060	2634	2535	2543	1090	428	448	429	594	1631	2634
Ruddy turnstone*	681	1531	1125	1171	1701	1725	1733	125	117	110	108	227	1476	1733
Great knot*	176	301	432	364	410	323	395	18	5	10	20	91	346	432
Red knot*	0	23	12	7	5	6	15	0	0	0	0	0	7	23
Sanderling*	0	177	36	96	56	75	96	24	0	1	4	29	93	177
Red-necked stint*	3005	7611	6860	5512	7011	7291	4845	1157	822	1033	1109	1400	4015	7611
Sharp-tailed sandpiper*	0	4	4	9	2	1	0	0	0	0	0	0	7	9
Curlew sandpiper*	128	102	133	168	145	128	85	7	4	5	4	54	105	168
Beach stone-curlew	0	0	0	0	4	3	5	2	5	4	3	3	5	5
Pied oystercatcher	112	261	256	269	321	341	345	352	362	334	344	333	348	362
Sooty oystercatcher	21	34	53	61	81	83	69	95	82	58	48	62	66	95
Pacific golden plover*	0	24	14	11	22	27	30	0	0	0	0	2	4	30
Grey plover*	58	141	114	162	188	142	178	12	5	20	9	9	159	188
Red-capped plover	171	208	182	271	243	355	133	266	226	262	250	200	323	355

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Species	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Max.
Lesser sand plover*	158	811	580	531	654	647	902	262	281	330	336	388	559	811
Greater sand plover*	729	372	572	455	659	821	499	234	206	164	211	777	903	903
Oriental plover*	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Oriental pratincole*	0	0	0	0	0	0	5	0	0	0	0	0	0	5
Silver gull	125	190	152	275	892	805	746	281	206	347	600	610	362	892
Gull-billed tern	0	12	1	5	3	4	0	1	1	4	8	10	0	12
Caspian tern*	29	43	56	73	116	161	232	78	59	62	35	36	41	232
Lesser crested tern*	78	63	83	69	150	107	40	37	98	175	137	113	318	318
Crested tern	83	76	627	78	337	610	815	749	957	2098	1605	109	334	2098
Roscate tern	0	0	46	8	0	0	1	0	0	55	606	721	7300	7300
Common tern*	0	7	1708	109	595	972	763	40	0	0	0	0	13	1708
Little tern*	0	28	37	19	0	2	31	12	3	0	0	0	0	37
Fairy tern	41	278	601	622	744	553	796	1060	81	137	57	512	429	1060
Bridled tern*	0	0	0	0	0	1	0	0	0	0	0	0	0	1
White-winged black tern*	0	0	314	0	151	35	140	1	0	0	0	0	0	314
Total Waterbirds	7155	15726	17087	13654	18697	19356	17319	6487	4565	6508	6468	7299	20428	32119

Attachment 3 - Number of Littoral Avifauna Counted in Each Region in Each Monthly Survey. These include numbers that are estimates for September to December 2003 based on proportions in complete counts. The percentage of waterbirds counted or estimated in that month in each region is also indicated.

Region	September 2003	October 2003	November 2003	December 2003	January 2004	February 2004
North	444 (3.7%)	377 (2.1%)	1028 (5.4%)	763 (4.7%)	766 (4.1%)	852 (4.4%)
North East	505 (4.3%)	1165 (6.6%)	1325 (7.0%)	819 (5.1%)	1473 (7.9%)	1169 (6.0%)
Upper East	662 (5.6%)	676 (3.8%)	514 (2.7%)	479 (3.0%)	580 (3.1%)	807 (4.2%)
Mid East	542 (4.6%)	993 (5.6%)	826 (4.4%)	464 (2.5%)	714 (3.8%)	893 (4.6%)
Lower East	2168 (18.3%)	2380 (13.5%)	2636 (14.0%)	2610 (16.2%)	2815 (15.1%)	3420 (17.7%)
South East	2902 (24.5%)	3272 (18.5%)	3132 (16.6%)	3683 (22.9%)	3790 (20.3%)	3867 (20.0%)
South	3270 (27.6%)	6645 (37.6%)	7743 (41.0%)	4934 (30.6%)	6423 (34.4%)	5459 (29.8%)
South West	235 (2.0%)	329 (1.9%)	65 (0.3%)	151 (0.9%)	192 (1.0%)	1104 (5.7%)
Lower West	519 (4.4%)	883 (5.0%)	803 (4.3%)	742 (4.6%)	1004 (5.4%)	655 (3.4%)
Mid West	248 (2.1%)	304 (1.7%)	261 (1.4%)	940 (5.8%)	240 (1.3%)	562 (2.9%)
Upper West	4 (<0.1%)	3 (<0.1%)	3 (<0.1%)	27 (0.2%)	43 (0.2%)	69 (0.4%)
North West	361 (3.0%)	638 (3.6%)	553 (2.9%)	506 (3.1%)	657 (3.5%)	499 (2.6%)
Total	11860	17665	18889	16118	18697	19356
Red-necked stint						
North	59 (1.3%)	96 (1.2%)	95 (1.3%)	87 (1.5%)	55 (0.8%)	137 (1.9%)
North East	265 (6.0%)	392 (4.9%)	642 (9.0%)	282 (4.9%)	614 (8.8%)	374 (5.1%)
Upper East	188 (4.3%)	219 (2.8%)	219 (3.1%)	150 (2.6%)	154 (2.2%)	304 (4.2%)
Mid East	185 (4.2%)	370 (4.7%)	190 (2.7%)	70 (1.2%)	125 (1.8%)	237 (3.3%)
Lower East	1169 (26.5%)	1370 (17.3%)	1298 (18.2%)	1321 (23.0%)	1152 (16.4%)	1538 (21.1%)
South East	1156 (26.2%)	1760 (22.2%)	1408 (19.7%)	2015 (35.1%)	2104 (30.0%)	1985 (27.2%)
South	1123 (25.4%)	3393 (42.8%)	3013 (42.1%)	1564 (27.2%)	2470 (35.2%)	1941 (26.6%)

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Region	September 2003	October 2003	November 2003	December 2003	January 2004	February 2004
South West	(0.5 %) 21	(0.4 %) 31	(0.6 %) 43	(0.4 %) 22	(0.1 %) 4	(7.6 %) 555
Lower West	(2.4 %) 104	(1.7 %) 135	(2.3 %) 167	(2.3 %) 135	(3.6 %) 255	(1.1 %) 77
Mid West	(2.9 %) 128	(1.8 %) 142	(0.6 %) 43	(1.3 %) 74	(0.6 %) 44	(1.6 %) 114
Upper West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
North West	(0.5 %) 20	(0.3 %) 25	(0.4 %) 32	(0.4 %) 25	(0.5 %) 34	(0.4 %) 29
Total	(100.0 %) 4418	(100.0 %) 7933	(100.0 %) 7150	(100.0 %) 5745	(100.0 %) 7011	(100.0 %) 7291
Grey-tailed tattler						
North	(5.3 %) 70	(2.8 %) 77	(7.2 %) 149	(4.4 %) 104	(2.9 %) 77	(5.3 %) 134
North East	(5.9 %) 79	(10.4 %) 283	(12.7 %) 263	(11.9 %) 281	(14.2 %) 374	(12.5 %) 317
Upper East	(11.8 %) 157	(6.4 %) 175	(2.3 %) 48	(3.2 %) 75	(4.1 %) 109	(3.6 %) 91
Mid East	(5.6 %) 75	(8.4 %) 228	(9.3 %) 192	(3.0 %) 70	(5.4 %) 143	(6.2 %) 156
Lower East	(9.8 %) 130	(7.6 %) 208	(11.4 %) 236	(12.9 %) 304	(11.0 %) 289	(11.5 %) 294
South East	(20.2 %) 269	(18.8 %) 512	(19.3 %) 400	(19.3 %) 456	(18.1 %) 478	(22.1 %) 561
South	(28.5 %) 379	(33.5 %) 910	(26.4 %) 547	(33.8 %) 800	(28.8 %) 759	(29.7 %) 753
South West	(0.2 %) 2	(<0.1 %) 1	(0 %) 0	(0 %) 0	(0.1 %) 2	(2.5 %) 63
Lower West	(5.1 %) 68	(5.8 %) 159	(5.9 %) 122	(6.4 %) 152	(9.2 %) 243	(1.0 %) 25
Mid West	(1.7 %) 22	(1.0 %) 26	(0.3 %) 6	(0 %) 0	(0.2 %) 4	(1.9 %) 47
Upper West	(0.2 %) 2	(0 %) 0	(0 %) 0	(0 %) 0	(0.1 %) 2	(0 %) 0
North West	(5.8 %) 77	(5.1 %) 140	(5.3 %) 109	(5.2 %) 123	(5.8 %) 154	(3.7 %) 94
Total	(100.0 %) 1330	(100.0 %) 2719	(100.0 %) 2072	(100.0 %) 2365	(100.0 %) 2634	(100.0 %) 2535
Ruddy turnstone						
North	(5.5 %) 83	(6.1 %) 132	(7.5 %) 119	(7.7 %) 128	(7.0 %) 119	(6.6 %) 114
North East	(6.4 %) 97	(8.6 %) 187	(9.0 %) 143	(4.6 %) 76	(10.3 %) 175	(9.9 %) 170
Upper East	(6.1 %) 92	(3.7 %) 81	2.8(%) 44	(4.2 %) 70	(4.9 %) 84	(5.3 %) 92

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Region	September 2003	October 2003	November 2003	December 2003	January 2004	February 2004
Mid East	(3.1 %) 47	(3.5 %) 77	(3.1 %) 50	(6.4 %) 107	(1.8 %) 31	(5.4 %) 94
Lower East	(13.3 %) 201	(9.2 %) 199	(10.2 %) 163	(13.6 %) 226	(12.5 %) 213	(12.3 %) 212
South East	(15.0 %) 226	(12.0 %) 260	(19.6 %) 313	(22.4 %) 372	(14.6 %) 249	(18.4 %) 318
South	(21.4 %) 323	(28.4 %) 617	(22.1 %) 352	(12.8 %) 212	(22.2 %) 378	(15.0 %) 259
South West	(3.7 %) 56	(3.7 %) 81	(0.4 %) 6	(3.0 %) 50	(0.7 %) 12	(4.1 %) 70
Lower West	(12.2 %) 184	(11.6 %) 251	(12.2 %) 194	(11.6 %) 192	(12.0 %) 204	(11.1 %) 192
Mid West	(3.0 %) 45	(3.0 %) 66	(2.8 %) 44	(1.8 %) 30	(0.8 %) 41	(2.8 %) 49
Upper West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
North West	(10.2 %) 154	(10.2 %) 222	(10.5 %) 168	(12.0 %) 199	(11.5 %) 195	(9.0 %) 155
Total	(100.0 %) 1508	(100.0 %) 2173	(100.0 %) 1596	(100.0 %) 1662	(100.0 %) 1701	(100.0 %) 1725
Common tern						
North	(0 %) 0	(22.2 %) 2	(19.3 %) 350	(3.9 %) 28	(2.9 %) 17	(0 %) 0
North East	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0.1 %) 1
Upper East	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0.1 %) 1
Mid East	(0 %) 0	(11.1 %) 1	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
Lower East	(0 %) 0	(22.2 %) 2	(4.9 %) 89	(8.6 %) 61	(55.3 %) 329	(42.5 %) 413
South East	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0.3 %) 2	(0 %) 0
South	(0 %) 0	(44.4 %) 4	(69.8 %) 1269	(1.1 %) 8	(41.0 %) 244	(47.1 %) 458
South West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(2.8 %) 27
Lower West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0.5 %) 5
Mid West	(0 %) 0	(0 %) 0	(6.1 %) 110	(86.3 %) 612	(0.5 %) 3	(6.9 %) 67
Upper West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
North West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
Total	0	(100.0 %) 9	(100.0 %) 1818	(100.0 %) 709	(100.0 %) 595	(100.0 %) 972

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Region	September 2003	October 2003	November 2003	December 2003	January 2004	February 2004
Bar-tailed godwit						
North	(6.3%) 26	(4.8%) 38	(7.4%) 68	(6.6%) 62	(9.3%) 89	(6.4%) 62
North East	(3.9%) 16	(3.8%) 30	(1.6%) 15	(3.6%) 34	(1.8%) 17	(2.6%) 25
Upper East	(1.5%) 6	(2.5%) 20	(1.2%) 11	(1.3%) 12	(1.2%) 11	(2.0%) 19
Mid East	(1.5%) 6	(9.4%) 74	(0.7%) 6	(2.6%) 25	(5.6%) 53	(4.0%) 39
Lower East	(25.6%) 105	(15.4%) 122	(15.3%) 140	(11.2%) 106	(11.0%) 105	(12.6%) 122
South East	(8.0%) 33	(10.8%) 85	(9.6%) 88	(5.1%) 48	(9.0%) 86	(7.9%) 77
South	(37.8%) 155	(40.9%) 323	(52.3%) 480	(57.6%) 545	(53.4%) 508	(44.0%) 427
South West	(0.5%) 2	(0.1%) 1	(0.4%) 4	(0%) 0	(0.3%) 3	(6.9%) 67
Lower West	(5.4%) 22	(5.3%) 42	(5.9%) 54	(6.0%) 57	(1.6%) 15	(9.0%) 87
Mid West	(4.6%) 19	(2.0%) 16	(0%) 0	(0.4%) 4	(0.4%) 4	(1.2%) 12
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(4.9%) 20	(4.9%) 39	(5.6%) 51	(5.6%) 53	(6.4%) 61	(3.4%) 33
Total	(100.0%) 410	(100.0%) 790	(100.0%) 917	(100.0%) 946	(100.0%) 952	(100.0%) 970
Lesser Sand Plover						
North	(1.3%) 3	(2.1%) 18	(2.2%) 13	(2.0%) 11	(1.5%) 10	(1.5%) 10
North East	(6.7%) 15	(10.0%) 84	(14.0%) 84	(1.6%) 9	(6.0%) 39	(2.6%) 17
Upper East	(11.2%) 25	(2.7%) 23	(7.5%) 45	(2.2%) 12	(0.3%) 2	(2.6%) 17
Mid East	(1.3%) 3	(10.1%) 85	(1.5%) 9	(3.3%) 18	(9.6%) 63	(1.7%) 11
Lower East	(29.5%) 66	(12.9%) 108	(7.5%) 45	(16.4%) 90	(9.0%) 59	(17.9%) 116
South East	(22.8%) 51	(22.0%) 184	(28.4%) 170	(23.9%) 131	(25.8%) 169	(30.4%) 197
South	(25.0%) 56	(36.3%) 304	(36.4%) 218	(48.3%) 265	(43.6%) 285	(35.2%) 228
South West	(0%) 0	(0.2%) 2	(0%) 0	(0%) 0	(0%) 0	(5.7%) 37
Lower West	(2.2%) 5	(2.6%) 22	(2.5%) 15	(2.4%) 13	(3.8%) 25	(0.3%) 2

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Region	September 2003	October 2003	November 2003	December 2003	January 2004	February 2004
Mid West	(0 %) 0	(0.8 %) 7	(0 %) 0	(0 %) 0	(0 %) 0	(1.9 %) 12
Upper West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
North West	(0 %) 0	(0.1 %) 1	(0 %) 0	(0 %) 0	(0.3 %) 2	(0 %) 0
Total	(100.0 %) 224	(100.0 %) 838	(100.0 %) 599	(100.0 %) 549	(100.0 %) 654	(100.0 %) 647
Great sand plover						
North	(4.8 %) 55	(5.3 %) 22	(7.3 %) 46	(4.4 %) 22	(3.2 %) 21	(3.7 %) 30
North East	(8.3 %) 95	(12.4 %) 51	(6.0 %) 38	(3.6 %) 18	(16.1 %) 106	(8.5 %) 70
Upper East	(3.7 %) 43	(7.5 %) 31	(1.6 %) 10	(3.6 %) 18	(8.0 %) 53	(9.1 %) 75
Mid East	(4.3 %) 50	(3.2 %) 13	(10.1 %) 64	(0.8 %) 4	(1.7 %) 11	(5.5 %) 45
Lower East	(14.8 %) 170	(18.9 %) 78	(15.8 %) 100	(20.4 %) 103	(12.7 %) 84	(11.6 %) 95
South East	(15.3 %) 176	(15.5 %) 64	(22.7 %) 144	(32.9 %) 166	(16.8 %) 111	(19.6 %) 161
South	(39.4 %) 453	(27.2 %) 112	(27.8 %) 176	(25.8 %) 130	(32.6 %) 215	(24.8 %) 204
South West	(0 %) 0	(1.2 %) 5	(0 %) 0	(0 %) 0	(0.3 %) 2	(7.2 %) 59
Lower West	(7.0 %) 80	(7.0 %) 29	(6.9 %) 44	(6.9 %) 35	(4.7 %) 31	(9.3 %) 76
Mid West	(0 %) 0	(0 %) 0	(0.2 %) 1	(0 %) 0	(0.5 %) 3	(0.7 %) 6
Upper West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
North West	(2.5 %) 29	(1.7 %) 7	(1.7 %) 11	(1.6 %) 8	(3.3 %) 22	(0 %) 0
Total	(100.0 %) 1151	(100.0 %) 412	(100.0 %) 634	(100.0 %) 504	(100.0 %) 659	(100.0 %) 821
Silver gull						
North	(12.0 %) 59	(11.2 %) 39	(9.0 %) 25	(10.1 %) 51	(12.1 %) 109	(13.4 %) 108
North East	(15.3 %) 75	(3.4 %) 12	(5.4 %) 15	(3.8 %) 19	(6.4 %) 57	(4.5 %) 36
Upper East	(4.7 %) 23	(2.3 %) 8	(9.4 %) 26	(2.0 %) 10	(3.8 %) 34	(7.5 %) 60
Mid East	(2.9 %) 14	(6.6 %) 23	(1.4 %) 4	(1.2 %) 6	(5.8 %) 52	(4.8 %) 39
Lower East	(7.3 %) 36	(10.1 %) 35	(7.9 %) 22	(6.0 %) 30	(10.1 %) 90	(6.2 %) 50

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Region	September 2003	October 2003	November 2003	December 2003	January 2004	February 2004
South East	(7.3 %) 36	(17.5 %) 61	(12.9 %) 36	(7.7 %) 39	(4.7 %) 42	(5.2 %) 42
South	(14.7 %) 72	(11.5 %) 40	(13.3 %) 37	(26.2 %) 132	(5.4 %) 48	(3.9 %) 31
South West	(4.9 %) 24	(1.1 %) 4	(0 %) 0	(2.8 %) 14	(14.6 %) 130	(6.3 %) 51
Lower West	(10.8 %) 53	(11.8 %) 41	(7.2 %) 20	(11.5 %) 58	(10.9 %) 97	(6.8 %) 55
Mid West	(2.4 %) 12	(4.0 %) 14	(17.6 %) 49	(8.5 %) 43	(10.0 %) 89	(22.4 %) 180
Upper West	(5.7 %) 28	(5.7 %) 20	(5.8 %) 16	(5.8 %) 29	(4.3 %) 38	(7.3 %) 59
North West	(11.8 %) 58	(14.7 %) 51	(10.1 %) 28	(14.5 %) 73	(11.9 %) 106	(11.7 %) 94
Total	(100.0 %) 490	(100.0 %) 348	(100.0 %) 278	(100.0 %) 504	(100.0 %) 892	(100.0 %) 805
Fairy tern						
North	(0 %) 0	(0 %) 0	(5.5 %) 33	(15.0 %) 116	(18.3 %) 136	(6.7 %) 37
North East	(0 %) 0	(0 %) 0	(0.7 %) 4	(0 %) 0	(0 %) 0	(1.6 %) 9
Upper East	(27.9 %) 34	(0 %) 0	(0 %) 0	(0.3 %) 2	(0 %) 0	(0 %) 0
Mid East	(1.6 %) 2	(0 %) 0	(0.2 %) 1	(0 %) 0	(0 %) 0	(0 %) 0
Lower East	(0 %) 0	(0.4 %) 1	(2.1 %) 13	(0.9 %) 7	(8.3 %) 62	(19.9 %) 110
South East	(0 %) 0	(0 %) 0	(0 %) 0	(1.7 %) 13	(2.7 %) 20	(4.0 %) 22
South	(64.8 %) 79	(98.9 %) 277	(90.9 %) 550	(62.7 %) 484	(69.6 %) 518	(66.5 %) 368
South West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0.9 %) 5
Lower West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
Mid West	(0 %) 0	(0 %) 0	(0 %) 0	(19.4 %) 150	(0 %) 0	(0 %) 0
Upper West	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0	(0 %) 0
North West	(5.7 %) 7	(0.7 %) 2	(0.7 %) 4	(0 %) 0	(1.1 %) 8	(0.4 %) 2
Total	(100.0 %) 122	(100.0 %) 280	(100.0 %) 605	(100.0 %) 772	(100.0 %) 744	(100.0 %) 553

Region	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
North	(4.5%) 785	(5.1%) 334	(8.3%) 379	(4.9%) 321	(4.4%) 283	(12.5%) 912	(39.4%) 8040
North East	(6.5%) 1122	(6.5%) 424	(3.4%) 153	(3.0%) 198	(3.4%) 222	(3.7%) 269	(5.2%) 1058
Upper East	(3.6%) 625	(3.6%) 232	(4.5%) 204	(2.2%) 141	(1.9%) 120	(2.4%) 177	(3.0%) 606
Mid East	(3.7%) 649	(3.5%) 225	(3.3%) 149	(1.2%) 77	(1.3%) 86	(2.6%) 193	(3.1%) 626
Lower East	(18.6%) 3226	(12.7%) 827	(26.0%) 1186	(16.9%) 1101	(11.6%) 749	(12.0%) 876	(10.9%) 2236
South East	(14.1%) 2440	(16.2%) 1053	(13.8%) 628	(12.1%) 785	(10.7%) 692	(18.1%) 1320	(11.4%) 2323
South	(21.4%) 3707	(21.0%) 1362	(24.9%) 1138	(23.2%) 1510	(20.9%) 1349	(27.8%) 2030	(16.8%) 3424
South West	(14.8%) 2555	(20.6%) 1336	(4.7%) 215	(24.4%) 1587	(5.7%) 369	(7.5%) 546	(6.2%) 1258
Lower West	(3.6%) 618	(3.5%) 227	(4.3%) 198	(6.9%) 451	(23.2%) 1501	(6.5%) 475	(1.4%) 289
Mid West	(4.7%) 806	(3.9%) 252	(4.8%) 218	(3.6%) 237	(10.8%) 701	(1.4%) 101	(0.8%) 165
Upper West	(0.2%) 31	(0.1%) 5	(>0.1%) 1	(0.2%) 14	(1.3%) 85	(0.3%) 24	(>0.1%) 5
North West	(4.4%) 755	(3.2%) 210	(2.1%) 96	(1.3%) 86	(4.8%) 311	(5.2%) 376	(1.9%) 398
Total	(100%) 17319	(100%) 6487	(100%) 4565	(100%) 6508	(100%) 6468	(100%) 7299	(100%) 20428
Red-necked stint							
North	(1.2%) 57	(6.2%) 72	(1.8%) 15	(1.0%) 10	(1.3%) 14	(3.4%) 47	(1.9%) 75
North East	(6.3%) 306	(8.6%) 99	(2.8%) 23	(1.4%) 14	(2.2%) 24	(2.7%) 38	(8.3%) 332
Upper East	(1.9%) 92	(4.2%) 49	(3.9%) 32	(1.8%) 19	(2.8%) 31	(2.0%) 28	(3.5%) 141
Mid East	(1.6%) 76	(1.7%) 20	(0.5%) 4	(0%) 0	(1.1%) 12	(1.1%) 16	(2.9%) 117
Lower East	(25.3%) 1228	(15.2%) 176	(38.2%) 314	(34.5%) 356	(35.8%) 397	(25.0%) 350	(21.5%) 865
South East	(17.5%) 846	(29.9%) 346	(4.4%) 36	(6.3%) 65	(9.2%) 102	(15.4%) 216	(22.1%) 889
South	(28.5%) 1379	(31.9%) 369	(47.6%) 391	(50.8%) 525	(40.2%) 446	(48.8%) 683	(33.5%) 1344
South West	(9.7%) 468	(2.0%) 23	(0%) 0	(0%) 0	(0.1%) 1	(0.1%) 1	(5.1%) 204
Lower West	(4.8%) 232	(0.3%) 3	(0.6%) 5	(2.0%) 21	(5.0%) 56	(0.7%) 10	(0%) 0
Mid West	(2.4%) 116	(0%) 0	(0.2%) 2	(0.1%) 1	(0%) 0	(0.3%) 4	(0.4%) 16

Region	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
Upper West	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
North West	45 (0.9%)	0 (0%)	0 (0%)	22 (2.1%)	26 (2.3%)	7 (0.5%)	32 (0.8%)
Total	4845 (100%)	1157 (100%)	822 (100%)	1033 (100%)	1109 (100%)	1400 (100%)	4015 (100%)
Grey-tailed tattler							
North	127 (5.0%)	23 (2.1%)	0 (0%)	0 (0%)	50 (11.7%)	22 (3.7%)	98 (6.0%)
North East	307 (12.1%)	160 (14.7%)	46 (10.7%)	56 (12.5%)	55 (12.8%)	52 (8.8%)	203 (12.4%)
Upper East	144 (5.7%)	68 (6.2%)	36 (8.4%)	25 (5.6%)	12 (2.8%)	23 (3.9%)	79 (4.8%)
Mid East	195 (7.7%)	73 (6.7%)	16 (3.7%)	7 (1.6%)	2 (0.5)	9 (1.5%)	79 (4.8%)
Lower East	309 (12.2%)	127 (11.7%)	108 (25.2%)	101 (22.5%)	65 (15.2%)	122 (20.5%)	208 (12.8%)
South East	446 (17.5%)	193 (17.7%)	58 (13.6%)	47 (10.5%)	101 (23.5%)	96 (16.2%)	283 (17.4%)
South	751 (29.5%)	333 (30.6%)	164 (38.3%)	201 (44.9%)	123 (28.7%)	208 (35.0%)	462 (28.3%)
South West	17 (0.7%)	66 (6.1%)	0 (0%)	0 (0%)	2 (0.5%)	4 (0.7%)	58 (3.6%)
Lower West	21 (0.8%)	38 (3.5%)	0 (0%)	6 (1.3%)	16 (3.7%)	35 (5.9%)	40 (2.5%)
Mid West	36 (1.4%)	7 (0.6%)	0 (0%)	0 (0%)	0 (0%)	12 (2.0%)	41 (2.5%)
Upper West	1 (>0.1%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
North West	189 (7.4%)	2 (0.2%)	0 (0%)	5 (1.1%)	3 (0.7%)	11 (1.9%)	80 (4.9%)
Total	2543 (100%)	1090 (100%)	428 (100%)	448 (100%)	429 (100%)	594 (100%)	1631 (100%)
Ruddy turnstone							
North	111 (6.4%)	15 (12.0%)	12 (10.3%)	13 (11.8%)	8 (7.4%)	9 (4.0%)	124 (8.4%)
North East	188 (10.8%)	5 (4.0%)	0 (0%)	7 (6.4%)	8 (7.4%)	22 (9.7%)	154 (10.4%)
Upper East	90 (5.2%)	4 (3.2%)	4 (3.4%)	5 (4.5%)	1 (0.9%)	5 (2.2%)	68 (4.6%)
Mid East	84 (4.8%)	8 (6.4%)	1 (0.9%)	0 (0%)	2 (1.9%)	6 (2.6%)	75 (5.1%)
Lower East	272 (15.7%)	10 (8.0%)	13 (11.1%)	12 (10.9%)	4 (3.7%)	18 (7.9%)	197 (13.3%)
South East	294 (17.0%)	17 (13.6%)	25 (21.4%)	30 (27.3%)	32 (29.6%)	60 (26.4%)	239 (16.2%)

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Region	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
South	(12.7%) 220	(15.2%) 19	(17.1%) 20	(14.5%) 16	(13.9%) 15	(29.5%) 67	(15.7%) 231
South West	(6.5%) 113	(32.0%) 40	(7.7%) 9	(6.4%) 7	(2.8%) 3	(3.1%) 7	(8.2%) 121
Lower West	(7.8%) 136	(0%) 0	(7.7%) 9	(6.4%) 7	(13.0%) 14	(5.3%) 12	(5.0%) 74
Mid West	(3.8%) 65	(4.8%) 6	(0%) 0	(0%) 0	(0%) 0	(0.9%) 2	(2.4%) 35
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(9.2%) 160	(0.8%) 1	(20.5%) 24	(11.8%) 13	(19.4%) 21	(8.4%) 19	(10.7%) 158
Total	(100%) 1733	(100%) 125	(100%) 117	(100%) 110	(100%) 108	(100%) 227	(100%) 1476
Common tern							
North	(0.3%) 2	(2.5%) 1	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(15.4%) 2
North East	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Upper East	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Mid East	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Lower East	(25.3%) 193	(95.0%) 38	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(30.8%) 4
South East	(3.9%) 30	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
South	(36.4%) 278	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
South West	(31.1%) 237	(2.5%) 1	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(53.8%) 7
Lower West	(1.6%) 12	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Mid West	(1.4%) 11	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Total	(100%) 763	(100%) 40	(100%) 0	(100%) 0	(100%) 0	(100%) 0	(100%) 13
Bar-tailed godwit							
North	(4.0%) 43	(7.7%) 14	(9.8%) 13	(7.7%) 8	(0%) 0	(7.3%) 8	(5.3%) 42
North East	(2.6%) 28	(5.5%) 10	(0%) 0	(1.9%) 2	(0%) 0	(0.9%) 1	(1.8%) 14

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Region	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
Upper East	(2.1%) 22	(2.7%) 5	(4.5%) 6	(2.9%) 3	(5.6%) 4	(1.8%) 2	(2.4%) 19
Mid East	(3.4%) 36	(1.1%) 2	(0%) 0	(0%) 0	(0%) 0	(10.0%) 11	(5.0%) 40
Lower East	(24.7%) 264	(8.2%) 15	(12.1%) 16	(15.4%) 16	(9.9%) 7	(5.5%) 6	(20.5%) 164
South East	(5.3%) 57	(3.3%) 6	(0%) 0	(3.8%) 4	(23.9%) 17	(0%) 0	(8.8%) 70
South	(41.0%) 439	(32.8%) 60	(65.9%) 87	(61.5%) 64	(54.9%) 39	(73.6%) 81	(39.6%) 317
South West	(4.0%) 43	(38.8%) 71	(5.8%) 10	(5.8%) 6	(5.6%) 4	(0.9%) 1	(14.1%) 113
Lower West	(7.1%) 76	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(2.3%) 18
Mid West	(1.0%) 11	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0.3%) 2
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(4.8%) 51	(0%) 0	(0%) 0	(1.0%) 1	(0%) 0	(0%) 0	(0.1%) 1
Total	(100%) 1070	(100%) 183	(100%) 132	(100%) 104	(100%) 71	(100%) 110	(100%) 800
Lesser Sand Plover							
North	(4.0%) 36	(0.4%) 1	(0.4%) 1	(0.3%) 1	(0.3%) 1	(0.8%) 3	(1.1%) 6
North East	(11.1%) 100	(6.9%) 18	(1.1%) 3	(0%) 0	(0.3%) 1	(0.5%) 2	(12.5%) 70
Upper East	(2.1%) 19	(3.8%) 10	(7.5%) 21	(1.8%) 6	(0/9%) 3	(1.3%) 5	(4.3%) 24
Mid East	(4.1%) 37	(0.4%) 1	(1.4%) 4	(0%) 0	(0%) 0	(0.3%) 1	(2.1%) 12
Lower East	(15.6%) 141	(11.1%) 29	(27.4%) 77	(1.2%) 4	(3.0%) 10	(13.9%) 54	(12.0%) 67
South East	(22.5%) 203	(6.5%) 17	(2.5%) 7	(0.6%) 2	(0.6%) 2	(9.5%) 37	(19.3%) 108
South	(39.4%) 355	(58.8%) 154	(59.8%) 168	(94.5%) 312	(93.2%) 313	(73.7%) 286	(43.8%) 245
South West	(0.8%) 7	(12.2%) 32	(0%) 0	(1.5%) 5	(1.5%) 5	(0%) 0	(3.6%) 20
Lower West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0.3%) 1	(0%) 0	(0.9%) 5
Mid West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0.4%) 2
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(0.4%) 4	(0%) 0	(0%) 0	(0%) 00	(0%) 0	(0%) 0	(0%) 0

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Region	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
Total	(100%) 902	(100%) 262	(100%) 281	(100%) 330	(100%) 336	(100%) 388	(100%) 559
Great sand plover							
North	(5.0%) 25	(3.0%) 7	(13.1%) 27	(5.5%) 9	(0.9%) 2	(7.1%) 55	(6.4%) 58
North East	(5.2%) 26	(15.0%) 35	(9.2%) 19	(10.4%) 17	(4.7%) 10	(10.4%) 81	(13.4%) 121
Upper East	(1.0%) 5	(4.3%) 10	(14.6%) 30	(9.8%) 16	(2.8%) 6	(5.0%) 39	(5.3%) 48
Mid East	(1.8%) 9	(6.0%) 14	(3.4%) 7	(0%) 0	(0%) 0	(5.4%) 42	(4.5%) 41
Lower East	(21.4%) 107	(16.7%) 39	(22.3%) 46	(1.2%) 2	(9.0%) 19	(15.1%) 117	(16.4%) 148
South East	(10.6%) 53	(7.7%) 18	(0.5%) 1	(2.4%) 4	(0%) 0	(8.1%) 63	(14.4%) 130
South	(49.5%) 247	(36.8%) 86	(35.0%) 72	(65.9%) 108	(75.8%) 160	(27.5%) 214	(25.6%) 231
South West	(1.2%) 6	(8.5%) 20	(0%) 0	(4.3%) 7	(2.4%) 5	(14.8%) 115	(7.9%) 71
Lower West	(0%) 0	(0.9%) 2	(0%) 0	(0%) 0	(0.5%) 1	(4.2%) 33	(1.6%) 14
Mid West	(1.8%) 9	(0%) 0	(1.9%) 4	(0%) 0	(1.4%) 3	(1.7%) 13	(1.6%) 14
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(2.4%) 12	(1.3%) 3	(0%) 0	(0/6%) 1	(2.4%) 5	(0.6%) 5	(3.0%) 27
Total	(100%) 499	(100%) 234	(100%) 206	(100%) 164	(100%) 211	(100%) 777	(100%) 903
Silver gull							
North	(7.8%) 58	(7.8%) 22	(19.4%) 40	(3.2%) 11	(1.8%) 11	(17.7%) 108	(51.4%) 186
North East	(2.3%) 17	(5.0%) 14	(4.4%) 9	(0.9%) 3	(1.3%) 8	(1.3%) 8	(1.1%) 4
Upper East	(8.0%) 60	(7.5%) 21	(3.4%) 7	(4.0%) 14	(1.8%) 11	(1.3%) 8	(0.8%) 3
Mid East	(1.2%) 9	(16.0%) 45	(2.9%) 6	(2.3%) 8	(2.2%) 13	(1.8%) 11	(3.9%) 14
Lower East	(5.8%) 43	(8.2%) 23	(4.4%) 9	(10.4%) 36	(8.2%) 49	(4.4%) 27	(6.9%) 25
South East	(1.7%) 13	(3.2%) 9	(3.9%) 8	(15.6%) 54	(8.0%) 48	(9.5%) 58	(9.9%) 36
South	(3.2%) 24	(2.8%) 8	(3.9%) 8	(5.2%) 18	(1.7%) 10	(5.4%) 33	(8.3%) 30
South West	(6.6%) 49	(13.2%) 37	(30.6%) 63	(25.1%) 87	(9.8%) 59	(4.3%) 26	(1.7%) 6

Appendix C3: Avifauna Technical Report

Region	March 2004	April 2004	May 2004	June 2004	July 2004	August 2004	September 2004
Lower West	(3.8%) 28	(8.2%) 23	(6.8%) 14	(21.9%) 76	(37.8%) 227	(30.3%) 185	(5.2%) 19
Mid West	(35.7%) 266	(4.3%) 12	(8.7%) 18	(7.2%) 25	(20.5%) 123	(4.6%) 28	(5.0%) 18
Upper West	(2.9%) 22	(0.4%) 1	(0%) 0	(2.9%) 10	(5.0%) 30	(2.6%) 16	(0%) 0
North West	(21.0%) 157	(23.5%) 66	(11.7%) 24	(1.4%) 5	(1.8%) 11	(16.7%) 102	(5.8%) 21
Total	(100%) 746	(100%) 281	(100%) 206	(100%) 347	(100%) 600	(100%) 610	(100%) 362
Fairy tern							
North	(5.4%) 43	(0.8%) 9	(1.2%) 1	(2.2%) 3	(0%) 0	(1.2%) 6	(0.2%) 1
North East	(3.4%) 27	(0.2%) 2	(0%) 0	(0%) 0	(1.8%) 1	(0%) 0	(0%) 0
Upper East	(0.1%) 1	(0.1%) 1	(0%) 0	(8.0%) 11	(0%) 0	(0.4%) 2	(1.2%) 5
Mid East	(0.4%) 3	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0.5%) 2
Lower East	(7.2%) 57	(1.4%) 15	(93.8%) 76	(3.6%) 5	(0%) 0	(0%) 0	(0%) 0
South East	(0.4%) 3	(8.5%) 90	(0%) 0	(7.3%) 10	(7.0%) 4	(0%) 0	(0%) 0
South	(75.4%) 600	(7.1%) 75	(4.9%) 4	(32.8%) 45	(15.8%) 9	(18.2%) 93	(7.5%) 32
South West	(7.8%) 62	(81.9%) 868	(0%) 0	(43.1%) 59	(71.9%) 41	(61.3%) 314	(80.0%) 343
Lower West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(18.2%) 93	(9.8%) 42
Mid West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
Upper West	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0	(0%) 0
North West	(0%) 0	(0%) 0	(0%) 0	(2.9%) 4	(3.5%) 2	(0.8%) 4	(0.9%) 4
Total	(100%) 796	(100%) 1060	(100%) 81	(100%) 137	(100%) 57	(100%) 512	(100%) 429

Attachment 4 - Bird Species Recorded from Barrow Island. Based on Sedgewick (1978) and WAPET (1991), with species apparently recorded for the first time on the Island during the 2003/2004 surveys marked with an asterisk. Under Status, species are classified as either: R = resident; M = regular migrant or V = vagrant. Under Habitat, species are classified as either: T = terrestrial; L = littoral (shoreline, shallows and inshore waters, including ephemeral wetlands); O = oceanic (marine) or OI = oceanic but breeding on offshore islets. The conservation status of species under the WA Wildlife Conservation Act, Federal EPBC Act and CALM priority list is indicated.

Species	Status	Habitat	Conservation status
Phasianidae (pheasants and quails)			
Brown quail <i>Coturnix ypsilophora</i>	R	T	
Anatidae (ducks, geese and swans)			
Black swan <i>Cygnus atratus</i>	V	L	
Australian wood duck <i>Chenonetta jubata</i>	V	L	
Grey teal <i>Anas gibberifrons</i>	V	L	
Podicipididae (grebes)			
Australasian grebe <i>Tachybaptus novaehollandiae</i>	V	L	
Procellariidae (shearwaters)			
Wedge-tailed shearwater <i>Puffinus pacificus</i>	M	OI	migratory
Diomedeidae (albatrosses)			
Yellow-nosed albatross <i>Diomedea chlororhynchos</i>	V	O	migratory
Hydrobatidae (storm-petrels)			
Wilson's storm-petrel <i>Oceanites oceanicus</i>	V	O	migratory
Sulidae (gannets and boobies)			
Masked booby <i>Sula dactylatra</i>	V	O	migratory
Brown booby <i>Sula leucogaster</i>	V	O	migratory
Anhingidae (darters)			
Darter <i>Anhinga melanogaster</i>	V	L	
Phalacrocoracidae (cormorants)			
Little pied cormorant <i>Phalacrocorax melanoleucos</i>	R*	L	
Pied cormorant <i>Phalacrocorax varius</i>	R	L	
Little black cormorant <i>Phalacrocorax sulcirostris</i>	R*	L	
Great cormorant <i>Phalacrocorax carbo</i>	R	L	
Pelecanoididae (pelicans)			
Australian pelican <i>Pelecanus conspicillatus</i>	R	L	
Fregatidae			
Lesser frigatebird <i>Fregata ariel</i>	V	O	migratory
Ardeidae (herons and egrets)			
White-faced heron <i>Ardea (Egretta) novaehollandiae</i>	R	L	
Little egret <i>Ardea (Egretta) garzetta</i>	V	L	

Species	Status	Habitat	Conservation status
Eastern reef egret <i>Ardea (Egretta) sacra</i>	R	L	migratory
Great egret <i>Ardea (Egretta) alba</i>	V*	L	migratory
Striated heron <i>Butorides striatus</i>	R	L	
Nankeen night heron <i>Nycticorax caledonicus</i>	R	L	
Accipitridae (kites, hawks and eagles)			
Osprey <i>Pandion haliaetus</i>	R	L	migratory
Black-shouldered kite <i>Elanus notatus</i>	R	T	
Square-tailed kite <i>Lophoictinia isura</i>	V	T	
Black-breasted buzzard <i>Hamirostra melanosternon</i>	V	T	
Whistling kite <i>Haliastur sphenurus</i>	V	T	
Brahminy kite <i>Haliastur indus</i>	R	L	
White-bellied sea-eagle <i>Haliaeetus leucogaster</i>	R	T	migratory
Spotted harrier <i>Circus assimilis</i>	R	T	
Wedge-tailed eagle <i>Aquila audax</i>	V	T	
Falconidae (falcons)			
Brown falcon <i>Falco berigora</i>	V	T	
Australian hobby <i>Falco longipennis</i>	V	T	
Nankeen kestrel <i>Falco cenchroides</i>	R	T	
Otididae (bustards)			
Australian bustard <i>Ardeotis australis</i>	V	T	Priority 4
Scolopacidae (sandpipers)			
Black-tailed godwit <i>Limosa limosa</i>	M	L	migratory
Bar-tailed godwit <i>Limosa lapponica</i>	M	L	migratory
Little curlew <i>Numenius minutus</i>	V	L	migratory
Whimbrel <i>Numenius phaeopus</i>	M	L	migratory
Eastern curlew <i>Numenius madagascariensis</i>	M	L	migratory
Marsh sandpiper <i>Tringa stagnatalis</i>	V	L	migratory
Common greenshank <i>Tringa nebularia</i>	M	L	migratory
Wood sandpiper <i>Tringa glareola</i>	V	L	migratory
Terek sandpiper <i>Tringa (Xenus) terek</i>	M	L	migratory
Common sandpiper <i>Tringa hypoleucos</i>	M	L	migratory
Grey-tailed tattler <i>Tringa brevipes</i>	M	L	migratory
Ruddy turnstone <i>Arenaria interpres</i>	M	L	migratory
Great knot <i>Calidris tenuirostris</i>	M	L	migratory
Red knot <i>Calidris canutus</i>	M	L	migratory
Sanderling <i>Calidris alba</i>	M	L	migratory
Red-necked stint <i>Calidris ruficollis</i>	M	L	migratory
Sharp-tailed Sandpiper <i>Calidris acuminata</i>	M	L	migratory
Curlew Sandpiper <i>Calidris ferruginea</i>	M	L	migratory

Species	Status	Habitat	Conservation status
Burhinidae (stone-curlews)			
Beach stone-curlew <i>Esacus neglectus</i>	R	L	
Haematopodidae (oystercatchers)			
Pied oystercatcher <i>Haematopus longirostris</i>	R	L	
Sooty oystercatcher <i>Haematopus fuliginosus</i>	R	L	
Recurvirostridae (stilts and avocets)			
Black-winged stilt <i>Himantopus himantopus</i>	V	L	
Banded stilt <i>Cladorhynchus leucocephalus</i>	V	L	
Charadriidae (lapwings and plovers)			
Pacific golden plover <i>Pluvialis fulva</i>	M	L	migratory
Grey plover <i>Pluvialis squatarola</i>	M	L	migratory
Red-capped plover <i>Charadrius ruficapillus</i>	R	L	
Lesser sand plover <i>Charadrius mongolus</i>	M	L	migratory
Greater sand plover <i>Charadrius leschenaultii</i>	M	L	migratory
Oriental plover <i>Charadrius veredus</i>	V	L	migratory
Glareolidae (pratincoles)			
Australian pratincole <i>Stiltia isabella</i>	V	L	migratory
Laridae (gulls and terns)			
Silver gull <i>Larus novaehollandiae</i>	R	L	
Gull-billed tern <i>Sterna (Gelocbelidon) nilotica</i>	R	L	
Caspian tern <i>Sterna (Hydroprogne) caspia</i>	R	L	
Lesser crested tern <i>Sterna bengalensis</i>	R	L	
Crested tern <i>Sterna bergii</i>	R	L	
Roseate tern <i>Sterna dougallii</i>	M	L/O	
Common tern <i>Sterna hirundo</i>	M	L/O	migratory
Little tern <i>Sterna albifrons</i>	M	L	migratory
Fairy tern <i>Sterna nereis</i>	?	L	
Bridled tern <i>Sterna anaethetus</i>	M	OI	migratory
White-winged black tern <i>Chlidonias leucoptera</i>	M	L	migratory
Lesser noddy <i>Anous tenuirostris</i>	?	O	
Columbidae (pigeons and doves)			
Crested pigeon <i>Ocyphaps lophotes</i>	V	T	
Peaceful dove <i>Geopelia placida</i>	V	T	
Bar-shouldered dove <i>Geopelia humeralis</i>	R	T	
Cacatuidae (cockatoos)			
Galah <i>Cacatua roseicapilla</i>	V	T	
Little corella <i>Cacatua sanguinea</i>	V	T	
Cockatiel <i>Nymphicus hollandicus</i>	V	T	
Psittacidae (lorikeets and parrots)			

Species	Status	Habitat	Conservation status
Budgerigar <i>Melopsittacus undulatus</i>	V	T	
Cuculidae (cuckoos)			
Oriental cuckoo <i>Cuculus saturatus</i>	*V	T	migratory
Pallid cuckoo <i>Cuculus pallidus</i>	R	T	
Horsfield's bronze-cuckoo <i>Chrysococcyx basalis</i>	R	T	
Black-eared cuckoo <i>Chrysococcyx osculans</i>	R	T	
Strigidae (hawk-owls)			
Southern boobook owl <i>Ninox novaeseelandiae</i>	V	T	
Tytonidae (barn owls)			
Barn owl <i>Tyto alba</i>	V	T	
Apodidae (swifts)			
Swiftlet species <i>Collocalia</i> sp.	V	T	
Fork-tailed swift <i>Apus pacificus</i>	?M	T	
White-throated needletail <i>Hirundapus candacutus</i>	?M	T	
Halcyonidae (forest kingfishers)			
Red-backed kingfisher <i>Todiramphus pyrrhopygia</i>	V	T	
Sacred kingfisher <i>Todiramphus sanctus</i>	R	L	
Maluridae (fairy wrens)			
Barrow Island white-winged fairy wren <i>Malurus leucopterus edouardi</i>	R	T	Sched. 1, Vulnerable
Meliphagidae (honeyeaters)			
Spiny-cheeked honeyeater <i>Acanthagenys rufogularis</i>	V	T	
Singing honeyeater <i>Lichenostomus virescens</i>	R	T	
Brown honeyeater <i>Lichmera indistincta</i>	V	T	
Crimson chat <i>Epthianura tricolor</i>	V	T	
Dicruridae (flycatchers)			
Magpie-lark <i>Grallina cyanoleuca</i>	V	T	
Willie wagtail <i>Rhipidura leucobryis</i>	V	T	
Campephagidae (cuckoo-shrikes)			
Black-faced cuckoo-shrike <i>Coracina novaehollandiae</i>	V	T	
White-winged triller <i>Lalage sneurii</i>	V	T	
Artamidae (woodswallows)			
White-breasted woodswallow <i>Artamus leucorhynchus</i>	R	T	
Masked woodswallow <i>Artamus personatus</i>	V	T	
Black-faced woodswallow <i>Artamus cinereus</i>	V	T	
Corvidae (ravens and crows)			
Little crow <i>Corvus bennetti</i>	V	T	
Motacillidae (pipits and true wagtails)			
Richard's pipit <i>Anthus novaeseelandiae</i>	R	T	
Passeridae (finches and allies)			

Species	Status	Habitat	Conservation status
Painted firetail <i>Emblema picta</i>	V	T	
Zebra finch <i>Taeniopygia guttata</i>	R	T	
Hirundinidae (swallows)			
Welcome swallow <i>Hirundo neoxena</i>	R	T	
Tree Martin <i>Hirundo nigricans</i>	V	T	
Fairy Martin <i>Hirundo ariel</i>	V	T	
Sylviidae (Old World warblers)			
Spinifexbird <i>Eremiornis carteri</i>	R	T	
Brown songlark <i>Cincloramphus cruralis</i>	V	T	
Zosteropidae (silveryeyes)			
Yellow white-eye <i>Zosterops luteus</i>	R	T	

Attachment 5 - Gorgon Development on Barrow Island. Technical Report on the White-winged Fairy-wren *Malurus leucopterus edouardi*.

Gorgon development on Barrow Island

Technical report

White-winged Fairy-wren *Malurus leucopterus edouardi*

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1 Introduction

The Gorgon Venture proposes to develop a gas processing facility on Barrow Island. The facility is proposed for Town Point on the east coast of the Island, with the associated gas feed pipelines running across the Island from a shore crossing at either North White's Beach or Flacourt Bay. The proposed development will result in the loss of some habitat for the endemic White-winged Fairy-wren *Malurus leucopterus edouardi*. The Barrow Island sub-species of the White-winged Fairy-wren is listed as Vulnerable under the *Wildlife Conservation Act 1950 (WA)* (Wildlife Conservation Act) and the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The aim of this study was to determine the number of White-winged Fairy-wrens inhabiting the proposed development area, and relate this to the estimated number of wrens in similar habitat on Barrow Island.

2 Methods

Surveys for the White-winged Fairy-wren were carried out in the late afternoon on the 22nd – 24th October 2004. The eight search areas surveyed are listed in Table 1. Each search area was approximately 100m wide and of variable length. The search areas were side-by-side and approximately 0.81 km² of the proposed 3 km² Development area was surveyed. The vegetation in the search areas generally consisted of mixed *Triodia* species with scattered clumps of *Acacia bivenosa* and scattered clumps of a *Melaleuca cardiophylla*.

Table 1. Location of each White-winged Fairy-wren search area. Each search area is a rectangular transect and all searches were carried out between 1500 and 1830hr.

Search Area	Date Searched	Eastern Edge	Western Edge	Northern Edge	Southern Edge	Area (m ²)
1	22-Oct-04	339450 E	337970 E	7700700 N	7700600 N	148000
2	22-Oct-04	339450 E	337970 E	7700600 N	7700500 N	148000
3	23-Oct-04	339160 E	338290 E	7700100 N	7700000 N	87000
4	23-Oct-04	339160 E	338290 E	7700200 N	7700100 N	87000
5	24-Oct-04	339236 E	337970 E	7700300 N	7700200 N	126600
6	24-Oct-04	339236 E	337970 E	7700300 N	7700400 N	126600
7	24-Oct-04	339800 E	339310 E	7700500 N	7700400 N	49000
8	24-Oct-04	339800 E	339395 E	7700650 N	7700550 N	40500

The search areas were surveyed by six people standing in a line, 20m apart, on one 100m wide front. The search area was swept by the six people moving forward into the search area at a walking pace, maintaining the straight line. Hand-held Global Positioning System (GPS) units were used to maintain the correct bearing at each boundary of the search line. If a bird was observed, the survey team paused while the observation was recorded. This ensured that a straight line was maintained.

As terrestrial birds are relatively uncommon on Barrow Island, all birds (in addition to White-winged Fairy-wrens) that were seen were recorded. Spectacled Hare-Wallabies (*Lagorchestes conspicillatus*) were also recorded. For each observation, notes were made on the species, the number of birds in the group, the habitat the birds were observed in, the soil type and the location in eastings and northings.

3 Results

The size of each search area ranged from 40500 to 148000m² (Table 1). The total area searched was 812700m², or 0.81km².

Three species of birds were recorded during the surveys: the White-winged Fairy-wren, Singing Honeyeater and Spinifex-bird (Table 2). The survey data for each species are presented in Appendix 1, and each species is discussed separately below.

Table 2. The number, the mean group size and density of the three bird species recorded during surveys 22nd – 24th October 2004.

Species	Number of records	Number of birds	Mean group size \pm SD	Density (birds/km ²)
White-winged Fairy-wren <i>Malurus leucopterus edouardi</i>	23	85	3.7 \pm 1.6	104.6
Singing Honeyeater <i>Lichenostomus virescens</i>	6	9	1.5 \pm 0.8	11.1
Spinifex-bird <i>Eremiornis carteri</i>	26	27	1.0 \pm 0.2	33.2

3.1 White-winged Fairy-wren

The White-winged Fairy-wren was observed on 23 occasions during the searches, with a total of 85 individual birds counted (Table 2). As the area of the proposed Gorgon development is 3 km², the number of White-winged Fairy-wrens in the entire development area is probably about 315 birds.

The density of White-winged Fairy-wrens was the highest of the three bird species observed; almost three times greater than the density of Spinifex-birds and almost 10 times greater than the density of Singing Honeyeaters. The mean group size of White-winged Fairy-wrens was 3.6 birds per group, which was larger than both the Singing Honeyeater and Spinifex-bird. The maximum number of White-winged Fairy-wrens recorded in a group was eight (Appendix 1).

The vegetation in the survey areas generally consisted of mixed *Triodia* species with scattered clumps of *Acacia bivenosa* and scattered clumps of *M. cardiophylla*. In 87% of White-winged Fairy-wren records, the habitat contained myrtaceous shrubs, and in 44% of records the habitat contained *A. bivenosa*. In 30% of records both *Melaleuca* shrubs and *A. bivenosa* were present.

White-winged Fairy-wren habitat is found over about 89.26 km² or approximately 40% of the island. The density of birds found in this study (Table 2) can be used to estimate the number of birds found in this habitat across the whole island, giving a figure of about 9336 birds.

3.2 Singing Honeyeater

The Singing Honeyeater, *Lichenostomus vireescens*, was the least common bird observed, with a total of only nine birds recorded during surveys (Table 2). Consequently, the density of the Singing Honeyeater was very low compared with the other species observed. The Singing Honeyeater was usually recorded in association with *A. bivenosa* when habitat type was recorded (Appendix 1).

3.3 Spinifex-bird

The Spinifex-bird, *Eremiornis carteri*, was usually observed as single birds rather than in groups (Table 2). This species was three times more abundant than the Singing Honeyeater, but only about a third as abundant as the White-winged Fairy-wren. Of the 18 records where habitat was recorded, 39% of records were in habitats containing *M. cardiophylla* and 44% of records were in habitats containing *A. bivenosa*.

4 Discussion

Johnstone and Storr (2004) state that the White-winged Fairy-wren is moderately common to common on Barrow Island, and is one of the most abundant birds on the island. This bird has an estimated Island population of 8 150 (Sedgwick 1978) to 7 519 (Pruett-Jones & O'Donnell unpubl.). The results of this study suggest that the White-winged Fairy-wren is also the most abundant bird in the proposed development area. Development of the proposed area will result in the loss of about 315 White-winged Fairy-wrens or approximately 3-4% of the islands population.

Groups of White-winged Fairy-wrens appeared to be associated with clumps of *M. cardiophylla* or *A. bivenosa*. These shrubs may provide favoured areas of dense shelter

for roosting and nesting. *Acacia bivenosa* may also provide higher perches from which to scan the surrounding landscape for danger. When re-vegetation is carried out in the future, it will be important to include *M. cardiophylla* and *A. bivenosa* as these are important elements of White-winged Fairy-wren habitat.

5 References

Johnstone, R.E. & Storr, G.M. (2004). *Handbook of Western Australian Birds. Volume 2: Passerines (Blue-winged Pitta to Goldfinch)*. Western Australian Museum, Perth.

Appendix 1. Observations of the (a.) White-winged Fairy-wren, (b.) Singing Honeyeater and (c.) Spinifex-bird in search areas 22nd – 24th October 2004.

a. White-winged Fairy-wren

Search area	Number of birds	Easting	Northing	Vegetation description	Soil
1	3	338669 E	7700673 N	Mixed <i>Triodia</i> with <i>M. cardiophylla</i> & <i>A. bivenosa</i>	Loam no exposed limestone
1	4	339008 E	7700578 N	<i>M. cardiophylla</i>	Rise with exposed limestone
2	1	339366 E	7700575 N	<i>Acacia coriacea</i> in <i>Triodia wiseana</i> with <i>M. cardiophylla</i> & <i>A. bivenosa</i>	-
2	3	338565 E	7700496 N	<i>Triodia wiseana</i> & myrtaceous shrub (20% cover)	Red loam, exposed limestone on lower slope
2	3	339300 E	7700520 N	Mixed <i>Triodia</i> with 15% mixed <i>A. bivenosa</i> & <i>M. cardiophylla</i>	Loam, no exposed limestone
2	4	338382 E	7700596 N	<i>M. cardiophylla</i>	Limestone ridge
2	6	338274 E	7700576 N	<i>M. cardiophylla</i> with mixed <i>Triodia</i>	Limestone ridge
3	2	338408 E	7700085 N	Mixed <i>Triodia</i> with <i>M. cardiophylla</i> & <i>A. bivenosa</i>	Red loam over limestone lower slopes
3	8	338308 E	7700085 N	Mixed <i>Triodia</i> with myrtaceous shrub & <i>A. bivenosa</i>	Red loam over limestone lower slopes
4	4	339152 E	7700180 N	<i>A. bivenosa</i> over <i>Triodia</i> sp.	Loam, no exposed limestone
4	4	338868 E	7700152 N	Mixed <i>Triodia</i> with <i>A. bivenosa</i>	-
4	5	338496 E	7700222 N	Myrtaceous shrub over <i>Triodia</i>	Loam no exposed limestone
5	2	338219 E	7700210 N	<i>M. cardiophylla</i> with <i>Triodia</i> sp.	Loam no exposed limestone

5	3	339129 E	7700197 N	<i>Acacia bivenosa</i> and <i>M. cardiophylla</i> over <i>Triodia</i> sp.	Loam no exposed limestone
5	3	339006 E	7700175 N	<i>M. cardiophylla</i> with <i>Triodia</i> sp.	Loam no exposed limestone
5	3	338123 E	7700165 N	<i>M. cardiophylla</i> with <i>Triodia</i> sp.	Exposed Limestone
5	3	337962 E	7700170 N	<i>M. cardiophylla</i> with <i>Triodia</i> sp.	Exposed Limestone
5	3	338756 E	7700285 N	<i>Triodia angusta</i> with <i>M. cardiophylla</i> (15% cover)	Red loam
5	3	338756 E	7700285 N	Mixed <i>Triodia</i> with 15% <i>M. cardiophylla</i> .	Red loam
5	6	338676 E	7700298 N	Mixed <i>Triodia</i> with <i>M. cardiophylla</i> (15%)	Loam with some exposed limestone
5	6	338676 E	7700298 N	Mixed <i>Triodia</i> with 15% <i>M. cardiophylla</i> .	Low limestone rise
6	3	338957 E	7700270 N	Mixed <i>Triodia</i> with mixed <i>M. cardiophylla</i> & <i>Acacia</i> sp. (15%)	Sandy Loam plain
7	3	339812 E	7700398 N	<i>Acacia coriacea</i>	sand

b. Singing Honeyeater

Search area	Number of birds	Easting	Northing	Vegetation description	Soil
1	1	339104 E	7700601 N	-	-
1	2	338762 E	7700689 N	Mixed <i>triodia</i> with <i>A. bivenosa</i> (10%cover)	Red loam, no exposed limestone
1	3	339242 E	7700595 N	<i>A. coriacea</i>	-
2	1	338703 E	7700610 N	<i>M. cardiophylla</i> with <i>A. bivenosa</i>	-
3	1	338938 E	7699997 N	<i>A. bivenosa</i> over <i>Triodia</i> sp.	-
4	1	339024 E	7700211 N	<i>A. bivenosa</i> over <i>Triodia</i> sp.	Exposed Limestone

c. Spinifex-bird

Searcharea	Number of birds	Easting	Northing	Vegetation description	Soil
1	1	339056 E	7700700 N	Mixed <i>Triodia</i> with 5% <i>A. bivenosa</i>	Red loam
1	1	338834 E	7700684 N	Mixed <i>Triodia</i> with <i>A. bivenosa</i> & <i>M. cardiophylla</i> (shrub cover 5%)	Red loam with some exposed limestone
1	1	338840 E	7700595 N	<i>M. cardiophylla</i> .	Exposed Limestone
1	1	338518 E	7700591 N	<i>Triodia</i>	Red sandy loam
1	1	338744 E	7700646 N	<i>T. angusta</i>	Low limestone rise
2	1	338400 E	7700470 N	-	-
2	1	338382 E	7700596 N	<i>M. cardiophylla</i>	Limestone ridge
3	1	339124 E	7700000 N	<i>A. bivenosa</i> over <i>Triodia</i> sp.	
3	1	338274 E	7700001 N	<i>M. cardiophylla</i>	Limestone ridge
3	1	338630 E	7700075 N	<i>Triodia angusta</i> with <i>Hakea chordophylla</i> and mixed <i>Acacia</i>	-
3	1	3391114 E	7700066 N	-	-
3	1	338913 E	7700059 N	-	-
3	1	338697 E	7700045 N	-	-
3	1	338638 E	7700025 N	-	-
5	1	338525 E	7700209 N	<i>M. cardiophylla</i> with <i>Triodia</i> sp.	Loam no exposed limestone
5	1	338123 E	7700165 N	<i>M. cardiophylla</i> with <i>Triodia</i> sp.	Exposed Limestone

5	1	338438 E	7700262 N	<i>M. cardiophylla</i> over <i>Triodia wiseana</i>	-
5	1	339145 E	7700241 N	-	-
6	1	338317 E	7700255 N	-	-
6	1	338927 E	7700400 N	<i>A. bivenosa</i>	Loam
7	1	339432 E	7700398 N	<i>A. bivenosa</i>	Loam
7	1	339477 E	7700426 N	<i>T. angusta</i> with <i>A. bivenosa</i>	-
7	1	339618 E	7700453 N	-	-
8	1	339752 E	7700552 N	<i>A. coriacea</i>	Sand
8	1	339780 E	7700510 N	<i>T. angusta</i> with 15% <i>A. bivenosa</i>	Sandy Loam plain
8	2	339560 E	7700549 N	<i>T. wiseana</i> with <i>A. bivenosa</i>	Low rise with limestone exposed

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