

The avifauna of Cartier Island Commonwealth Marine Reserve, north-western Australia

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Abstract. Cartier Island and the surrounding reef is an isolated Australian Territory situated in the Timor Sea. Little is known about the avifauna of the reef system and the adjacent waters. Here we summarise all known ornithological records from the Island and detail the results of twice-annual bird surveys conducted within the Cartier Island Commonwealth Marine Reserve between 2010 and 2014. By the conclusion of the surveys, a total of 34 bird species had been recorded within the Reserve. The Crested Tern *Thalasseus bergii* was shown to breed on the Island in small numbers. Several additional species of seabird and small numbers of shorebirds are regular visitors. Most other species occur as occasional visitors or vagrants.

Introduction

Cartier Reef is situated at 12°32'S, 123°33'E in the Timor Sea at the eastern extremity of the Indian Ocean ~190 km south-east of the Indonesian island of Roti and ~290 km north-west of the Kimberley coastline of Australia (Figure 1). The nearest neighbouring islands are at Ashmore Reef ~52 km to the north-west. Collectively the area is known as the Ashmore Region. Cartier Reef has an elliptical boundary and is ~4.6 km long and 2.3 km wide. Cartier Island is a small uninhabited island within the reef and consists of coarse grit and coral rubble and rises 1–2 m above the high-tide line. In April 2010, Cartier Island had a total land area of 2.1 ha measured at the high-tide line using a handheld GPS (RHC unpubl. data). There is evidence that the entire island can be wave-washed following gales and cyclonic events. Although shifting sands result in regular, small changes to both the size and shape of the Island (Russell *et al.* 1993), the position of the Island within the reef is stable as it is 'anchored' by a small platform of permanent beach rock at its south-western end. The island, reef and adjacent waters are protected legally by Cartier Island Commonwealth Marine Reserve, which has a circular boundary that extends in a 4-nM radius from Cartier Island (172 km²).

Propagules of various plants are cast ashore with some regularity, yet there is no extant vegetation on Cartier Island and this appears to have long been the case (Russell *et al.* 1993; Pike & Leach 1997). A low dune ridge (<1 m high) encircles the rim of the Island and here large numbers of Green Turtles *Chelonia mydas* nest (Guinea 1993). In its centre, the Island consists of a relatively flat basin of compacted sand, which appears to be used infrequently by nesting turtles (RHC pers. obs.). Nevertheless, because of the Island's small size and the large numbers of breeding turtles, almost all surface substrate is regularly disturbed by the activities of turtles when they haul ashore.

During high tides, the Island provides the only available land within this particular reef for roosting birds. At lower tides, reef-flats provide additional resting and foraging substrates for species such as egrets and shorebirds.

History of human visitation in the Ashmore Region

A history of human visitation in the Ashmore Region is presented in Russell (2005). What follows is a condensed history, of relevance to the avifauna in the region especially as it relates to anthropogenic pressures on breeding seabirds at Ashmore Reef (a likely source of visiting seabirds to Cartier Reef), and legislation that has played a role in the management of the region. Ashmore Reef, and by inference Cartier Reef, were known to Indonesian fishers as early as the first half of the 18th century, with regular visits beginning sometime between 1725 and 1750 (Fox 1977; Russell 2005). The first recorded European discovery of Cartier Reef was in 1800 by Captain Nash aboard the ship *Cartier*, and nearby Ashmore Reef was discovered 11 years later (King 1827). American whalers began operating in the area in the 1850s and, with the discovery of guano deposits on the islands at Ashmore Reef, phosphate mining began in the latter half of the 19th century. Britain annexed Ashmore Reef in 1878. As Cartier Reef was of perceived lower value, it was not annexed until 1909 (Langdon 1966). Guano deposits were exhausted at Ashmore by 1891 and, with a decline in European activity in the region, Indonesian fishers are said to have resumed visits to the islands in the following years (Langdon 1966). In 1931, Britain placed Ashmore and Cartier Islands under the authority of the Commonwealth of Australia and this passed through the Australian Parliament as the *Ashmore and Cartier Islands Acceptance Bill* in 1934 (Russell 2005). Both areas were under the control of the Administrator of the Northern Territory before responsibility was transferred to the Commonwealth of Australia when self-government was instituted in the Northern Territory in 1978. During the Second World War, the territory was visited regularly by the Australian Navy, and Cartier Island was used as a bombing and air weapons range for defence training. The use of Cartier Reef for this purpose ceased sometime before the 1980s, and in 1986 a clearance operation was conducted to remove any obvious unexploded ordinance from the Island and surrounding reef-flats. In 2000, the Cartier Island Marine Reserve was established under the

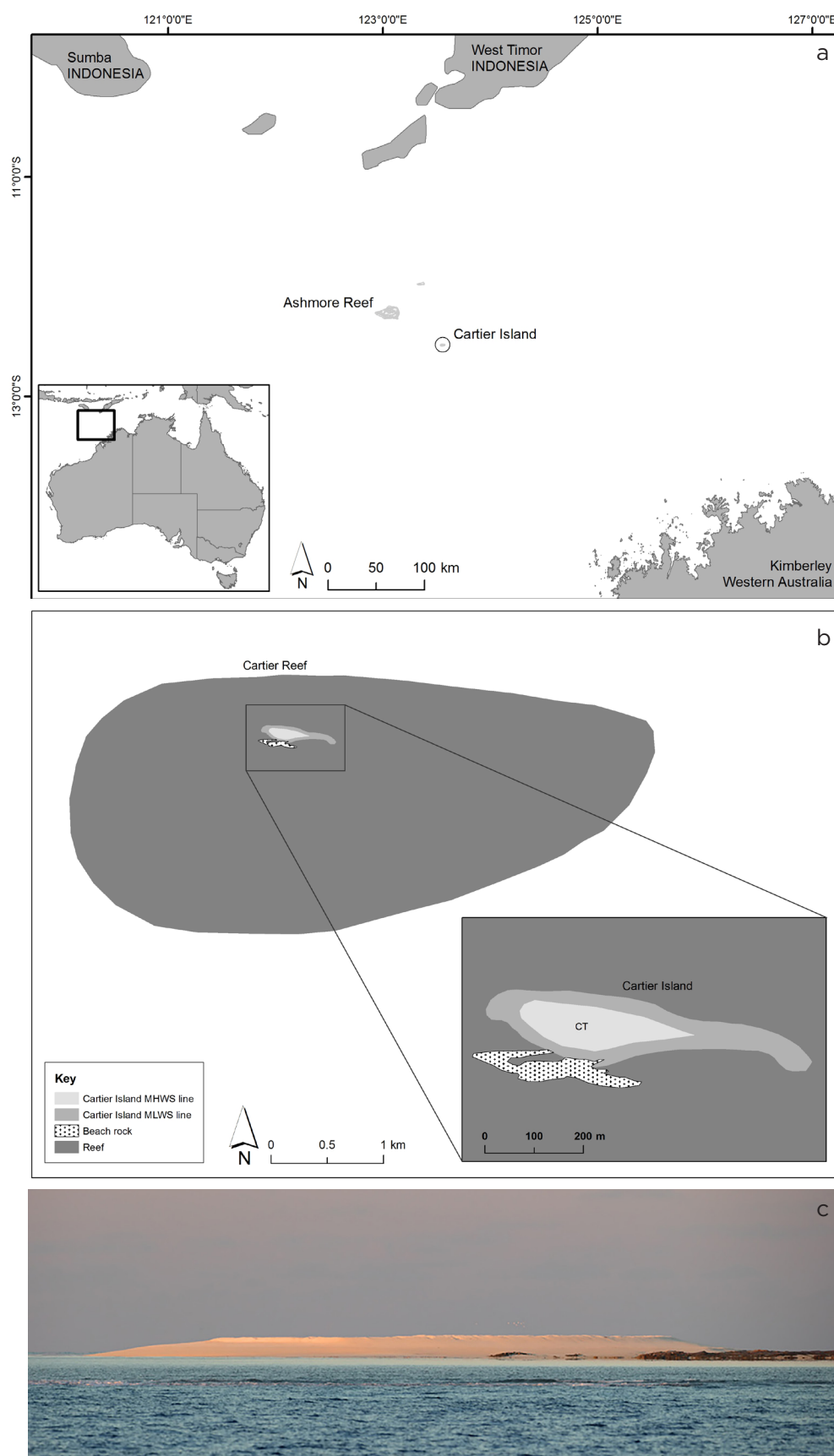


Figure 1. (a) Map of the Timor Sea showing the position of Cartier Island relative to Ashmore Reef, the Australian mainland and Indonesia. The circle around Cartier Island indicates the 4-nM boundary of the Cartier Reef Commonwealth Marine Reserve. (b) Map of Cartier Reef showing the reef, Cartier Island mean high-water spring-tide line and mean low-water spring-tide line, and beach rock to the south-west of the Island. Location of the Crested Tern breeding colony on Cartier Island is represented as CT on inset map. (c) Cartier Island and Cartier Reef, including exposed rock at low tide when viewed from a vessel off the south-western edge of the fringing reef, April 2014. Photo: Rohan H. Clarke

Commonwealth *National Parks and Wildlife Conservation Act 1975*. Its name subsequently changed to the Cartier Island Commonwealth Marine Reserve (CICMR). The area is currently reserved under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and forms part of the North-west Commonwealth Marine Reserves Network (Cochrane 2016). The reef remained a gazetted, but unused, Defence Practice Area until 2011. In recent times, it is apparent that Indonesian fishers have maintained occasional visits to Cartier Reef and landings at Cartier Island: the grave of an Indonesian fisher who was buried there in the early 2000s remains a prominent feature on the otherwise barren island (RHC pers. obs.).

Ornithological observations

Cartier Reef is infrequently visited by birdwatchers and ornithologists. The first report of an ornithological nature was by Serventy (1952). Although he did not land on the Island when he visited in October 1949, he noted Pacific Reef Heron, Lesser Frigatebird, Brown Booby, Crested Tern and probable Sooty Tern (Scientific names of all species are presented in Appendix 1 and follow Gill & Donsker 2016) as being present at Cartier Reef. No doubt because of the use of the reef as a bombing range, and the associated restricted access, there were just four further visits up to 2010 where ornithological observations have been reported. Two visits occurred in the early 1990s (March 1990 and May 1992), when six species of seabird and shorebird were observed on each landing (Guinea 1993). Subsequent landings were made by MJC in October 1996 and by GS in January 2002. These later visits documented similar species richness and added two further species to the CICMR list (Table 1).

Following the *Montara* oil spill in August–October 2009, RHC and others were engaged to conduct surveys of seabirds and shorebirds at several islands in the Browse and Bonaparte Basins (Clarke 2010). Cartier Reef and Cartier Island were included in surveys at the request of the then Department of the Environment, Water, Heritage and the Arts. Although this area was expected to support relatively few birds, the anticipated benefits of these surveys were twofold. First, it provided opportunity to rigorously document the avifauna at Cartier Reef during repeat visits and compare these results with previous opportunistic surveys. Secondly, it presented an opportunity to establish a baseline of bird occurrence gathered in a standardised fashion against which future change may be assessed. Here we summarise the results of those surveys and place these records in context with past ornithological observations at Cartier Reef.

Methods

Cartier Reef and Cartier Island were visited over 1–2 days via a live-aboard vessel in April and November of each year from 2010 to 2014 ($n = 10$ surveys). Surveys were timed to coincide with known peaks in breeding activity of seabirds (mostly egg laying and incubation) at nearby Ashmore Reef (April surveys; Clarke 2010), and at a time when migratory shorebird numbers are stable around an annual upper limit, having largely completed southbound migration from the Northern Hemisphere (November surveys; Rogers *et*

al. 2011). During each visit, a single landing by the survey team consisting of two–six experienced ornithologists was made on Cartier Island. All birds present were identified to species and counted, a traverse around the Island was made at the high-tide mark and the centre of the Island was inspected for evidence of seabird breeding. The presence of any dead birds was also noted; as seabird carcasses degrade relatively rapidly in this tropical setting (RHC pers. obs.), return visits at 6-monthly intervals did not detect previously counted dead birds. The survey team was typically ashore on Cartier Island for 1–2 hours. Given that the Island measures just 2.1 ha, even when tidal flats were exposed, our survey of birds was exhaustive (i.e. it is very unlikely that any birds were missed). Sometimes the vessel remained at anchor overnight just beyond the fringing reef and any incidental observations of birds made during this time are referred to in the annotated species list (Appendix 1).

When travelling to and from Cartier Reef, a constant watch was maintained from the bow of the vessel by one or more observers. Average vessel speed was 8–9 knots. Observers were positioned 2–3 m above the sea surface. A GPS-equipped personal digital assistant, loaded with dedicated software, was used to log the vessel's location every 30 seconds during survey transects and to log each individual seabird observation, including species, count, date, time and GPS co-ordinates; and weather and sea conditions.

Results

Cartier Island

Documented landings on Cartier Island and visits to Cartier Reef where ornithological observations have been made total just 15 visits over a c. 65-year period. Standardised surveys between April 2010 and November 2014 recorded between five and 12 species per visit and saw the addition of 18 species to the CICMR list (Tables 1 and 2). The only land birds that were seen ashore were up to three Sacred Kingfishers, and they were feeding mainly from tidal rock pools. Three other species (Pacific Swift, Rainbow Bee-eater and a martin) were seen flying over the sea nearby (Appendix 1).

When all surveys are combined, it is apparent that several species, including the Pacific Reef Heron, Brown Booby, Ruddy Turnstone and Crested Tern, are regular visitors to Cartier Island and Cartier Reef. Evidence of past breeding by the Crested Tern was detected on five visits. No other bird species have been detected breeding. The majority of species now recorded within the Reserve are best categorised as occasional visitors or vagrants (Table 1, Appendix 1).

Marine waters of Cartier Island Commonwealth Marine Reserve

A total of 89.0 km of shipboard transects was completed within the Cartier Island Commonwealth Marine Reserve (CICMR) (i.e. within a 4-nM radius of Cartier Island) during 10 surveys conducted in 2010–2014. Survey effort varied between visits (range 1.65–16.42 km of transects per survey) because of occasional weather conditions that made it unsuitable to conduct surveys and some night-time

Table 1. Counts of all birds recorded inside the fringing reef at Cartier Reef, north-western Australia, 1949–2014. nc = the species was present on the reef but not specifically counted, D = dead.

Date	Oct. 1949	Mar. 1990	May 1992	Oct. 1996	Jan. 2002	Apr. 2010	Nov. 2010	Apr. 2011	Nov. 2011	Apr. 2012	Nov. 2012	Apr. 2013	Nov. 2013	Apr. 2014	Nov. 2014
Source	Serventy (1952)	Guinea (1993)	Guinea (1993)	Clarke (2010)	Clarke (2010)	This study	This study	This study	This study	This study	This study	This study	This study	This study	This study
Wedge-tailed Shearwater			nc							(1D)					
Little Egret					1										
Pacific Reef Heron	3	6	15			14	6	17	3	9	5	23	2	15	1
Australian Pelican							1								
Lesser Frigatebird	1		6	2	3	1	1							1	
Brown Booby	6	3	nc					17		1	5	3	1		6
Little Pied Cormorant							(1D)								
Australasian Darter											(2D)				
Black-winged Stilt		1					1								
Pacific Golden Plover									1		1		2		
Lesser Sand Plover		1													
Greater Sand Plover							1								1
Whimbrel						3									1
Common Greenshank				1					1						
Grey-tailed Tattler							1				1				3
Ruddy Turnstone		24	15		24	8	46	26	44	19	38	36	14		
Sanderling											1		4		
Red-necked Stint								2		1					
Oriental Pratincole									1						
Common Noddy						1			(1D)	(2D)			2 (+ 3D)	3 (+1D)	
Crested Tern	2	200+	50	400	85	165 ^a	(61D)	290	1 (+ 2D)	322	4 (+20D) ^b	109	13 (4D) ^c	335	3
Bridled Tern								1	1					(4D)	
Sooty Tern	2			3	2		1	20	3	5					5
Common Tern							2		1			1			
White-winged Tern							1		3						
Pacific Swift								~40							
Sacred Kingfisher		1		1								1			3
Rainbow Bee-eater						6		1							
Fairy Martin				[1] ^d											

^a5 old nests were also present, ^b365 old nests were also present, and ^c134 old nests were also present; ^dspecific identification is questioned (see text).

travel. A total of nine seabird species was recorded during these surveys, with the Brown Booby and Sooty Tern being the most frequently encountered species. Flocks of 24 and six migratory Rainbow Bee-eaters were also noted flying north over the sea in April 2011 and 2012 respectively (Appendix 1).

Discussion

A total of 34 species of birds has been recorded from the Cartier Island Commonwealth Marine Reserve. Most species occur as occasional visitors or as overflying trans-Timor Sea migrants. Small numbers of seabirds including

Table 2. Counts of all birds recorded during shipboard transects within Cartier Island Commonwealth Marine Reserve, north-western Australia, between April 2010 and November 2014. Dates are given as month, year.

Date	4.2010	11.2010	4.2011	11.2011	4.2012	11.2012	4.2013	11.2013	4.2014	11.2014	Total
Length of shipboard transects (km)	10.36	13.91	12.24	16.42	4.78	10.82	6.25	6.47	6.08	1.65	88.98
Bulwer's Petrel	2										2
Streaked Shearwater			3								3
Brown Booby	1	1	2			2	4			1	11
Lesser Frigatebird									1		1
Frigatebird sp.				1							1
Common Noddy	2										2
Crested Tern	1		2	5			2		3		13
Sooty Tern	4	18	5	1		10	2				40
Bridled Tern			1								1
Bridled/Sooty Tern	2					12			66		80
White-winged Tern		1		1							2
Rainbow Bee-eater			24								24

species that breed at nearby Ashmore Reef (e.g. Wedge-tailed Shearwater, Brown Booby, Common Noddy, Crested Tern and Sooty Tern), as well as migrant species from the Northern Hemisphere (e.g. Streaked Shearwater, Bulwer's Petrel and White-winged Tern) have been detected in the offshore waters of the Reserve.

The rarity of land birds is in marked contrast with Ashmore Reef, where cuckoos and many species of passerines occur as vagrants or regular visitors mainly to the vegetation on West Island (e.g. Clarke *et al.* 2009; Carter *et al.* 2011). Some of these species can be expected to make brief landings on Cartier Island, but the absence of vegetated habitat means that they will not stay long, reducing the probability of detection.

Surveys and review of previous avian records demonstrate that although the exposed reef-flats and island provide an important feeding area and roost-site for small numbers of shorebirds, herons and seabirds, these areas do not support internationally significant numbers of any species (e.g. Bamford *et al.* 2008). Surveys in marine areas are less conclusive given the limited coverage achieved to date (~89 km of at-sea transects). These surveys do, however, demonstrate the regular occurrence of some seabird species in surrounding waters. Given the proximity of the CICMR to Ashmore Reef, where internationally significant numbers of many seabird species breed (Clarke *et al.* 2011), a precautionary approach would be to regard the waters of the CICMR as important foraging grounds for seabirds that frequent the Ashmore Reef Region unless proven otherwise. In support of this position is that tracking studies of four large breeding seabird species at Ashmore Reef (Red-tailed Tropicbird, Great Frigatebird, Lesser Frigatebird and Red-footed Booby) demonstrate that individuals of all four species breeding on Ashmore Reef have crossed into CICMR waters on one or more occasions (Mott *et al.* 2017; RHC unpubl. data).

Cartier Island is one of the most infrequently visited land areas in Australian territory. Access is by permit only, and requires the use of a live-aboard vessel and a 1–2-day voyage from the nearest major ports, Darwin in

the Northern Territory or Broome in Western Australia. Regular access by traditional Indonesian fishers also appears infrequent. Although traditional Indonesian *prahus* do visit on occasion [e.g. Berry (1993) noted three present at the reef in September 1986], no such vessels were observed at the reef during the 10 surveys documented here (RHC & AH pers. obs.). In this context, anthropogenic threats to the avifauna that frequent the CICMR differ from those at many other sites. For instance, threats associated with the presence of visitors, including direct disturbance to roosting birds and illegal taking of Crested Tern eggs and chicks, are likely to be negligible. Similarly, potential source points for pollution of a terrestrial origin are limited, and commercial fishing operations are currently at very low intensities in the Ashmore Region (United Nations Environment Programme 2013; Department of Fisheries Western Australia 2015). Broad-scale threats that remain include marine oil spills (as demonstrated by the *Montara* oil spill) and interactions between seabirds and marine debris (especially plastics: e.g. Lavers *et al.* 2013). Cartier Reef is also likely to be susceptible to the effects of climate change both through coral-bleaching events (e.g. Ceccarelli *et al.* 2011) and rising sea-levels (Church & White 2006) that have the potential to modify or indeed remove Cartier Island in the future. Despite the relatively low species richness and low abundance of birds utilising Cartier Reef, the surveys documented here provide a valuable baseline against which the effects of future impact or change may be assessed.

Acknowledgements

Vessel support was provided by Unreel Adventure Safaris, Diversity Charter Company and Great Escape Charter Company, and crews are thanked for their professional support. Shane Baylis, Adrian Boyle, Juliana Coffey, Amanda Lilleyman, and Alistair Stewart are acknowledged for their assistance in the field. We are grateful to Russell Palmer whose feedback improved the manuscript. All research was conducted under Monash University Animal Ethics (BSCI/2010/08) and Wildlife Research (110217-01) permits. Permission to visit Cartier Island was provided by Parks Australia. Funding was provided by PTTEP Australia.

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Received 16 April 2016, accepted 12 October 2016,
published online 2 February 2017



Appendix 1. Annotated list of bird species recorded on Cartier Island and Cartier Reef in the Cartier Island Commonwealth Marine Reserve (CICMR).

Streaked Shearwater *Calonectris leucomelas*. Visitor to waters of CICMR. A common non-breeding visitor to the Browse and Bonaparte Basins (Lavers *et al.* 2014), three individuals were detected within the Reserve during shipboard surveys in April 2011.

Wedge-tailed Shearwater *Ardenna pacifica*. Visitor to waters of CICMR. Although ~40 pairs breed at nearby Ashmore Reef (Clarke *et al.* 2011), there are only two records from within the Reserve: an observation of an unspecified number in May 1992 (Guinea 1993) and the desiccated remains of a single bird on Cartier Island in April 2012.

Bulwer's Petrel *Bulweria bulwerii*. Visitor to waters of CICMR. Two individuals were detected within the boundary of the CICMR during shipboard surveys in April 2010. Another individual was observed in flight 1–2 km outside of the reef fringe while the vessel was at anchor in April 2011. This species occurs mostly over waters >200 m in depth in the region (Lavers *et al.* 2014).

Red-tailed Tropicbird *Phaethon rubricauda*. Visitor to waters of CICMR. One GPS-tracked individual that originated from Ashmore Reef was recorded overflying the Reserve in April 2014 (RHC, AH unpubl. data).

Little Egret *Egretta garzetta*. Vagrant to land and intertidal areas of CICMR. A single bird was recorded on the reef-flats in January 2002. This species is present year-round in small numbers at Ashmore Reef (Clarke *et al.* 2011), so occasional visits to Cartier Reef are not surprising.

Pacific Reef Heron *Egretta sacra*. Visitor to land and intertidal areas of CICMR. Present during most surveys, with 1–23 individuals being counted. On average, white-morph individuals outnumber grey-morph individuals 3:1 (data from all surveys combined). The species is a common breeding resident at Ashmore Reef where it nests in shrubs and on the ground amongst ephemeral herbs (Clarke *et al.* 2011), but to date there is no evidence of breeding at Cartier Island.

Australian Pelican *Pelecanus conspicillatus*. Vagrant to land and intertidal areas of CICMR. A single adult was present at the reef in November 2010.

Great Frigatebird *Fregata minor*. Visitor to waters of CICMR. One GPS-tracked individual that originated from Ashmore Reef was recorded overflying the Reserve in April 2014 (Mott *et al.* 2017).

Lesser Frigatebird *Fregata ariel*. Visitor to waters of CICMR. Small numbers reported on most visits to the Reserve. Individuals were mostly observed in flight, though a single adult female was observed perched on a large piece of driftwood that projected from the sand on Cartier Island in April 2014. At least three GPS-tracked individuals (all from April 2014) that originated from Ashmore Reef were recorded overflying the Reserve (Mott *et al.* 2017).

Red-footed Booby *Sula sula*. Visitor to waters of CICMR. One GPS-tracked individual that originated from Ashmore Reef was recorded overflying the Reserve in September 2013 (RHC unpubl. data).

Brown Booby *Sula leucogaster*. Visitor to all areas of CICMR. Small numbers were present within the Reserve on most visits. Generally observed flying over offshore waters or the fringing reef, with occasional birds perched on the exposed reef platform or the shoreline of Cartier Island.

Little Pied Cormorant *Microcarbo melanoleucos*. Vagrant to land and intertidal areas of CICMR. The desiccated remains of a single individual were present on Cartier Island in November 2010.

Australasian Darter *Anhinga novaehollandiae*. Vagrant to land and intertidal areas of CICMR. The desiccated remains of two individuals were present on Cartier Island in November 2012.

Black-winged Stilt *Himantopus himantopus*. Visitor to land and intertidal areas of CICMR. Single individuals were reported in March 1990 and November 2010 from the shoreline of Cartier Island. Observations at Ashmore Reef indicate that small numbers of this species move through the Ashmore Region regularly (authors' unpubl. data).

Pacific Golden Plover *Pluvialis fulva*. Visitor to land and intertidal areas of CICMR. One–two birds were recorded on three separate occasions on the shoreline of Cartier Island. The species is common at nearby Ashmore Reef (Clarke 2010; Rogers *et al.* 2011).

Lesser Sand Plover *Charadrius mongolus*. Visitor to land and intertidal areas of CICMR. A single individual was recorded in March 1990 (Guinea 1993). Small numbers (10–50) occur annually at nearby Ashmore Reef (Clarke 2010; Rogers *et al.* 2011).

Greater Sand Plover *Charadrius leschenaultii*. Visitor to land and intertidal areas of CICMR. Single individuals were recorded in November 2010 and November 2014 on the shoreline of the Island. Large numbers (up to 2559) occur annually at nearby Ashmore Reef (Clarke 2010; Rogers *et al.* 2011).

Whimbrel *Numenius phaeopus*. Visitor to land and intertidal areas of CICMR. There were three individuals in April 2010 and a single individual in November 2014 on the shoreline of the Island. There are usually 200–300 present at Ashmore Reef during summer shorebird counts (authors' unpubl. data).

Common Greenshank *Tringa nebularia*. Visitor to land and intertidal areas of CICMR. Singles in October 1996 and November 2011 on the shoreline of the Island. There are usually 200–300 present at Ashmore Reef during summer shorebird counts (authors' unpubl. data).

Grey-tailed Tattler *Tringa brevipes*. Visitor to land and intertidal areas of CICMR, being observed on the beach rock. One–three were recorded on Cartier Island on three occasions. Numbers usually exceed 1000 at Ashmore Reef during summer shorebird counts (authors' unpubl. data).

Ruddy Turnstone *Arenaria interpres*. Visitor to land and intertidal areas of CICMR, typically being observed on the rock platform or adjacent exposed beach. A regular visitor with small numbers apparently 'over-summering' in most years. The species was detected during 73% of visits, with flock size varying between eight and 46 individuals. Since 2010, numbers have exceeded 1000 individuals at Ashmore Reef during summer shorebird counts (authors' unpubl. data).

Sanderling *Calidris alba*. Visitor to land and intertidal areas of CICMR. There was a single individual in November 2012 and four individuals in November 2013 along the shoreline of the Island. More than 700 are regularly present at nearby Ashmore Reef (Clarke 2010; Rogers *et al.* 2011).

Red-necked Stint *Calidris ruficollis*. Visitor to land and intertidal areas of CICMR, being observed on the exposed beach rock. One or two individuals were present in November 2011 and November 2012. More than 800 are regularly present at nearby Ashmore Reef (Clarke 2010; Rogers *et al.* 2011).

Oriental Pratincole *Glareola maldivarum*. Vagrant to land and intertidal areas of CICMR. Flocks of 100–300 are regularly observed on migration over nearby Ashmore Reef in early November (authors' unpubl. data) and similar numbers are likely to overfly CICMR during their annual migration. Nevertheless, there is no suitable habitat for this grassland-frequenting species at Cartier Island, and the single bird present in November 2011 is best regarded as a vagrant to the land area of the Reserve.

Common Noddy *Anous stolidus*. Visitor to all areas of the CICMR. One–three were occasionally observed on the Island or over adjacent waters within the Reserve. Dead individuals were also regularly encountered on the shoreline of Cartier Island. Up to 70 000 Common Noddies breed at nearby Ashmore Reef during the dry season (Clarke *et al.* 2010), so the small numbers of birds encountered at CICMR suggest that the Ashmore breeding population does not range far.

Crested Tern *Thalasseus bergii*. Breeding visitor to all areas of the CICMR. The only bird species to be recorded during all 15 visits to the Reserve (Table 1): numbers have exceeded 100 individuals on seven of these visits. Evidence of breeding by Crested Terns on Cartier Island was first detected in April 2010 when five Crested Tern eggs were located on coarse grit and coral rubble in the centre of the Island. All eggs were bleached on the upper surface and had dehydrated contents, indicating that the eggs had been abandoned for some time. Further evidence of breeding was detected on four of the subsequent nine surveys: (1) the desiccated remains of 45 runners (a small flightless age-class) and a single desiccated egg in November 2010; (2) a small number of broken eggs in November 2011; (3) 365 old nests (visible scrapes made obvious by the build-up of guano), along with 20 dead runners in November 2012; and (4) 134 old nests in November 2013.

Bridled Tern *Onychoprion anaethetus*. Visitor to all areas of CICMR. Single individuals were observed at Cartier Island or at sea within the Reserve on several occasions. The remains of four beach-cast individuals were present on the Island in April 2014. Small numbers breed at nearby Ashmore Reef, with a maximum count of 377 since 2010 (authors' unpubl. data).

Sooty Tern *Onychoprion fuscatus*. Visitor to all areas of CICMR. Commonly encountered at Cartier Island and in surrounding waters of the Reserve, with a maximum count of 20 on the Island. Up to 25 000 have been reported breeding at Ashmore Reef since 2010 (authors' unpubl. data).

Common Tern *Sterna hirundo*. Visitor to all areas of CICMR. One–two were recorded on three occasions on Cartier Island or overflying the fringing reef. A non-breeding migrant from the Northern Hemisphere, small numbers pass through the Ashmore Region annually (authors' unpubl. data).

White-winged Tern *Chlidonias leucopterus*. Visitor to all areas of CICMR. It was recorded in November 2010 and again in November 2011, both during shipboard surveys and surveys of Cartier Island and the fringing reef. A non-breeding migrant from the Northern Hemisphere, small numbers pass through the Ashmore Region annually (authors' unpubl. data).

Pacific Swift *Apus pacificus*. An aerial migrant that overflies CICMR. A flock of ~40 birds passed over the reef fringe and the anchored vessel in April 2011. This observation coincided with the passage of a storm front over the Reserve. The species is a common migrant through the Ashmore Region (authors' unpubl. data).

Sacred Kingfisher *Todiramphus sanctus*. Migrant and visitor to land and intertidal areas of CICMR. One–three individuals were recorded on Cartier Island and exposed beach rock on four separate occasions. The species is a common migrant through the Ashmore Region (authors' unpubl. data).

Rainbow Bee-eater *Merops ornatus*. A migrant that overflies CICMR. A flock of 24 was observed flying north past the vessel in offshore waters of the Reserve in April 2011. A single bird was observed around the anchored vessel adjacent to the reef fringe later that same day. A flock of six was observed flying past the anchored vessel adjacent to the reef fringe in April 2012. Observations at Ashmore Reef demonstrate that significant numbers pass through the Ashmore Region annually (authors' unpubl. data).

Fairy Martin *Petrochelidon ariel*. A possible aerial migrant that overflies CICMR. A single individual was reported in May 1992 (Guinea 1993). This species appears to be rare in the Ashmore region, and the authors are yet to observe it at Ashmore Reef after ~25 visits there, though Milton (2005) listed a record for Ashmore Reef in August 1985. By contrast, the Tree Martin *P. nigricans* is a common annual migrant through the Ashmore Region in small numbers. Because of similarities between the two species, however, it is possible that the CICMR record refers to this latter species.