



A long term view: distribution of small terns (*Sternula*) in Western Australia and implications for their conservation

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ABSTRACT

Recent observations confirm the Indo-Pacific Little Tern *Sternula albifrons sinensis* has been extending its breeding range in Western Australia in recent years, following a pattern documented in other tern and noddy species on the western coast of Australia. Nesting Indo-Pacific Little Terns have been recorded annually as far south as North West Cape since 2016. A similar southward shift in breeding range may have occurred during the last interglacial period and it is hypothesised that Little Terns isolated at the Houtman Abrolhos Islands during the following glacial period gave rise to the Australian Fairy Tern *Sternula nereis nereis*. The Australian Fairy Tern subsequently colonised the continental shelf from Dampier, Western Australia to the south-eastern states and then New Zealand as sea levels rose again during the Holocene. The two former sibling species are now sympatric between Dampier and North West Cape and interbreeding and hybridisation have the potential to occur in that area. Most jurisdictions require populations to be defined at the species or subspecies level in order to be listed and managed as threatened. However, relying on such taxonomic criteria has the potential to obscure the management of threats faced by each inter-breeding population unit. Approaches that identify and protect the sub-structure of superspecies and meta-populations might be more effective in the longer term.

Keywords: breeding range expansion, conservation, Fairy Tern, Little Tern, management units, meta-population, *Sternula*, superspecies complex, range extension, tropicalisation.

Introduction

Tropical terns (Roseate Tern *Sterna dougallii*, Sooty Tern *Onychoprion fuscatus*, Bridled Tern *Onychoprion anaethetus*) and noddies (Common Noddy *Anous stolidus* and Lesser Noddy *Anous tenuirostris*) were well established at the Houtman Abrolhos Islands during the colonial period (most ornithological records in the region commenced from the 1880s), having occupied or re-occupied the islands earlier in the Holocene (Fig. 1; Dunlop *et al.* 2015; Surman 2019). The sub-tropical latitude of these colonies for tropical tern species has been attributed to the influence of the warm, southward flowing Leeuwin Current (Dunlop and Wooller 1990; Surman 2019). Since the beginning of the historical record in Western Australia, there has been a southward shift in the distribution of several tern species – populations, particularly south of the Houtman Abrolhos Islands (Serventy *et al.* 1971; Dunlop and Wooller 1986, 1990). The species include the Bridled Tern (Dunlop 2009), Roseate Tern, (Dunlop and Wooller 1990), Crested Tern *Thalasseus bergii* (Dunlop 1985), Sooty Tern (Dunlop and Mitchell 2001), and Common Noddy (Dunlop 2009). The Lesser Crested Tern is also, purportedly, expanding southwards from northern Australia and is now known to breed as far south as Shark Bay (Burbidge and Fuller 2000; Johnstone *et al.* 2013). The range extensions south of the Houtman Abrolhos Islands since 1900 are likely to have been driven by the marine climate changes of the Anthropocene (Dunlop 2009).

The Little Tern *Sternula albifrons* is a coastal species found on the Australian mainland and surrounding continental islands and two subspecies have been identified in Australia (BirdLife Australia 2019). The Indo-Pacific Little Tern *Sternula albifrons sinensis* consists of

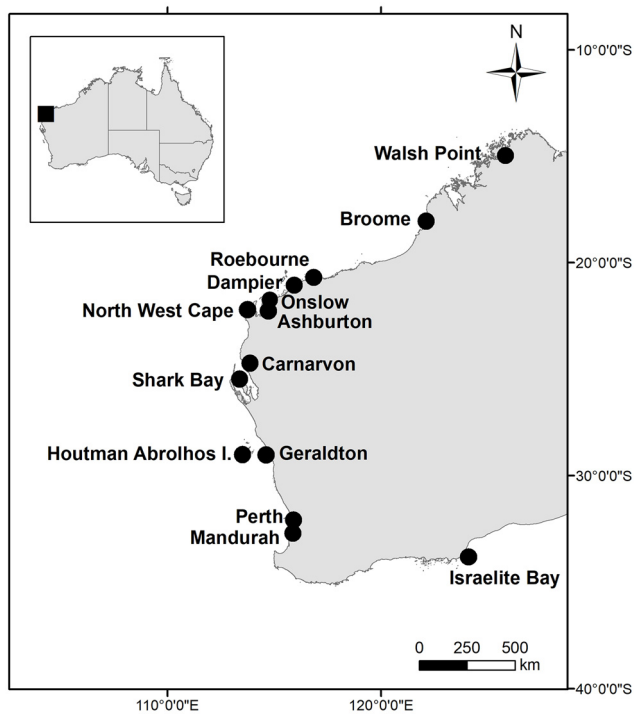


Fig. 1. Map showing localities of breeding and nuptial Little Tern *Sternula albigrons sinensis*. Inset with symbol (■) shows the area between Roebourne and North West Cape, where annual breeding records were made between December 2016 and December 2021.

an Australian breeding population that nests in northern Australia (Garnett *et al.* 2021) and Asian migrants that visit Australia in their non-breeding period during spring and summer (Johnstone and Storr 1998). These non-breeding Little Terns are found around Australia, except between Perth, Western Australia, and Adelaide, South Australia, and are considered vagrants south of Onslow in Western Australia (Higgins and Davies 1996; Collins and Jessop 1997; Johnstone and Storr 1998; Garnett *et al.* 2021). A second subspecies, the Tasman Little Tern *Sternula albigrons placens*, is found in south-eastern Australia and New Zealand (Gochfeld *et al.* 2016; Mahon *et al.* 2021; Department of Agriculture Water and the Environment 2022). This subspecies is, however, not currently universally agreed, with all birds in Australian territory previously considered to belong to *S. a. sinensis* (Department of Agriculture Water and the Environment 2022).

In Western Australia, the first Indo-Pacific Little Tern (hereafter, Little Tern) colonies were recorded near Broome in 1995 and 1996 and represented an important breeding range extension on the western coast (Fig. 1, Collins and Jessop 1997; Johnstone and Storr 1998). Subsequently, breeding Little Terns were recorded on Eighty Mile Beach (~350 km south of Broome), Walsh Point and elsewhere in the Kimberley, where the local breeding population appeared to be increasing, and establishment in the Pilbara

was predicted (Fig. 1, Johnstone and Storr 1998; Johnstone *et al.* 2013). These southern colonies most probably emanated from the spring–summer component of the breeding population that inhabits northern Australian waters (Chatto 2001).

This contribution documents a recent expansion of the breeding range of the Little Tern along the Western Australian coastline and records of Little Terns in nuptial plumage. It also discusses the overlap and relationship with the closely related Australian Fairy Tern *Sternula nereis*, and associated conservation implications.

Results and discussion

Observations

Since 2013, there have been ≥ 57 unique records (excluding breeding records) of Little Terns in breeding plumage, including adults feeding fledglings, on the Western Australian coastline between Dampier and Mandurah (Fig. 1, Table 1). Presumably, these records of nuptial birds made during the Austral summer (including April and May) are individuals from the Australian breeding population (Table 1). It is possible there have been further observations, however, records available from Birddata (BirdLife Australia 2022) and eBird (Cornell Lab of Ornithology 2022) often do provide detail on plumage that would allow sightings to be allocated to breeding or migratory populations.

Since 2016, there have been ≥ 25 known breeding attempts made by Little Terns between Dampier and North West Cape (Table 2), outside the previously reported breeding distribution. Most breeding consisted of a single pair, and several observations were made at the same location over multiple breeding seasons, suggesting a degree of site faithfulness among pairs (Table 2). Between 2019 and 2021, there were three instances where Little Terns nested in small colonies of 2–4 pairs, with nests spaced ~50 m apart (J. Greer, M. Panhuyzen, pers. comm.). In spring 2020, four pairs of Little Terns were observed nesting ~50 m north and south of a small Australian Fairy Tern colony at Jurabi Point, North West Cape (J. Greer, M. Panhuyzen, pers. comm.). While Little Terns and Fairy Terns are known to breed in mixed flocks in the eastern states of Australia, this is the first record of breeding sympatry between two *Sternula* species in Western Australia.

Colonisation of continental shelf by tropical terns

Seabirds colonised the Western Australian continental shelf as islands were isolated by the rising sea levels of the Holocene marine transgression (Serventy *et al.* 1971; Surman 2019). It is likely that the tropical species arrived early in the period as the Leeuwin Current strengthened (Surman 2019). Subsequently, during the historical period of the late Holocene and Anthropocene, a number of tropical terns and

Table 1. Records of Indo-Pacific Little Tern *Sternula albifrons sinensis* in breeding plumage south from North West Cape (NW Cape), Western Australia.

Location	Locality	Month, year	Max no. in nuptial plumage	Obs.	Notes
Town Precinct, Carnarvon	Carnarvon	May, 2013	1	Birdata	
Town Precinct, Carnarvon	Carnarvon	February, 2014	1	Birdata	
Pelican Point, Carnarvon	Carnarvon	February, 2014	1	LG	
Whitmore Island	Carnarvon	May, 2014	1	LG	
Wedge Island	Mid-west	April, 2017	2	JND	Loafing alongside Fairy Terns
Bundegi Sanctuary	NW Cape	November, 2017	2	GG	
Lake Walyungup, Rockingham	Perth metro	March, 2018	1	JG	
Geraldton Port	Geraldton	March, 2018	4	TD, CG	
Miabooya Creek, Carnarvon	Carnarvon	March, 2018	1	LG	
Woodman Point, Coogee	Perth metro	April, 2018	1	Birdata	
Long Point, Port Kennedy	Perth metro	April, 2018	6	Birdata/eBird	
Woodman Point, Coogee	Perth metro	April, 2018	3	Birdata	
Monkey Mia	Shark Bay	April, 2018	2	eBird	
Peel-Harvey Estuary	Mandurah	March, 2020	1	NG	Loafing alongside Fairy Terns
Mangrove Bay	NW Cape	September, 2020	2	CG	Courtship feeding
Tantabiddi	NW Cape	December, 2020	5	MP	Large flock, mostly eclipse plumage
Tantabiddi	NW Cape	December, 2021	7	MP	Five adults, two fledglings
Jurabi Point	NW Cape	December, 2021	16	MP	+8 fledglings provisioned by adults

Obs., observers: LG, Les George; JND, Nic Dunlop; GG, Grant Griffin; JG, John Graff; TD, Tegan Douglas; CG, Claire Greenwell; NG, Natalie Goddard; MP, Mark Panhuyzen, Birdata, BirdLife Australia 2022; eBird, Cornell Lab of Ornithology 2022.

Table 2. Breeding records of Indo-Pacific Little Tern *Sternula albifrons sinensis* in Dampier and North West Cape (NW Cape), Western Australia.

Location	Locality	Month, year	Max. no. confirmed nests	Obs.
Town Beach, Exmouth	NW Cape	December, 2016	1	GG
Town Beach, Exmouth	NW Cape	December, 2017	1	GG
Burrup Peninsula	Dampier	November, 2017	2	TH
Yardie Creek	NW Cape	December, 2017	1	Birdata
Burrup Peninsula	Dampier	November, 2018	1	TH
Harding River	Ashburton	November, 2018	1	eBird
South Ashburton	Ashburton	November, 2018	1	eBird
South Ashburton	Ashburton	November, 2018	1	eBird
Wapet Creek	NW Cape	December, 2018	1	GG
Jurabi Point	NW Cape	October, 2019	2	JG
Yardie Creek	NW Cape	November, 2019	1	MP
Jurabi Point ^A	NW Cape	October, 2020	4	GG, MP, JG
Yardie Creek	NW Cape	November, 2020	1	MP
Point Sampson	Roebourne	November, 2020	1	eBird
Town Beach, Exmouth	NW Cape	January, 2020	1	GG
Lighthouse Bay ^B	NW Cape	December, 2021	5	MP

^ALittle Terns were found nesting ≤ 50 m of Fairy Tern colony and multiple breeding attempts were made in this location over 3 months.

^BPossible relaying observed with ≥ 4 chicks seen in December.

Obs., observers: GG, Grant Griffin, TH, Tracey Heimberger, JG, John Greer, MP, Mark Panhuyzen, Birdata, BirdLife Australia 2022; eBird, Cornell Lab of Ornithology 2022.

seabirds have established colonies south of the Abrolhos Islands. For example, Bridled Terns have now colonised islands off the entire western coast (Surman and Wooller 2000) and island groups off the north-west coast of Eyre Peninsula, South Australia (D. Harper, pers. comm.). The southward shift of Bridled Terns has been attributed to changes in the ENSO pattern and a general rise in the background temperature of the Eastern Indian Ocean (Dunlop 2009).

***Sternula* in Western Australia**

Since 1995, the known breeding distribution of the Little Tern in Western Australia has extended south-east along the coast to Dampier in the Pilbara and North West Cape in the Gascoyne, a distance of ~1000 km (Fig. 1). Nuptial-plumaged adults have been observed as far south as Wedge Island (~170 km north of Perth) during the autumn months and a single bird in nuptial plumage was observed in Mandurah in February 2020 (Table 2). A similar southward range shift of Little Terns from the tropical colonies in the north to the south-eastern Australian coastline appears to have preceded the expansion in Western Australia.

The Australian Fairy Tern in Western Australia occurs as a breeding species along the coast south from Dampier Archipelago to, at least, Israelite Bay, west of the Great Australian Bight. The core migratory population winters on the mid-west coast, with most of the birds stationed at the Houtman Abrolhos Islands during this time. During spring and summer, these birds move to breeding areas from around the tip of North West Cape to the western edge of the Great Australian Bight (Dunlop and Greenwell 2021). This two-way breeding migration to both tropical and temperate waters is curious and may reflect the evolutionary history of *Sternula nereis*.

During the previous period of global warming, the Eem interglacial (120 000–130 000 BP), the Houtman Abrolhos Islands area was a vibrant coral reef near the shelf-edge (Wyrwoll *et al.* 2009). Indeed, that reef (the Wallabi Limestone) provided the geological basement for the present day 'high' islands.

Determining the taxonomic boundaries within the *S. a. sinensis* and *S. nereis* superspecies and the emergence of *S. nereis* as a sibling species to *S. a. sinensis* will require genetic studies of both forms and may provide further insights into processes influencing speciation. However, during this warm period, it is hypothesised the Little Terns expanded south (as they are now) to colonise the coral cays in the reef system. As sea levels dropped during the Pleistocene these Little Terns were possibly isolated from the tropical population and evolved into the Australian Fairy Tern during the Pleistocene.

During the glacial maximum of the Würm Ice Age, the location of the Houtman Abrolhos Islands was still only about 18 km from the coastline. This assessment is based

on a bathymetric cross-section on Marine Chart Aus 751 from Rat Island in the Easter Group and on Pleistocene sea levels and dating adapted by C. A. Surman (Surman 2019) from a variety of sources including Wyrwoll *et al.* (2009) and Veeh and France (1988). Apatite deposits derived from guano and dated from the Eem Interglacial indicate that seabirds were breeding among the Houtman Abrolhos coral reefs at this time (Veeh and France 1988). Unlike other terns, *Sternula* often nest on mainland shorelines and could have progressively shifted colony locations with the falling sea level.

Presumably, as sea levels rose during the early Holocene, Fairy Terns colonised the shallow waters of the continental shelf, north and south of their origin, as per their current distribution. From here, the Western Australian population purportedly colonised south-eastern Australia and New Zealand (Baling and Brunton 2022). Later, New Zealand birds founded the population in New Caledonia (Baling and Brunton 2022). Genetic investigations support this evolutionary history with the Western Australian birds being the most genetically diverse than the other populations on the south-east coast, New Zealand (subspecies *Sternula nereis daviase*) and New Caledonia (*Sternula nereis exsul*) (Baling and Brunton 2005, 2022; Baling 2008).

The former sibling species Little Tern and Fairy Tern have probably been allopatric for, at least, the last 7000–10 000 years. Bridge *et al.* (2005) suggest divergence between the two species may have occurred as long as 1–2 million years ago but note this may be an overestimate. However, now with the continental shelf largely submerged and a warming eastern Indian Ocean, breeding Little Terns on the western coastline are sympatric with Australian Fairy Terns for the first time, at least in the Pilbara and Gascoyne coastal regions.

The species remain very closely related and in eastern Australia are known to hybridise (Cox and Close 1977; Ross *et al.* 1999). Hybridisation may be a conservation threat due to genetic dilution or the potential for reduced fitness or fertility of offspring (Ross *et al.* 1999), and has been identified as threat under the *National Recovery Plan for the Australian Fairy Tern* (Commonwealth of Australia 2020). In New South Wales, interventions are required to actively discourage hybridisation (Commonwealth of Australia 2020).

The conservation status of populations within a superspecies complex are difficult to determine. Baling and Brunton (2022) recommended the retention of Fairy Tern subspecies *S. n. exsul* and *S. n. daviase* because these populations are very small, genetically distinct, impoverished (probably resulting from founder effects), and isolated from the core Australian population (*S. n. nereis*, Baling and Brunton 2022).

Banding studies of the Western Australian migratory *S. n. nereis* population indicate that the regional natal philopatry of individuals produces a substructure of management units (Dunlop and Greenwell 2021). Maintaining small

tern populations in local marine/estuarine ecosystems may be a better conservation objective than a pre-occupation in saving closely related taxa. The real conservation problem here is species/subspecies-level conservation legislation. Most jurisdictions require populations to be defined at the species (sometimes sub-species) level to be listed and managed as threatened, and species with a higher conservation status often attract greater resources and funding. However, relying on these taxonomic criteria obscures the necessity to manage the threats in each inter-breeding population unit.

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