A COMPARISON OF ARCTIC TERN *STERNA PARADISAEA* AND COMMON TERN *S. HIRUNDO* NEST-SITE CHARACTERISTICS ON COQUET ISLAND, NORTH-EAST ENGLAND

JAMES A. ROBINSON_, LORRAINE S. CHIVERS & KEITH C. HAMER

Robinson J.A., Chivers L.S. & Hamer K.C. 2001. A Comparison of Arctic Tern *Sterna paradisaea*and Common Tern *S. hirundo* nest-site characteristics on Coquet Island, north-east England. Atlantic Seabirds 3(2): 49-58. *The nest-site characteristics of Common Terns* Sterna hirundo *and Arctic Terns* S. paradisaea *were examined at a mixed colony at Coquet Island, north-east England. All Common Terns and the majority of Arctic Terns nested within areas of short grass enclosed by swards of much taller and dense vegetation. The majority of these nesting areas had been artificially managed to attract nesting terns. A fifth of all Arctic Tern pairs nested on sandy and shingle beaches. Within vegetated nesting areas, Arctic Terns nested less densely, in larger open areas and in shorter vegetation than did Common Terns. Neither species showed preferences for the types of plants amongst which to nest.*

Department of Biological Sciences, University of Durham, South Road, Durham DH1 3LE, UK. _Present address: The Wildfowl & Wetlands Trust, Slimbridge, Glos GL2 7BT, E-mail: James.Robinson@wwt.org.uk

INTRODUCTION

Common Terns *Sterna hirundo* and Arctic Terns *S. paradisaea* breed syntopically over only a small part of their range in northern Europe (Hagemeijer & Blair 1997). Both species nest in a variety of habitats including grassland, dunes and moorland near the coast, offshore islands and inland lochs and even on arable land yet Arctic Terns tend to be more maritime than Common Terns (Lloyd *et al.* 1991). The two species are colonial and often nest in close proximity to each other (Cramp 1985). However, within a site, the nesting areas of the two species are generally discrete, suggesting that differences in habitat preference and/or interspecific competition prior to egg-laying determine nest-site selection.

Both Common and Arctic Terns nest at high densities at relatively few sites around the UK and are therefore prone to the effects of localised catastrophic events. For these reasons, conservation actions are focused at protecting and managing colonies effectively to maintain or improve the conservation status of these species. Most of the largest colonies of Arctic and

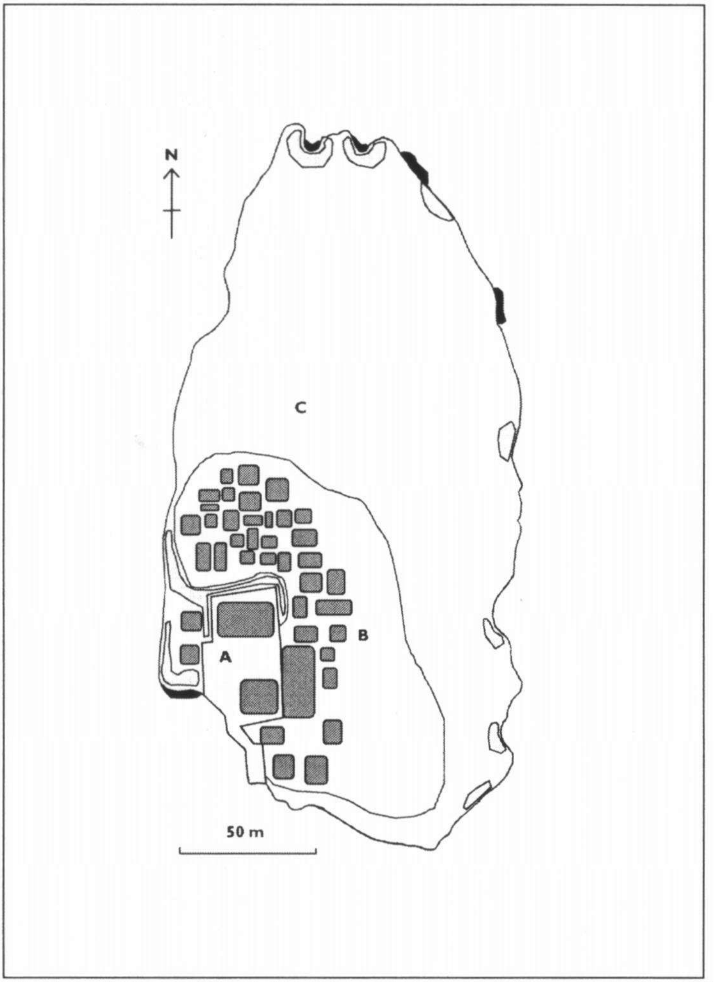

Figure 1. Map of Coquet Island showing nesting areas of Common and Arctic Terns in 1998. Nesting sites in managed plots are shaded in dark grey, in short vegetation outside of managed plots in light grey, and on beaches in black. The area marked A is a walled lighthouse enclosure, B is a dense nettle bed interspersed with managed plots for nesting terns, and C is a Puffin/large gull colony.

Figuur 1. Coquet-eiland met nestplaatsen van Visdief en Noordse Stern in 1998. Donkergrijs = nestplaatsen in beheerde plots; lichtgrijs = nestplaatsen in korte vegetatie buiten de beheerde plots; zwart = nestplaatsen op stranden. A = ommuurde "vuurtoren-enclosure"; B = dicht begroeide netelvegetatie met verspreid beheerde plots; C = kolonie van Papegaaiduiker en grote meeuwen.

Common Terns throughout northern Europe are already protected under national legislation and managed specifically for their benefit.

At colonies where the two species nest within vegetation, traditional nesting areas are often managed to provide expanses of short grass, favoured by nesting adults, enclosed by swards of higher and denser vegetation which provide chicks with shelter and protection from predators during the nestling period. Herbicidal sprays are used to assist with this vegetation management and are applied several weeks before the terns return to a site to avoid any potential negative effects to breeding birds. However, due to the varying effectiveness of spraying techniques there is often a high degree of variation in the species-richness and tallness of vegetation in managed areas. Although this method of vegetation management is extremely successful in attracting breeding terns, there are no data to indicate why different species of terns choose some managed areas and not others. Furthermore, although there is some quantitative information on nest-site differentiation between Arctic and Common Terns (Langham 1974; Boecker 1967), very little statistical information has been presented.

In this paper, we compare the characteristics of nest-sites used by Common and Arctic Terns at a large mixed colony in north-east England and provide statistical evidence for differences.

STUDY SITE

This study was carried out from 24 May to 8 June 1998 at Coquet Island (55 20'N, 1 32'W) which is a small low-lying island 1 km off the coast of Northumberland, north-east England where large colonies of Arctic and Common Terns nest synchronously in close proximity, but in discrete areas using both semi-natural and managed habitats. This island is managed by the Royal Society for the Protection of Birds primarily for the benefit of breeding seabirds. In 1998, approximately 800 pairs of Common Terns and 850 pairs of Arctic Terns nested on the island. Timing of peak laying was similar for both species (modal laying dates for the colony: Arctic Tern 25 May; Common Tern 26 May).

The plateau of the island is approximately 5 ha in area. In 1998, over half of the plateau was covered in thick nettle beds (predominantly *Urtica urens* with smaller areas of *U. dioca*) interspersed with rectangular areas of grass managed specifically for the terns, hereafter referred to as plots (Fig. 1). To maintain the vegetation structure within these plots, conventional herbicides were sprayed in autumn 1997 and in early spring 1998, at least one month prior to the return of the breeding terns. The herbicides chosen do not persist beyond a one-month period and therefore have no effect on the birds breeding on the island. Black-headed Gulls *Larus ridibundus* (2 100 pairs), Roseate Terns *S.*

dougallii (29 pairs) and Sandwich Terns *S. sandvicensis* (1 900 pairs) also nested on the island, often within the managed plots or in close proximity, but generally discretely, to the Arctic and Common Terns.

Most of the remaining area of the plateau not covered by nettles or managed plots was honeycombed by the burrows of approximately 11 500 pairs of Puffins *Fratercula arctica* (Fig. 1). Much of this area was covered in bare sandy soil interspersed with small patches of nettles and tall grasses within which Herring Gulls *L. argentatus* (c.25 pairs) and Lesser Black-backed Gulls *L. fuscus* (c.95 pairs) also nested. Shorter vegetation, similar to that found within plots, was present on paths which led up to a lighthouse from the shoreline and on the very edges of the plateau. The island was surrounded by mostly rocky shoreline with several small sandy and shingle beaches.

METHODS

The gross habitat types used by nesting pairs of both species were recorded on 7 June at the same time as the numbers of breeding pairs were counted. Gross habitat types would not have changed between the time of laying and the date of the survey and, since 7 June was 20 days after the first Common Tern egg had been laid, the timing of the survey allowed the maximum number of clutches to be attributed to gross habitat types prior to the hatching of the first chick. Nest-sites were allocated to one of the following categories: managed plots; vegetated areas outside of managed plots (predominantly paths); shingle beaches; and sandy beaches. The availability of suitable habitat not used by these species was also assessed. The perimeter of each discrete vegetated nesting area was measured to the nearest 1 cm with measuring tape. Boundaries of these areas were defined by dense nettle beds or the edge of the plateau. This information was then used to calculate the area of each discrete vegetated area and nest density within (no. of nests per m^2).

Micro-habitat surveys were carried out between 24 and 26 May, the period of peak laying for both species, in managed plots and other discrete vegetated areas. Transects were made throughout the vegetated areas and sampling points were taken at randomly selected distances along each transect (between one and nine metres selected using random number tables). At each sampling point a one metre squared quadrat was held just above the ground to avoid damaging eggs. Within each quadrat the following eight habitat variables were measured: % coverage by vegetation 0-5 cm; % coverage by vegetation 5.5-10 cm; % coverage by vegetation 10.5-30 cm; % coverage by grasses; % coverage by thistles; % coverage by nettles; % coverage by bugloss; % coverage by bare ground. The vegetation on Coquet Island is dominated by very few plant species. Therefore, rare plant species (i.e. those occupying less than 1% coverage of total area sampled) were omitted from statistical analyses.

Table 1. Habitat coverage of Coquet Island at mean high water mark and use by nesting Common and Arctic Terns in 1998.

Tabel 1. Verdeling van habitats op Coquet Eiland bij gemiddeld hoog water en gebruik door Visdief en Noordse Stern in 1998.

Gross habitat type	Estimated coverage of island (%)	% of total no. of breeding pairs	
		Common Tern (n = 805)	Arctic Tern (n = 843)
Managed plots (short grass)	16	91	60
Short vegetation outside of managed plots	10	9	23
Dense nettle beds	18	0	0
Puffin/large gull colony (sandy soil)	40	0	0
Shingle shores	5	0	16
Sandy shores	3	0	1
Rocky shores	8	0	0

Linear discriminant analysis was used to differentiate between the micro-habitats used by nesting Common and Arctic Terns. This technique compares the between-group variation to the within-group variation and establishes optimal separation of groups based on linear transformation of the independent variables (Green 1971; Gauch 1982). The statistical package SPSS (Norusis 1994) was used to conduct this analysis.

All variables were transformed prior to the discriminant analysis to ensure that all skewed data distributions were normalised. Proportions were arcsine transformed, other continuous variables were logarithmically transformed and counts were square-root transformed (Sokal & Rolhf 1969). The percentage of nests classified correctly was used to indicate the effectiveness of the analysis (Clark *et al.* 1983; Rice *et al.* 1983). Statistically significant differences between groups were based on one-way ANOVAs using the discriminant scores as the dependent variable and the two group variables as the independent variables (Norusis 1994).

RESULTS

Gross habitat types used by nesting Arctic and Common Terns The distribution of Common and Arctic Tern nest-sites on Coquet Island in 1998 is shown in Figure 1. Of the 54 plots managed specifically for the terns 13 (24%) were not occupied by either Arctic or Common Terns on 7 June. These plots were occupied by nesting Black-headed Gulls and Sandwich Terns. A high proportion of the nests of Common and Arctic Terns were found within the vegetated plots that had been managed specifically for the purpose of attracting terns (Table 1). Common Terns nested exclusively in vegetated areas on the plateau of the island whereas many Arctic Terns also nested on shingle beaches and, to a much lesser extent, on sandy beaches (Table 1). Vegetated areas not sprayed but which held large numbers of nesting Common and predominantly Arctic Terns were situated on paths leading from the shoreline to the lighthouse and on small areas of short vegetation towards the edge of the plateau. Both species avoided dense nettle beds, rocky shorelines and predominantly bare areas of the island with high concentrations of Puffin burrows and nesting large gulls (Table 1).

Table 2. Habitat variables measured at the nest-sites of Common and Arctic Terns on Coquet Island 1998 and the results of the discriminant analysis. D.A. scores presented in the table are unstandardised canonical coefficients. * $P < 0.01$; ** $P < 0.001$.

Tabel 2. Habitatkenmerken gemeten op nestplaatsen van Visdief en Noordse Stern op Coquet Island 1998 en resultaten van discrimant analyse. D.A.-scores in de tabel zijn niet-gestandaardiseerde, kanonieke coëffiënten. * $P < 0.01$; ** $P < 0.001$.

Habitat variable	Common Tern	Arctic Tern	D.A. score	%correct	*F* value
	mean ± S.D.	mean ± S.D.			
% 0-5 cm	67.5 ± 22.9	68.5 ± 26.8	-0.34	52.4	0.2
% 5.5-10 cm	21.2 ± 20.5	30.0 ± 27.3	-0.08	67.7	7.3*
% 10.5-30 cm	11.4 ± 16.2	2.0 ± 8.1	-0.09	75.8	17.7**
% grass	72.2 ± 23.7	78.9 ± 19.4	-0.00	54.8	2.1
% thistle	6.8 ± 8.7	3.9 ± 10.1	-2.37	58.1	1.3
% bugloss	2.6 ± 5.8	1.2 ± 5.5	1.21	62.9	1.0
% nettle	2.9 ± 4.5	2.9 ± 7.6	1.26	41.9	0.0
% bare ground	13.9 ± 22.1	10.0 ± 16.2	-1.08	53.2	0.7
Area (m^2)	141.7 ± 122.6	628.9 ± 522.9	8.42	99.9	198.7**
Nest density (n m^{-2})	0.2 ± 0.2	0.1 ± 0.1	49.05	83.9	289.5**
All variables	-	-	-	100	177.4

Micro-habitat selection within vegetated areas The discriminant analysis correctly classified 100% of Arctic and Common Tern nests based on all variables (Table 2). Vegetation height, nest density and plot area were the variables best distinguishing nest-sites of the two species (Table 2). Arctic Terns nested in less densely occupied sites of greater open area than did Common Terns. Both species nested in areas where the vegetation height was predominantly 0-5 cm with much smaller areas of vegetation over 5 cm tall.

However, Arctic Terns nested in areas with a higher proportion of medium height vegetation coverage and a lower proportion of tall vegetation coverage than did Common Terns (Table 2). There was no difference between the two species in the types of vegetation present at the nest-site; both species nested in areas covered predominantly with grasses (Table 2) with smaller areas of nettle, bugloss *Lycopsis arvenis* and thistle (*Sonchus* and *Cirsium* spp.).

DISCUSSION

In this study, the majority of Arctic and Common Terns at Coquet Island nested within vegetated areas managed specifically to provide expanses of short grass enclosed with swards of higher and denser vegetation (Table 1). Other areas of naturally short vegetation were also favoured. Arctic Terns were more cosmopolitan in their choice of nest-site than were Common Terns, the former nesting on small shingle and sandy beaches as well as within vegetated areas on the plateau of the island (Table 1). However, breeding success was low at the beach sites due to tidal inundation during spring series in July (RSPB unpubl. data).

All of the available managed plots (i.e. those without nesting Black-headed Gulls or Sandwich Terns which laid eggs much earlier than the two study species) were occupied by Common and Arctic Terns, together with small numbers of Roseate Terns. Furthermore, very little (< 5%) of the suitable vegetated habitat outside of the managed plots had been left unoccupied by breeding terns. Within-plot nesting density was low compared to that measured at other colonies (Table 2; c.f. Nisbet & Drury 1972; Coulson & Horobin 1976; Bullock & Gomersall 1981; Richards & Morris 1984; Neubauer 1998) which might suggest that the two species could have nested at higher concentrations. However, site-specific characteristics such as nest-site substrate, colony size or predation pressure are important determinants of nesting density at a site (Boecker 1967). Therefore, it is unclear whether these two tern species were nesting at optimal densities at Coquet Island in 1998.

These results suggest that interspecific competition may be of some importance in determining nest-site selection at Coquet Island because the areas available for these two species were confined and very few potentially suitable habitats were left unoccupied in 1998. However, clear differences between the micro-habitats occupied by the two species indicated that there was a certain degree of species-specific choice of nest-site within vegetated areas.

Discriminant analysis has been used in many previous studies to investigate interspecific variations in nest-site selection (e.g. Rice *et al.* 1983; Ramos & Del Nevo 1995; Calladine 1997). The results of our discriminant analysis confirmed much of what has been suggested for Arctic and Common Terns previously (Boecker 1967; Langham 1974; Neubauer 1998). Our analyses showed that within vegetated areas, Common Terns chose to nest in those which had a slightly higher proportion of tall vegetation than those where Arctic Terns nested (Table 2). Benefits of nesting in well vegetated areas may include enhanced nest site recognition by chicks and adults, protection of chicks and adults against predators, and/or shelter from inclement weather conditions (Bloeckpoel *et al.* 1978; Burger & Lesser 1978). However, extremely dense vegetation may make a site unattractive to nesting Common Terns, possibly because of reduced site recognition (Courtney & Blokpoel 1983). Arctic Terns have longer wings and shorter legs than Common Terns, so it may be more difficult for Arctic Terns to lift from, walk and land in areas of higher vegetation (Cramp 1985). In this study, both species nested in similar types of vegetation, i.e. predominantly grasses with scattered areas of taller plants such as nettle, thistle and bugloss (Table 2).

The results also showed that Common Terns nested in smaller plots and nested at higher density than did Arctic Terns at Coquet Island in 1998 (Table 2). Many previous studies of breeding density at Coquet Island and elsewhere have also shown that, in general, Arctic Terns nest less densely than do Common Terns (Nisbet & Drury 1972; Langham 1974; Cramp 1985). The reasons for this difference remain unclear.

Although the effects of interspecific competition may be important in determining the nest-site locations of these two species when available nest-sites are limited, the results of this study provide some indications as to how Coquet Island could be managed further for the benefit of these two species by increasing suitable habitat types. Experimental manipulation of the vegetation on Coquet should be encouraged in the future to determine whether such management techniques could be successful in attracting target species. Similar work has been successfully undertaken elsewhere (Richards & Morris 1984; Fasola & Canova 1996).

To summarize, the results of this study show that, on Coquet Island, although both species nest predominantly in vegetated areas, Common Terns nest in smaller plots with higher vegetation and more densely than do Arctic Terns and that this can be shown statistically. However, species-specific nest-site preferences can differ markedly between sites (Ramos & Del Nevo 1995). For example, at many sites Common Terns nest in areas with little or no vegetation, in contrast to the results of this study (Burger & Lesser 1978; Richards & Morris 1984; Neubauer 1998; Sudmann 1998). Furthermore, traditional nesting areas may be used annually, irrespective of changes in vegetational succession (Blokpoel *et al.* 1978). We therefore recommend that the nest-site requirements of these two species should be determined on a site-specific basis wherever this is possible.

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EEN VERGELIJKING TUSSEN NESTPLAATSKARAKTERISTIEKEN VAN DE NOORDSE STERN *STERNA PARADISAEA* EN HET VISDIEFJE *S. HIRUNDO* OP COQUET ISLAND, NOORDOOST-ENGELAND

De karakteristieken van broedplaatsen van Noordse Sterns Sterna paradisaea *en Visdiefjes* Sterna hirundo *werden in 1998 onderzocht en vergeleken in een gemengde kolonie op Coquet Island, aan de noordoostkust van Engeland. Alle Visdiefjes en de meeste Noordse Sterns nestelden op plekken met kort gras, omgeven door stroken met een veel hogere, dichte vegetatie. De meeste nesten werden gevonden in stukken waar het beheer was afgestemd op het creëren van een aantrekkelijke broedbiotoop voor sterns door de vegetatie kort te houden. Noordse Sterns hadden een bredere biotoopkeus dan Visdiefjes: ongeveer een vijfde van alle Noordse Sterns nestelde op kale zand- en grindstranden (tabel 1). In de begroeide gebiedjes kwamen de Noordse Sterns hoofdzakelijk op de meest kale plekken tot broeden, in veel lagere dichtheden dan Visdieven. Vegetatiehoogte, nestdichtheid en plotgrootte bepaalden het verschil in nestplaats grotendeels (tabel 2). Geen van beide soorten had een duidelijke voorkeur voor de plantensoorten in de nabijheid van het nest.*

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