

Ecology of breeding Fairy Terns *Sternula nereis* in the Coorong



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INTRODUCTION

The Fairy Tern *Sternula nereis* is a small piscivorous bird, that is generally restricted to shallow coastal wetlands and estuaries (Higgins and Davies 1996). Globally, the species as a whole is listed as Least Concern until recently (Birdlife International), although the New Zealand subspecies *S. n. davisae* is limited to 25-30 birds. In Australia, two subspecies are recognised, *S. n. horni* (SW Australia) and *S. n. nereis* (SE Australia). In South Australia, the Fairy Tern is currently listed as Vulnerable (Schedule 8) under the National Parks and Wildlife Act 1972. However, historic declines in the State's South-East and elsewhere in South Australia (e.g. Paton *et al.* 2002), and in particular within the Coorong National Park (e.g. Paton *et al.* 2009), suggest that this classification requires re-assessment.

In 1984-1985, the Coorong National Park supported a Fairy Tern population of approximately 1,500 individuals, with 1,330 being recorded for the South Lagoon alone in January 1985 (Paton 2010). Given that the global population size for the subspecies is estimated to be 2,580 individuals (and that this population size has been considered stable until recently), the Coorong population should be considered the traditional stronghold for the taxa. Furthermore, the Fairy Tern is one of the species that contributes to the Coorong's Ramsar status (Phillips and Muller 2006). However, recent dramatic declines in the Coorong population threaten the species in South Australia (Paton *et al.* 2009, Paton 2010), and the subspecies as a whole: recent population estimates for the Coorong are around 350 individuals since 2006, an >75% decline since 1984-1985. Recent declines in the Coorong Fairy Tern population are associated with contractions in the distribution of suitable prey fish species (Rogers & Paton 2009; Paton 2010). In particular the Small-mouthed Hardyhead *Atherinosoma microstoma* has undergone dramatic declines in the southern Coorong particularly since 2006.

During the breeding season, Fairy Terns are central-place foragers, and as such their foraging locations are restricted by the location of their nest site (as they must return to the nest site between foraging bouts). For central-place foragers, longer distance trips from central places must provide increased benefit than shorter trips, and a threshold exists where longer trips are unprofitable. The added difficulty for Fairy Terns (and other species of terns) is that they return to their breeding colonies with a single prey item and so unlike other piscivorous species cannot increase the number of items that they return with. Furthermore being small terns there is a limit on the size of the prey item that can be returned and so there is little scope for these terns to increase the size of the prey. These added constraints are likely to force Fairy Terns to nest in close proximity to a reliable source of suitable-sized fish.

With the loss of hardyhead fish populations, Fairy Terns have been forced to abandon traditional breeding sites in the South Lagoon as the distances between these sites and adequate sources of food (now concentrated in the northern Coorong) are likely to exceed threshold distances for efficient prey delivery to chicks. Given this, Fairy Terns should shift their breeding activity to the northern Coorong. Unfortunately there are no secure islands free from predators close to areas still supporting reasonable abundances of small fish that are preyed upon by Fairy Terns are likely to be restricted to breeding in areas where the characteristics of the nesting areas are suboptimal, increasing the risk of nest failure. These areas are presumably chosen because these are the only areas where fish abundance is still adequate.

For central-place foragers, determining the distribution of habitat quality requires information on the distribution of key habitat variables (as with any prediction of habitat quality distribution), but these variables must be analysed in the context of the location of suitable nest sites. In addition, optimal foraging theory predicts that, for a site to be used by animals,

the “quality” of that site must increase with increasing distance from the nest site. As such, if we wish to determine the distribution of breeding habitat for Fairy Terns in the Coorong, and how this distribution might shift in response to environmental change, we require information on the relationship between habitat quality and foraging flight distances (distance between nesting sites and feeding sites), and the maximum distance that breeding terns are willing to fly from nest sites. By incorporating the spatial relationship between feeding and nesting sites into spatially-explicit habitat models, we will be able to determine more precisely the causes of recent declines in distribution and abundance, and more accurately predict how breeding Fairy Terns will respond to environmental change (such as management actions that increase the distribution and abundance of key prey species).

This project was primarily aimed at documenting the distances that breeding Fairy Terns will travel from nest sites to feeding grounds to harvest food.

METHODS

The central themes of this project are twofold: i) patterns of movement between breeding and feeding sites for breeding Fairy Terns, and ii) the availability of food (harvesting rates by terns) at feeding sites, relative to their distance from breeding sites. The spatial distribution of feeding trips from nest sites will be determined by radio-tracking adult breeding Fairy Terns. Ten adult terns were captured using a nest trap, whereby a cage with a narrow funnel entrance is placed over a nest (with eggs) in the adult’s absence, and the bird is captured once they return to sit on the nest. Each individual was then fitted with a single-stage VHF radio-transmitter using supa glue. They were attached by clipping back a section of back feathers and attaching with gauze and glue to this section of the back using the feather stubs as a basis for gluing the transmitter. The transmitters weighed 2.0 g, or less than 3% of adult body mass (approximately 70g; Paton unpubl.; Higgins and Davies 1996).

Following the attachment of radio-transmitters, individuals were located using a hand-held receiver and directional aerial. This was done systematically by commencing near the nesting colony and working out to about 5km from the breeding colony.

RESULTS

Distributions of small fish in the Coorong

In January 2009, Small-mouthed Hardyhead fish were absent from the South Lagoon. The first location where they were caught was 8km N of the southern end of the North Lagoon. The salinities at this site in January were 120g/L, and all sites further south had higher salinities in excess of 140g/L and up to 160g/L. There were no fish caught in waters with these salinities which are above the upper threshold salinity for hardyhead fish (ca 120g/L). Small fish were present over the rest of the North Lagoon and in the Murray Estuary. This pattern was typical of the distributions of small fish in the Coorong over the last 3 years.

Foraging ranges of breeding Fairy Terns

During the course of the study only two breeding colonies were detected over 2 years, one colony near the Murray Mouth which bred in Nov-Dec 2008 and Jan-Feb 2009. Another colony established on Goat Island near the southern end of the North Lagoon in the vicinity of the Needles (6km N of the southern end) from mid January to early February. Neither of these colonies successfully raised chicks to fledging.

Radio-tracking – Colony 1 Murray Mouth estuary

Four Fairy Terns were fitted with radio-transmitters at this colony. All birds were relocated regularly around the sandbar or spit on which the colony had established. None of these birds were detected more than 100m from the nesting colony. This was consistent with observations of Fairy Terns foraging in the vicinity of the breeding colony. Most of the birds fed within 100m of the colony, the birds catching primarily garfish and anchovies (*Sardinops* sp). Some were fishing no more than 10m off shore from the island. One week later the colony had been abandoned and none of the radio-tagged birds could be detected within a 5km radius of the nesting area. Inspection of the area showed fox prints around the nest scrapes, so the likely cause of nest abandonment was disturbance from foxes. One of the radio-tagged birds was, however, recaptured at the same location breeding again in early February 2009. However, this second breeding event also failed, again probably because of fox predation. The tagged bird was resighted still present on the island after the second breeding attempt had failed.

Radio-tracking – Colony 2 Goat Island

Six Fairy Terns were caught and fitted with transmitters at this island which has approximately 6 km N of the southern end of the North Lagoon. This colony was establishing in early to mid-January and grew to over 50 pairs during January, with trapping of the birds being conducted in early February. The nearest fish in the Coorong were approximately 2 km further north of the colony. However none of the radio-tagged birds fished in the Coorong lagoon, and all tagged birds flew west over Youngusband Peninsula and foraged in the Southern Ocean beyond the surf zone, and fish at an estimated 500m out from the shore.. The radio-receivers could not pick up signals from the tagged birds once they had gone out to sea, but birds could be seen fishing directly out from the shore-line. This distance to these fishing grounds from the colonies was 2km.

Observations of the return directions and departure directions indicated all of the terns were fishing out to sea rather than fishing in the Coorong. These observations were made during relatively calm conditions. All of the Fairy Terns were flying directly to the sea and returning along the same route, the birds bringing back Anchovies (*Sardinops* sp.) and small garfish. However, there was at least one Small-mouthed Hardyhead that had been regurgitated by a chick that must have come from the Coorong, and the nearest source of hardyheads was approximately 2km northwest of the colony.

This colony also failed to fledge any chicks despite most eggs hatching and chicks surviving at least for the first 10-15 days. Inspection of the colony at the time when most of the chicks were expected to start fledging revealed that this colony had been abandoned and there was no sign of any chicks and only a handful of adult birds in the area.

Movements of Fairy Terns over longer time periods.

Table 1 provides an inventory of all of the Fairy Terns that have been recaptured on nests over the last 12 years in the Coorong. Up until 2006 Fairy Terns bred on islands in the South Lagoon. Most of the breeding colonies were in the southern half of the South Lagoon. Birds banded at these colonies have in recent years been recaptured at nests in the North Lagoon (Goat Island) or near the Murray Mouth, indicating that the birds have traditionally bred in the South Lagoon have shifted northwards to areas where small fish are still present. That the birds have shifted to areas closer to where fish are still present suggests that the distance between foraging areas and nesting sites is an important determinant in where the birds will attempt to breed.

Table 1. Recaptures of banded Fairy Terns in the Coorong region. For details of the location of each nesting colony shown in the Table see Table 2. Note that A- adult and P= Pullus in the age column in the Table.

BAND	AGE	DD1	MM1	YY1	Banding Locality	Recapture Locality	DD2	MM2	YY2	Elapsed Time	Dist (km)
040-55420	P	20	1	1985	Island 300m Sth Seagull Is	Cow Island	9	1	1999	13y 354d	21.4
042-03954	P	24	12	1997	Reef nr Snipe/Wild Dog Is	South Reef	5	2	2006	8y 43d	6.1
042-03963	A	10	1	1998	Reef nr Snipe/Wild Dog Is	South Reef	5	2	2006	8y 26d	6.1
042-03965	A	10	1	1998	Reef nr Snipe/Wild Dog Is	South Reef	5	2	2006	8y 26d	6.1
042-03968	A	10	1	1998	Reef nr Snipe/Wild Dog Is	South Reef	15	1	2006	8y 5d	6.1
042-03973	A	11	1	1998	Reef nr Snipe/Wild Dog Is	Teal Island	8	1	2000	1y 362d	10.3
042-03985	P	16	1	1998	Cowrie Island, nr Beachport	Goat Island	5	2	2009	11y 20d	188.5
042-04103	A	9	1	1999	Reef nr Cattle Is	Teal Island	8	1	2000	0y 364d	3.5
042-04104	A	9	1	1999	Reef nr Cattle Is	Teal Island	8	1	2000	0y 364d	3.5
042-09783	A	16	1	1999	Cow Island	West Cattle Is	20	2	1999	0y 35d	10.0
042-04105	A	9	1	1999	Reef nr Cattle Is	West Cattle Is	20	2	1999	0y 41d	2.9
042-04106	A	9	1	1999	Reef nr Cattle Is	West Cattle Is	20	2	1999	0y 41d	2.9
042-09803	P	16	1	1999	West Cattle Is	South Reef	15	1	2006	6y 364d	9.6
042-04115	A	9	1	1999	Cow Island	South Reef	5	2	2006	7y 27d	19.3
042-09833	A	13	2	1999	West Cattle Is	near Salt Creek (mainland)	16	12	2001	2y 306d	17.5
042-04144	A	9	1	1999	Cow Island	near Salt Creek (mainland)	16	12	2001	1y 341d	27.2
042-04146	A	9	1	1999	Cow Island	near Salt Creek (mainland)	16	12	2001	1y 341d	27.2
042-04145	P	9	1	1999	Cow Island	Murray Mouth	30	11	2006	7y 325d	66.3
042-09832	A	13	2	1999	West Cattle Is	Obelisk, 2 km W of Robe	3	12	2004	5y 293d	129.5
042-07837	A	8	1	2000	Teal Is	South Reef	15	1	2006	6y 7d	4.3
042-07853	P	8	1	2000	Teal Is	South Reef	15	1	2006	6y 7d	4.3
042-09886	P	25	1	2000	Teal Is	South Reef	5	2	2006	6y 11d	4.3
042-07837	A	8	1	2000	Teal Is	near Salt Creek (mainland)	16	12	2001	1y 342d	12.1
042-07839	A	8	1	2000	Teal Is	near Salt Creek (mainland)	16	12	2001	1y 326d	12.1

042-09870	A	8	1	2000	Teal Is	near Salt Creek (mainland)	16	12	2001	1y 342d	12.1
042-07808	P	8	1	2000	Teal Is	Goat Island	20	2	2009	9y 43d	28.4
042-07848	A	8	1	2000	Teal Is	Goat Island	20	2	2009	9y 43d	28.4
042-09879	A	8	1	2000	Teal Is	Goat Island	5	2	2009	9y 28d	28.4
042-09899	A	25	1	2000	Teal Is	Goat Island	20	2	2009	9y 26d	28.4
042-07838	A	8	1	2000	Teal Is	Murray Mouth	30	11	2006	6y 326d	81.2
042-07885	P	8	1	2000	Teal Is	Murray Mouth	30	11	2006	6y 326d	81.2
042-07891	P	8	1	2000	Teal Is	Murray Mouth	24	11	2006	6y 320d	81.2
042-25376	A	16	12	2001	near Salt Creek (mainland)	South Reef	4	2	2006	4y 40d	7.9
042-07837	A	16	12	2001	near Salt Creek (mainland)	South Reef	15	1	2006	4y 30d	7.9
042-25358	A	16	12	2001	near Salt Creek (mainland)	South Reef	4	2	2006	4y 40d	7.9
042-25364	A	16	12	2001	near Salt Creek (mainland)	South Reef	15	1	2006	4y 30d	7.9
042-25357	A	16	12	2001	near Salt Creek (mainland)	Goat Island	5	2	2009	7y 41d	40.5
042-25358	A	16	12	2001	near Salt Creek (mainland)	Goat Island	5	2	2009	7y 51d	40.5
042-25376	A	16	12	2001	near Salt Creek (mainland)	Murray Mouth	24	11	2006	4y 334d	93.1
042-25380	A	16	12	2001	near Salt Creek (mainland)	Murray Mouth	30	11	2006	4y 349d	93.1
042-39721	A	30	11	2006	Murray Mouth	Murray Mouth	4	2	2009	2y 66d	0.0
042-35840	A	15	1	2006	Mellor Island	Goat Island	5	2	2009	3y 21d	32.0
042-35865	A	15	1	2006	South Reef	Goat Island	5	2	2009	3y 21d	32.6
042-50121	A	4	2	2006	South Reef	Goat Island	5	2	2009	3y 1d	32.6
042-50101	A	30	11	2006	Murray Mouth	Goat Island	20	2	2009	2y 82d	53.0
042-50135	A	24	11	2006	Murray Mouth	Goat Island	20	2	2009	2y 277d	53.0
042-25376	A	4	2	2006	South Reef	Murray Mouth	24	11	2006	0y 293d	85.2
042-50101	A	4	2	2006	South Reef	Murray Mouth	30	11	2006	0y 299d	85.2
042-50135	A	5	2	2006	South Reef	Murray Mouth	24	11	2006	0y 292d	85.2

Table 2. Easting and Northings of locations where Fairy Terns were breeding or recovered.

Nesting Site	Region of Coorong	Map	Units	Easting	Northing
Murray Mouth	Murray Estuary	54H	WGS84	308000	6063250
Goat Island	North Lagoon	54H	WGS84	350700	6031800
Island 300m S Seagull Is	South Lagoon	54H	WGS84	373250	6005500
Reef nr Snipe/Wild Dog Is	South Lagoon	54H	WGS84	376000	6002500
Reef nr Cattle Is	South Lagoon	54H	WGS84	368100	6013750
Cow Island	South Lagoon	54H	WGS84	360250	6022500
West Cattle Island	South Lagoon	54H	WGS84	365100	6013750
Teal Island	South Lagoon	54H	WGS84	370100	6011000
Nr Salt Creek (mainland)	South Lagoon	54H	WGS84	377700	6001600
Mellor Island	South Lagoon	54H	WGS84	371650	6007550
South Reef	South Lagoon	54H	WGS84	372200	6007300
Obelisk 2kmW Robe	South-East Coast	54H	WGS84	388500	5886400
Cowrie Is, nr Beachport	South-East Coast	54H	WGS84	410100	5852875

The banding and recapture data show two other important demographic aspects. First at least some of the chicks banded in their nests over the years 1997 to 2000 have recruited into the adult breeding population in subsequent years, but none of the chicks banded since then have appeared. These data suggest that there has been no recent successful breeding that has given rise to individuals recruiting into the adult population, perhaps for the last decade. The longest elapsed time between initial banding and recovery has been approximately 14 years (Table 1).

DISCUSSION

During this study Fairy Terns have been found to forage consistently in areas no more than 2km from their nests and if the fish were available substantially closer. This 2km distance should not be used as a maximum distance over which breeding Fairy Terns will travel to catch fish while breeding, and they may well be able to forage over greater distances but probably not much greater. There are few data available for comparison. However the much larger Crested Tern may forage as much as 40 km from their breeding colonies, but the majority of Crested Terns nevertheless forage at much closer distances from their colonies (McLeay *et al.* in review). These distances are substantially more than for Fairy Terns obtained to date, so Fairy Terns may also have the capacity to forage over greater distances than those so far recorded. Based on the data provided here these distances are unlikely to be great and so the absence of breeding Fairy Terns from the South lagoon of the Coorong is likely to be directly related to the loss of the Small-mouthed Hardyheads from this lagoon, and so, easily explained.

For small terns like the Fairy Tern foraging in the open ocean is likely to have some risks. Storm events are likely to make it very difficult for small terns to be able to forage, let alone forage efficiently. A possible reason for the breeding colony at Goat Island failing to fledge any chicks in 2009 might be because some inclement weather may have prevented them from being able to forage.

Finally, the banding data suggest that there has been an extended period of time since Fairy Terns have succeeded in fledging young birds that have then established in the Coorong's breeding population. The longest known bird for this region is nearly 14 years (Table 1), so on-going poor recruitment threatens this species, since most of the current birds in the population are probably approaching if not exceeding 10 years of age.

At present the only reliable place for small fish that Fairy Terns can harvest close to their nests is near the Murray Mouth. Unfortunately there are no secure breeding locations in this region as foxes can access the shoal on which they attempt to breed via Younghusband Peninsula. Most nesting attempts over the last 4 years at least at this location have been disrupted by foxes. There are two options that should be considered for managing this species to improve their prospects. First, the salinities in the South Lagoon urgently need to be reduced so that Small-mouthed Hardyheads can re-colonise the South Lagoon and once again provide a source of fish close to their secure (from foxes) traditional breeding islands used by Fairy Terns until recently. This will almost certainly require the highly saline water from the South Lagoon to be pumped out to sea. Unfortunately this is still being assessed and is unlikely to be implemented until 2011 and then take 2 years to lower the salinities adequately (R. Seaman pers. comm.). So there is at least 3 years before the South Lagoon might have suitable salinities again. Given that Fairy Terns are unlikely to live for much more than 10 years (based on the maximum longevity recorded to date of 14 years), and that apparently they have not recruited for 10 years (and so most of the current birds are approaching 10 years, if not older) this species is facing imminent local extinction. One possible management action for providing improved chances for this species to successfully reproduce (measured as recruitment of young birds into the breeding population) from next year onwards (the current breeding attempt has failed once again- Clare Manning pers. comm.) would be to isolate the current shoal that is used almost annually by Fairy Terns. This shoal is near the Murray Mouth and by dredging a channel between this shoal and Younghusband Peninsula to produce a mote, will act as an additional barrier to foxes. In addition to this to reduce the risks of spring tides and storms leading to high water levels that may inundate the shoal there may be merit in raising the height of part of this shoal (perhaps by a metre) using some of the sand that is being dredged in the area, and hope the birds continue to attempt to breed at the site.

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