

Observations of Little Tern nesting at Winda Woppa, Port Stephens, 2016-2017

Neil Fraser

8 Flannel Flower Fairway, Shoal Bay, NSW 2315, Australia neil8fff@gmail.com

A nesting colony of Little Tern *Sternula albifrons* at Winda Woppa was surveyed regularly from 13 December 2016 to 8 February 2017. Data on the numbers of nest sites, eggs, chicks and fledglings was collected and analysed. Observations of predation, disturbance and Little Tern behaviour were also recorded. As many as 122 Little Tern were present, 49 nest sites with 106 eggs were recorded and 28 fledglings were successfully raised. A minimum of 23 breeding pairs was estimated to have been present. The number of fledglings per nest site was 0.57 which was less than rates recorded from the Manning Estuary, NSW. Birds fledged per egg was 26.4% which indicated breeding success was lower than recorded in the Manning Estuary. Quantitative data showed that egg predation by Australian Raven *Corvus coronoides* and possibly Lace Monitor *Varanus varius* was minimal. Observation of chick predation by Silver Gull *Chroicocephalus novaehollandiae* suggested they were the primary predator. An analysis of the nesting sites indicated there were significant differences in predation and disturbance across the colony but overall the location is considered to be ideally suited for Little Tern nesting. Proactive protection of the site by the local and State Government authorities is required to ensure the success of future nesting events.

INTRODUCTION

A nesting colony of Little Tern *Sternula albifrons* was located at Winda Woppa, Port Stephens (32°40'44"S, 152°08'46"E) in mid-December 2016. Although Little Tern have been previously reported nesting at Winda Woppa (Smith 1990; A. Morris pers. comm.; I. McMaster pers. comm.; C. Patterson pers. comm.), this is the first documented study of a nesting event at this site (see **Figure 1**).

The Little Tern is a migratory species found in small flocks on coastlines worldwide during summer. Three subspecies are recognised. Those found in East Asia and northern and eastern Australia belong to the subspecies *Sternula albifrons sinensis*. Three populations of Little Tern are recognised around the Australian coast; a population that visits Australia in its non-breeding season, a northern Australian population that nests in northern Australia, and a south-eastern Australian population that nests in eastern Australia (Department of the Environment 2017). In NSW, Little Tern are present as a medium-sized, non-breeding population that is relatively stable and a small, threatened breeding population (Chafer & Brandis 1991). Territories may overlap but the two populations are believed to

be sexually isolated. The majority of Little Tern present in south-eastern Australia in spring and summer are non-breeding birds from colonies in Japan (Smith 1995; Minton 1996).

The Little Tern that breeds along the NSW coast is listed as a migratory species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In NSW it is listed as an endangered species on Schedule 1, Part 1, of the *Threatened Species Conservation Act 1995* (TSC Act). The species is considered to be an ecological specialist, which has a population and distribution reduced to a critical level, poor recovery potential and severe threatening processes. Garnett (1992, 1993) classified the Australian breeding population of the Little Tern as vulnerable. The breeding population in south-eastern Australia has declined and its beach-nesting sites are particularly prone to human disturbance, predation and natural catastrophes (NSW National Parks and Wildlife Service 2003).

The objective of this study was to document the nesting event, estimate breeding success, identify predators and other threats and assess the suitability of the site.

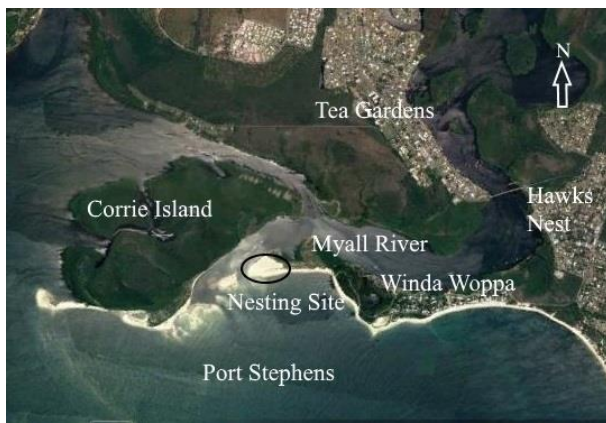


Figure 1. Location of Little Tern nesting site, Winda Woppa, Port Stephens.

Location and description of the nesting site

The nesting site is located on a sandspit at the western end of Jimmys Beach at Winda Woppa, Port Stephens. The sandspit is part of the estuary of the Myall River where the eastern arm flows into Port Stephens. The site is part of the General Use Zone of the Port Stephens - Great Lakes Marine Park. The Corrie Island Nature Reserve is located approximately 200 m to the west. In 2015, the Mid Coast Council dredged 90,000 cu m of sediment from the river mouth to be used for nourishment of nearby eroded beaches and to improve environmental flows in the lower Myall River. The dredged spoil was pumped onto the sandspit. The dredging also created a small sand cay approximately 250 m southwest of the sandspit. Little Tern were observed nesting on the dredged spoil and on an adjacent area of beach. All council activity on the sandspit was suspended from 1 November to 31 March during the migratory shorebird nesting period.

The spoil pile is elongate in shape, approximately 200 m long, 70-100 m wide and maximum height of 8 m. The outer section of the pile is 3-6 m high and forms a berm 4-10 m wide surrounding an internal depression 1-2 m below the rim of the berm. A conical pile approximately 5 m high is located within the centre of the depression. The dredge spoil is comprised of a mixture of coarse sand, shell grit, broken shell fragments, driftwood, small rocks and other marine debris. It also includes a small section of semi-consolidated muddy sediment. Little Tern were observed nesting in three locations. Area 1 and Area 2 were located on the spoil pile and Area 3 was at the southwest end of the sandspit (see **Figure 2**).

Area 1 is located on a wide section of berm on the north-eastern side of the spoil pile, 4-5 m above the

sandspit. Here, nests were clustered around the edge of the pile in an area approximately 80 x 10 m. There is no vegetation on Area 1. In Area 2, nests were present in an area approximately 40 x 20 m covering a narrow section of the berm on the south and east side of the spoil pile and the adjacent internal depression. The berm is 3-4 m above the sandspit while the depression is 1.5-2 m below the berm. Sparse vegetation is present on the southern section of berm.

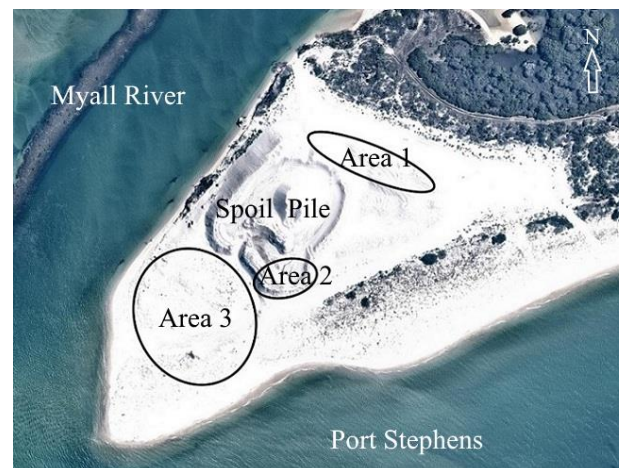


Figure 2. Location of nesting areas on Winda Woppa sandspit.

Area 3 lies at the southwestern end of the sandspit. Little Tern nests were present over most of the area which is roughly circular in shape, approximately 60 m in diameter and has beach on three sides. Most of the area is covered with 0.5-2.5 m of dredge spoil while a narrow section of the original sandy beach is preserved on the southern side. A channel scoured by returning dredge water runs across the southern side of the area, partially separating the area of dumped spoil from the section of sandy beach.

The majority of Area 3 is sparsely vegetated with 3-5% coverage by plants with a low, spreading form. The most common plants are Sea Rocket *Cakile maritima* and Spinifex Grass *Spinifex sericeus*. Other plants present are Coastal Wattle *Acacia longifolia sophorae*, Pigface *Carpobrotus glaucescens* and Pennywort *Hydrocotyle bonariensis*, Beach Daisy *Arctotheca populifolia*, Yucca *filamentosa* and Sea Holly *Eryngium maritimum*. The section of sandy beach has 15-20% vegetation coverage which is dominated by Sea Rocket with lesser amounts of Spinifex Grass.

The majority of the nest sites were located well above the high-tide mark, on relatively flat ground. The nests were unadorned shallow scrapes in areas of soft, loose sand and shell grit. Other adjacent debris provides camouflage for the mottled eggs.

Egg colour varied through shades of grey, grey-green and olive and mottling varied from dark grey, dark green-grey to black. The maximum depth of water at high tide in adjacent areas of Port Stephens and the Myall River is 2-3 m.

The sandspit at Winda Woppa is Crown Land over which the Mid Coast Council has a lease for the stockpiling of dredge spoil. The land is zoned Environmental in the Local Environmental Plan and has considerable conservation significance. It is located within the Port Stephens - Great Lakes Marine Park and is within 200 m of the Corrie Island Nature Reserve which was added to the Ramsar site covering the Myall Lakes National Park in March 1999. The sandspit lies within the buffer zone of the Ramsar site for which land use should be 'of sustainable use through ecosystem management, consistent with the maintenance of the ecological character of the wetland' (Ramsar Convention Secretariat 2010, p. 30).

METHODOLOGY

On the initial inspection of the site it was recognised that a significant nesting event was underway and it was decided to survey the site methodically on a regular basis. To ensure the surveying was conducted in accordance with appropriate ethical considerations, the "Monitoring Procedure for Threatened Beach-nesting Shorebirds" developed by the NSW Office of Environment and Heritage was adopted (Office of Environment and Heritage, Animal Ethics Committee 2015).

Between 13 December 2016 and 8 February 2017, ten weekly surveys of the site were conducted. The initial survey was the most extensive as nesting areas within the site were identified and surveyed for the first time. Areas with a high incidence of alarm calls from Little Tern flying overhead were surveyed in detail on traverses approximately 5 m apart. All nest sites were photographed and surrounding details recorded. Areas with little or no alarm-call activity were surveyed in less detail to ensure there were no indications of nesting activity. Information recorded for each nest site included the number of eggs, number of chicks, site distinguishing features and evidence of predation. Behaviour of the Little Tern was recorded including observations of agonistic behaviour towards other avian species. Disturbance by recreational beach users was also recorded.

The above process was repeated for each survey. Photographs of nest sites from each survey were compared to identify repeat observation records. Due to the high incidence of large shell fragments and other marine debris, each nest site had unique characteristics that allowed accurate discrimination. Site visits were

between two and three hours and were conducted between 7.30 am and 10.30 am. Nest sites were surveyed early in the day when there was minimum disturbance from recreational beach users and temperatures were moderate. Surveys were conducted as quickly as possible to minimise disturbance to chicks and incubating birds. Counts of Little Tern numbers and other observations were made mid-morning when the birds began to form flocks flying over the site or roosting on the adjacent beach. Other observations included numbers of fledglings and non-breeding birds, chick and fledgling feeding behaviour, courtship behaviour, leg bands, other avian species present and behaviour of potential predators.

To evaluate the recorded data, fledglings per nest site, fledglings per breeding pair and fledglings per egg were calculated. The results were compared with Little Tern monitoring data from the Manning Estuary from 1996 to 2012. In order to compare Winda Woppa monitoring data directly with Manning Estuary data, Manning Estuary fledgling ratios were recalculated using records for fledglings counted only.

RESULTS

The survey data from the three nesting areas is presented in **Table 1** and final numbers are summarised in **Table 2**. A total of 49 nests were located which contained 106 eggs, 5 of which involved instances where the clutch increased between surveys. A total of 38 nests were located only once and 11 were recorded on repeat occasions. As the initial survey was conducted several weeks after nesting commenced and the subsequent surveys were conducted at weekly intervals, it was not possible to accurately determine the commencement of individual nesting attempts, hatching success or the full extent of predation. In particular, the records of chicks in **Table 1** is not indicative of breeding success due to the concealment of chicks by parents within 24-48 hours of hatching and the absence of quantitative predation data. Some 'runner' chicks were undoubtedly recorded more than once.

The total number of Little Tern on site increased over the survey period. Initially numbers increased as additional birds in breeding plumage joined the colony and subsequently as fledglings were recruited into the flock. The initial counts included a mixture of birds in breeding plumage and non-breeding birds. The maximum count of non-breeding birds in December was 26 but by the end of the survey period this had increased to 48 as the plumage of fledglings changed to that of non-breeding birds. The maximum number of birds in

Table 1. Summary of nest observations, fledglings and total numbers (adult and fledged) of Little Tern.

Site Surveys		13/12/16	20/12/16	28/12/16	03/01/17	10/01/17	17/01/17	25/02/17	27/02/17	01/02/17	08/02/17
Area 1	New Nest Sites	12									
	Eggs	33									
	Repeat Nest Records		1								
	Eggs		2								
	Chicks		3								
Area 2	New Nest Sites	2		1	1	1					
	Eggs	4		1	1	2					
	Repeat Nest Records				1	2	3	1	1		
	Eggs				2*	4*	4				
	Chicks		2		2	2	2	2	3	2	
Area 3	New Nest Sites	6	7	5	7	4	2	1			
	Eggs	12	15	11	11	6	3	2			
	Repeat Nest Records				1	7	5	4	3		
	Eggs				3	13**	9	1			
	Chicks	4			2	2	1	7	6	3	
Fledglings				5	7	21	15	3	4	4	7
Total Little Tern		-	60	75	-	105	80	67	80	84	122

*Includes one additional new egg ** Includes 3 additional new eggs

breeding plumage is estimated to have been around 65. However, it is noted that all birds in breeding plumage do not necessarily breed, and consequently this number is not an indication of total breeding birds on site. The plumage of fledglings was noted to change rapidly and within three weeks they became indistinguishable from other non-breeding birds. The number of newly fledged birds present at each survey is shown in **Figure 3**. These counts represent birds that had readily identifiable juvenile plumage. However, some birds were undoubtedly counted on more than one occasion. The number of fully-fledged birds at the end of the survey period was considered to be 28 birds. This figure should however be regarded with some caution as some of the earlier fledged birds may have already dispersed.

At the first survey conducted on 13 December, 20 nests were located all of which were considered to be first nesting attempts. This indicated that a minimum of 20 breeding pairs were present on site at that time. This number could be higher as the

number of failed nesting attempts prior to this date is unknown. On subsequent surveys, fewer new nests were located (see **Figure 3**). These additional nests could be the result of first nesting attempts by late arrivals to the colony or re-nesting attempts by birds following earlier failures.

Data from other recent nesting sites in NSW (NSW National Parks and Wildlife Service 2003) records Little Tern re-nesting on average 10-12 days after loss of all eggs or chicks. Little Tern will re-lay up to twice after failure (Higgins & Davies 1996). The average number of eggs per nest over the survey period is shown in **Figure 3**. Most of the initially located nests contained three eggs while nests located subsequently contained one or two eggs. The decline in average number of eggs per nest is shown in **Figure 3**. Three new nests, each with three eggs, were located in surveys in the two weeks following the initial survey and were considered to be first nesting attempts. It was therefore considered that there was a minimum of 23 breeding pairs in the colony.

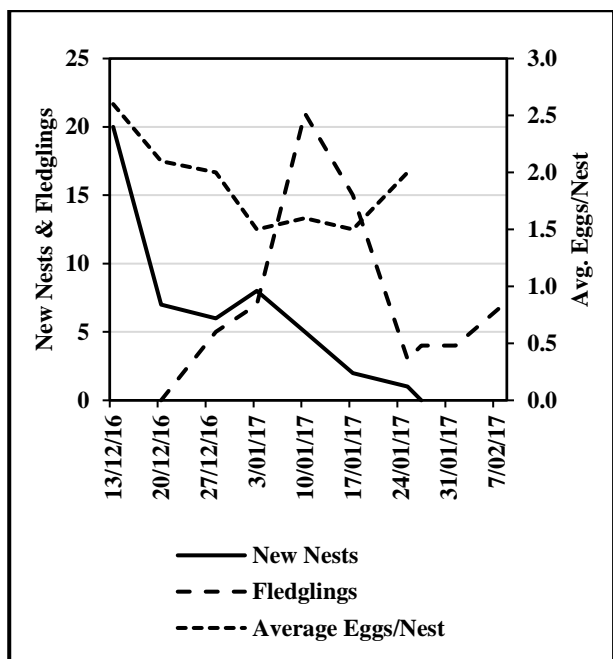


Figure 3. Chart showing number of new nests located, average number of eggs in new nests, and fledglings observed over the survey period.

Table 2. Comparison of nesting data, Winda Woppa 2016-17 and Manning Estuary 1996-2012.

	Winda Woppa 2016-17	Manning Estuary 1996-2012	
		Range	Median
Breeding Pairs	23	84 - 152	120
Nest Sites	49	103 - 219	143
Eggs Found	106	217 - 453	311
Fledglings	28	94 - 251	106
Fledglings/nest site	0.57	0.38 - 1.88	0.77
Productivity Rate (Fledglings/pair)	1.20	0.60 - 1.81	0.93
Breeding Success (Fledglings/egg)	26.4%	18.0 - 79.0%	35.5%

Breeding period

Day-old chicks were located in nests in Area 3 on the first survey of the site on 13 December 2016. Studies by other researchers in NSW have recorded incubation periods of 17-22 days at Forster (Smith 1994) and 20-21 days at Botany Bay (Campion 1963). By assuming an average incubation period of 21 days for Winda Woppa, incubation for these chicks would have commenced around 22 November 2016. Smith (1994) also recorded a fledging period of 17-19 days for Little Tern at Forster. Fledglings were first recorded at Winda Woppa on 28 December 2016. Assuming a fledging period of 18 days and that the birds fledged

intermediate between the two survey dates, incubation would have commenced around 43 days previously on 16 November 2016.

These estimates indicate that egg laying and incubation had commenced at the site by mid-November. Mid Coast Council beach nourishment activity with earth-moving equipment was terminated at the site on 31 October. It would be reasonable to assume nesting activity commenced soon after this date.

These estimated dates are in accordance with the findings of Hitchcock (1959) who found breeding typically began in NSW in mid-October to mid-November and continued through into January or February. The timing of breeding of individual colonies varied greatly between years, nevertheless there was a general pattern of breeding beginning in colonies on the North Coast in October or November and colonies on the South Coast in November or December.

During the survey period only one nest was located that was observed through the full laying, incubation and hatching period. Nest 22 in Area 3 was first observed on 3 January 2017 with one egg and again on 10 January with two eggs. Two chicks, each one day old, were observed in the nest on 25 January 2017. These dates indicate an incubation period for this nest of 21 days, assuming the second egg was laid on 4 January. This agrees with other incubation records from NSW (Campion 1963; Smith 1994).

New nest sites with eggs continued to be recorded up until 10 January and all nesting activity had finished by 8 February when no new nests or eggs were located. This indicates nesting activity occurred from early to mid-November to early February, a period of around 13 weeks.

Predation and disturbance

When considering the large numbers of individual nests (49) and eggs (106) located across the site and the number of successfully fledged birds (28), it is apparent that significant natural predation and mortality occurred over the nesting period. Five potential predators, Silver Gull, Australian Raven, Australian Pied Oystercatcher *Haematopus longirostris*, Lace Monitor and Ghost Crab *Ocypode cordimanus* were identified at or near the nesting site. Two of these were confirmed to be active predators at Area 3. A Silver Gull was observed to predate a chick (Shaun McKay pers. comm.) and intervention by the author prevented another from

doing so. An Australian Raven was observed to predate a nest in Area 3, probably taking an egg. Australian Ravens were however rarely noted in the vicinity of the site. Australian Pied Oystercatchers were observed being mobbed by Little Tern when they ventured near the nesting sites at Area 3 on two occasions and their tracks were observed across the area on other occasions.

There are a number of potential ground predators in the area. Lace Monitor tracks were observed in Area 3 on two occasions. Their tracks were also observed leading towards the Area 1 nest site and material that may have been coagulated egg contents was noted in two empty nest sites in this area on 20 December. Ghost Crab burrows were common in the south of Area 3 where several nest sites were located. However, no burrows were found within or adjacent to nest sites.

Repeat observations of 11 nests did not reveal any loss of eggs prior to hatching. All of these repeat observations were in Area 2 and Area 3. It is considered that egg predation in these two areas was minimal.

Red Fox *Vulpes vulpes* is the most frequently recorded and most destructive predator of Little Tern colonies in NSW (NSW National Parks and Wildlife Service 2003). A significant part of NPWS funding for Little Tern management is directed towards fox threat abatement and specific plans have been developed to manage this predator (Office of Environment and Heritage 2011). No fox tracks were identified on or around the nesting site. Wild Dogs *Canis lupus* ssp. are also known to be present in the area but no tracks were identified. Control programmes for Wild Dogs and foxes have previously been conducted on Corrie Island and the Winda Woppa peninsula. (Office of Environment and Heritage 2014). The absence of Red Fox and Wild Dogs may be an indication that these management programmes have been successful. Other potential predators are Cats *Felis catus* and Black Rats *Rattus rattus*. No indications of their presence were noted.

While some limited quantitative data was obtained relating to egg predation, no quantitative data was obtained for predation of chicks. It is considered that the main predators of eggs were Australian Raven and possibly Lace Monitor. From limited observations it is considered that the main predator of chicks was Silver Gull and the majority of predation occurred to both newly hatched and 'runner' chicks. The number of Silver Gull recorded on the beach adjacent to Area 3 during surveys

varied from 1 to 12. However, 65 Silver Gull were observed roosting within Area 3 on the final survey after nesting had been completed.

Human disturbance was widespread across the site. The Winda Woppa sandspit is a recreational beach area frequented by holiday makers, fishermen and local residents, a number of whom are accompanied by dogs. The spoil pile is popular with visitors for climbing and scenic photography and as a play area for children. The extent of damage to nest sites by people and dogs is unknown, but is considered to be a factor influencing the breeding success of Little Tern at this site. Warning posters were installed by the Mid Coast Council in late December, but had limited impact on visitor behaviour.

Nesting was not impacted by any adverse weather events during the survey period. There were no storm events and the January king tides did not encroach upon the nest sites. The record hot weather of January did not appear to impact nesting and no abandoned eggs were located. Two dead chicks were located during the surveys. A chick less than one week old was found in Area 2 and a near-fledged chick was found in Area 3. Cause of death was not apparent.

Behavioural observations

As breeding activities restricted Little Tern movement to the immediate vicinity of the nesting site it was possible to make extended observations of behaviour. Paton & Rogers (2009) note that several small-sized species of tern are central-place foragers with their foraging locations restricted by the location of their nest site. The birds were observed feeding singly and in flocks in adjacent shallow waters of Port Stephens and the Myall River. Little Tern hover momentarily before diving from a height of 5-10m to take small fish. Abandoned fish found on the site were Whitebait *Hyperlophus vittatus* and Hardyhead *Atherinosoma microstoma*. Little Tern were observed fishing on the Myall River up to 2 km from the nesting site.

Breeding birds were observed presenting fish to potential mates as part of a courtship ritual. This behaviour continued up until early January when the last new nest sites were recorded. Adults were observed feeding developing chicks within the nesting site and newly-fledged birds on the adjacent beach. As the nesting period proceeded and fewer birds were engaged in breeding activities, flocks of Little Tern began to vacate the beach around the sandspit and roost on the nearby sand cay,

particularly at low tide. There was comparatively little difference between the total numbers of birds roosting at high and low tide.

Throughout the nesting period Little Tern continued to make nest scrapes in the sand across the site. This activity was recorded up until early February, three weeks after the last new nest was recorded. The majority of these scrapes were not used.

Incubating Little Tern were observed sitting on nests for relatively short periods only. Disturbance from natural sources and occasionally from humans, appeared near constant. The incubating birds frequently took flight with the adjacent roosting flock whenever they were disturbed. Studies by Weston *et al.* (2012) showed the mean flight initiation distance for Little Tern was 21.5 m with a standard deviation of 7.9 m. Similar flight initiation distances were observed at Winda Woppa.

When eggs hatch, the incubating birds were observed to leave the newly-hatched chicks in the sand scrape for 24 to 48 hours before moving them to the cover of adjacent vegetation, usually Sea Rocket. In areas where there was no vegetation, the developing chicks remained in depressions in the sand or crouched against large items of marine debris for up to a week. Chicks maintained a very cryptic appearance and lay motionless with their heads down. Some newborn chicks were a uniform pale cream while others were light brown with dark streaks on the head and back.

When flying over the site, adult birds were observed to be constantly giving alarm calls. The calls could be heard at a considerable distance from the site, regardless of the presence of obvious intruders. Large numbers of birds in breeding plumage were also observed mobbing potential avian predators.

When nesting activity was completed and chicks fledged, the plumage of some breeding adults changed rapidly. Within one week yellow bills became red-brown and the black cap receded as feathers at the front of the head began to be replaced by white feathers.

A boat survey of shorebirds in the Winda Woppa area on 10 February 2017 recorded 176 Little Tern. The final land-based survey two days previously had recorded 122 birds. This suggests birds from other locations were temporarily joining the colony at Winda Woppa. It also indicates there were likely to be adequate fish resources in the area to support these population numbers.

A number of other avian species were observed roosting on the beach around Area 3 at various times, often in close proximity to the Little Tern. These were Silver Gull, Crested Tern *Thalasseus bergii*, Australian Pied Oystercatcher, Sooty Oystercatcher *Haematopus fuliginosus*, Red-necked Stint *Calidris ruficollis*, Red-capped Plover *Charadrius ruficapillus* and Ruddy Turnstone *Arenaria interpres*. The Red-capped Plover were also observed breeding in Area 3 and successfully raised two chicks. A nest site was located around 5 m from a Little Tern nest. It is possible that Red-capped Plover nest within the Little Tern colony to take advantage of the added protection from predation provided by the Little Tern. Generally, there was no interaction between the different species although Red-capped Plover chased off Little Tern when they ventured to close to their chicks. Agonistic behaviour by Little Tern was observed towards Australian Pied Oystercatcher and Silver Gull.

DISCUSSION

Breeding success

A summary of total breeding pairs, nest sites, eggs and fledgling numbers is presented in **Table 2**. Here, the data is compared with records for Little Tern nesting in the Manning Estuary from 1996-2012 (Fawcett & Thomas 2012). The Manning Estuary is a nominated priority site for Little Tern in NSW with significantly more nesting pairs than Winda Woppa. Nesting activity in the Manning Estuary is systematically monitored and managed (NSW National Parks and Wildlife Service 2003).

The number of Little Tern fledged per nest site was 0.57. This is less than the median value for the Manning Estuary (**Table 2**), although it lies within the overall range (Fawcett & Thomas 2012). This figure should be regarded with some caution due to the difficulty of accurately identifying fledged birds as discussed above. The minimum fledging rate required to maintain a stable population of Little Tern is approximately 0.5 (Hadden & Knight 1983).

The number of fledglings per pair, which is a measure of productivity, was 1.20. This is more than the median value for the Manning Estuary (**Table 2**) and lies around the middle of the overall range (Fawcett & Thomas 2012). This value however, should be treated with some caution. The number of breeding pairs (23) is a minimum estimate due to monitoring commencing several weeks after nesting commenced.

Breeding success for Little Tern in eastern Australia is often low, with overall success of only 6.5-17.9% of birds fledged per egg at some colonies (Higgins & Davies 1996). At Winda Woppa in 2016-17 the success rate was 26.4%. This figure should be regarded with some caution as surveys did not start for several weeks after nesting commenced and predation rates are poorly understood. The success rate is less than the median value for the Manning Estuary (**Table 2**) and lies towards the lower end of the overall range (Fawcett & Thomas 2012).

Overall, breeding success at Winda Woppa was less than that achieved in the Manning Estuary. The higher rates in the Manning Estuary can be attributed to the systematic monitoring and management of that site. Higher predation rates at Winda Woppa may have resulted in fewer fledglings but no quantitative data was obtained to support this conclusion.

Previous records of Little Tern in Port Stephens

The earliest documented records of Little Tern in Port Stephens were probably made by members of the Royal Australian Ornithologists Union (RAOU) in November 1928 and January 1931. Chisholm & Cayley (1928) reported a small flock of Fairy Tern *Sternula nereis* in Port Stephens and Hordern & Hordern (1931) reported the species as being very common. The locations of the observations were not reported. Subsequently, Sharland (1938) concluded that the RAOU observers had most likely misidentified Little Tern *Sternula albifrons*.

Corrie Island was recorded as a nesting site by Hitchcock (1959) and Campion (1963) and approximately ten pairs were reported nesting on a sandspit on the island in 1972-73 (Morris 1979). Several pairs were reported to have nested on the nearby sandspit at Winda Woppa in 1979-80 (Smith 1990). Local Hawks Nest residents report Little Tern have been present on the sandspit in summer for many years (I. McMaster pers. comm.; C. Patterson pers. comm.)

Since 2004, members of Hunter Bird Observers Club, in conjunction with NSW National Parks and Wildlife Service (NPWS), have conducted regular summer surveys of shorebirds in Port Stephens. Surveys were conducted in February, except for 2005 when the survey was conducted in March. Little Tern were recorded in all the surveys except 2005 and 2009. The birds were recorded on a sandspit on the southern end of Corrie Island (see **Figure 1**), on sand cays along the eastern shore of Corrie

Island, and on the sandspit at Winda Woppa. The maximum count was 87 Little Tern in February 2016 (Stuart 2015; Alan Stuart pers. comm.). As these surveys were conducted from a boat it was difficult to confirm that the birds were nesting.

The above reports indicate that Little Tern have bred on various occasions in the Corrie Island/Winda Woppa area since at least 1959 and probably much earlier. It is also evident that they use different sites for nesting within this area from time to time.

Suitability of nesting sites

The Little Tern in NSW is strictly a coastal species, nesting in estuaries or on coastal beaches, and feeding in nearby waters. Most of the nesting sites in NSW are sandspits, sand islands or beaches within or adjacent to the estuaries of rivers, creeks and coastal lakes. Nesting usually occurs at or near the mouth of an estuary (NSW National Parks and Wildlife Service 2003). Little Tern have been observed nesting on newly deposited dredge-spoil from numerous locations in NSW. Such sites may support large and highly successful colonies, as occurred on an artificial sand island at Forster in the 1993-94 season (Smith 1994). The Winda Woppa sandspit meets all the above criteria and appears to be an ideal site for Little Tern nesting. The three nesting areas identified at Winda Woppa (Areas 1, 2 and 3) are shown in **Figure 2**.

Area 1 is an elevated (4-5 m), relatively flat site on the northeast end of the spoil pile. It is comprised of deep soft sand and shell grit and has commanding views of its surrounds. Twelve nests were found clustered around the edge of the spoil pile on the first survey of the site. All sites were within 150 m of the water. Two of these nesting attempts produced chicks. However, there was no repeat nesting in this area. There could be several reasons for this. Area 1 is only 30-50 m distant from the natural bush on the peninsula and would have the highest risk of predation by ground predators such as Lace Monitor, fox and dogs. There is no vegetation on Area 1, and consequently no natural cover for protection of developing chicks. Chicks observed in this area were crouched down in depressions in the sand. Area 1 also lies immediately adjacent to a location where boat-borne visitors access the spoil pile from the Myall River. Overall, Area 1 is considered to be the least suitable of the three areas, with the greatest potential for predation and disturbance.

Area 2 is also elevated (3-4 m) and is in part located on a narrow section of the berm surrounding the

spoil pile on its eastern and southern sides. The eastern section of the berm is comprised of deep soft sand and shell grit and has no vegetation. The southern section of the berm is comprised of compacted muddy sediment and has a sparse covering of Sea Rocket. Two initial nest sites were located here, one on the eastern berm and one on the southern berm. Both sites produced chicks. Subsequent nesting attempts resulted in three further nests in the internal depression, below the berm. This area is comprised of hard-packed sand and shell grit, has no vegetation and has a very limited view of surrounds. All nests in this location produced chicks. All nest sites were within 100 m of the water. No predators or predator tracks were observed in the area, although the remains of one recently deceased chick were found. Newly-hatched chicks in this area were observed crouched down in depressions in the sand or huddled against a large piece of marine debris. One near-fledged chick was observed sheltering in the Sea Rocket. Despite its drawbacks, Area 2 had the highest ratio of observed chicks to known nest sites.

Area 3 is relatively low-lying (0.5-2.5 m) and is surrounded by water on three sides. A thin covering of dredge spoil comprising soft sand and shell grit, shell fragments and other marine debris covers the majority of the site while the southern section is fine beach sand. A channel scoured through the area has exposed a harder substrate. Vegetation in varying amounts is present over all of the site. Little Tern were observed nesting over the entire site at varying times. All nest sites were within 50 m of the water and there was good visibility in all directions. Two thirds of all nests (32) located at Winda Woppa were in Area 3. Initially the majority of the nests were located towards the west of the area but subsequent nesting was dominantly in the south. This change is postulated to be due to the distribution of vegetation. There is very little vegetation that could provide cover for chicks in the western area, compared to the southern area. The site was subject to near constant daily disturbance by visitors, some of whom were accompanied by dogs, but their activities were generally restricted to the beach. Predation by Silver Gull and Australian Raven was confirmed, while there were indications that other predators including Lace Monitor, Australian Pied Oystercatcher and Ghost Crab had been active on site. While Area 3 is the preferred nesting site for most of the Little Tern, it is also subject to the most disturbance and has the highest incidence of observed predation.

The Winda Woppa site covers over 3 ha and most of the area is considered suitable for Little Tern

nesting. Nest density was relatively low and the minimum distance between nests was observed to be around 7 m. The lack of agonistic behaviour between nesting Little Tern also indicated there was adequate space between nest sites. The site is considered to be capable of successfully supporting a much larger nesting colony.

Breeding success ratio also provides a measure of the suitability of the site. The number of fledged Little Tern per nest at Winda Woppa lies within the overall range achieved in the Manning Estuary.

The presence of the waters of Port Stephens on the southern side of the nesting location and the Myall River to the north adds to the suitability of the site. When conditions on Port Stephens are choppy, the calmer waters of the Myall River continue to provide a suitable fishing environment for Little Tern. Paton & Rogers (2009) have shown foraging only in the open ocean presents risks for successful breeding of Fairy Tern *Sternula nereis* in the Coorong, SA. They also demonstrated that it is essential to have an adequate resource of a suitable-sized fish for successful breeding. The Winda Woppa area appears to meet this requirement. The authors have also shown that Fairy Tern, which are a similar size to Little Tern, will not forage more than 2 km from the nest site. Similar fishing distance observations were made at Winda Woppa.

During the survey period, the southern end of Corrie Island was also visited to check for the presence of Little Tern. None was located on the two sandspits in this area which are 1.2 km and 2 km southwest of the Winda Woppa site. Little Tern have been previously reported nesting there in 1972-73 (Morris 1979) and have been recorded as present in all but two surveys conducted by the Hunter Bird Observers Club between 2004 and 2016 (Stuart 2015; Alan Stuart pers. comm.). Both sites are now heavily overgrown with Saltwater Couch *Sporobolus virginicus*.

CONCLUSIONS

A small colony of Little Tern nested successfully at Winda Woppa in the summer of 2016-17. However, the lack of quantitative data on egg and chick predation prevented a complete evaluation of nesting success. Future monitoring of nesting should be on a more frequent basis and adopt a more targeted approach to data gathering. The current and historical records indicate that the Winda Woppa site and adjacent Corrie Island have been used by Little Tern since 1959 and possibly much earlier.

The dredge spoil deposited on the sandspit in 2015 appears to have created an ideal habitat and may have stimulated the current nesting activity. It is probable that the site will be used for nesting in future years. However, the continued use of the dredged spoil to re-nourish eroded nearby beaches may eventually result in the loss of the habitat. It remains to be seen if the Little Tern will continue to nest on the sandspit without the spoil pile.

Considerable disturbance of the site by recreational users, particularly over the Christmas/New Year holiday period may also be impacting breeding success, but to an unknown extent. The management of behaviour of this group, many of whom are short-term visitors, will present a significant challenge. Short-term exclusion barriers around nesting areas may be the only effective option.

Although the nesting colony at Winda Woppa is smaller than those in the Manning Estuary it is one of a very few sites with the requisite ecological requirements for successful nesting of Little Tern in the Hunter Region. The disturbance issues identified in this study point to the need for ongoing management and protection to ensure this site is able to continue to make a contribution towards the conservation of this species. Breeding success rates comparable with the Manning Estuary would undoubtedly be achieved by a proactive programme of monitoring and management, including public education and increased protection of the site by local authorities. Additionally, programmes to provide threat abatement from foxes and wild dogs on the Winda Woppa peninsula and Corrie Island should be continued on a regular basis.

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