Regional Studies in Marine Science 8 (2016) 14–19

Contents lists available at ScienceDirect

Regional Studies in Marine Science

journal homepage: www.elsevier.com/locate/rsma

Reproductive success of nesting terns on the central Texas coast

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HIGHLIGHTS

- We establish correlations between nest-site parameters and hatching success of terns.
- Colonies on dredge material islands in Nueces Bay were monitored from 2012 to 2013.
- Hatching success was most strongly influenced by *Spartina* spp. coverage and elevation.
- Findings imply a previously understated impact of storm events on nesting terns.
- Predation effects were also observed within colonies containing Gull-billed terns.

ARTICLE INFO

Article history:
Received 25 April 2016
Received in revised form
27 July 2016
Accepted 10 August 2016
Available online 16 August 2016

Keywords:
Terns
Seabirds
Coastal ecology
Nesting
Dredge islands

ABSTRACT

Terns are relatively long-lived seabirds that possess significant potential as bioindicators due to their sensitivity to changes in the marine and coastal environment. Nest site selection is important because the demands of reproduction can be substantial and the reproducing pair is often confined to the area selected for the duration of the breeding season. This study defines temporal effects and correlations between hatching success of nesting Forster's Tern *Sterna forsteri*, Gull-billed Tern *Gelochelidon nilotica*, and Least Tern *Sternula antillarum* and environmental characteristics of a complex of newly constructed dredge material islands in Nueces Bay. Colonies were monitored during the 2012 and 2013 breeding seasons. Correlations of hatching success varied with species but most were strongly influenced by *Spartina* spp. coverage and elevation implying a previously understated importance of storm events on the hatching success of these species on the central Texas coast. Establishing these correlations in environmental nest site characteristics and hatching success between years of succession provides a baseline understanding of tern breeding biology on dredge material islands in the central Coastal Bend region of Texas, which may assist future management decisions and restoration efforts.

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1. Introduction

Terns (Sternidae) nest in single species or mixed colonies and construct nests or nest scrapes on the ground (Thompson and Slack, 1982). Nest site selection strongly influences reproductive success because the nesting pair and any offspring are essentially confined to the area until the young are capable of flight (Burger and Gochfeld, 1988). The availability of resources such as cover and food, the densities of nesting competitors – conspecifics or other species, such as gulls – and predators, and disturbance contribute greatly to a pair's success or failure in any given breeding season (Burger and Gochfeld, 1988; Langham, 1974; Monaghan et al., 1989). Vegetative cover protects chicks from predation and extreme temperatures once they leave the nest but before they are capable of flight (Miyazaki, 1996; Saliva and Burger, 1989; Stauffer and Best, 1986). Denser colonies of ground-nesters may help prevent predation because predators are detected earlier (Wittenberger and Hunt, 1985) but large colonies may attract predators, diseases and parasites may be more prevalent (Larivière and Messier, 1998; Brunton, 1997), and other adults within colonies may prey upon chicks (e.g., gulls). Disturbance in optimal nest sites means that nesting pairs may choose less suitable sites and flushing of adults exposes eggs/chicks to predation and, later in the breeding season, high temperatures (Burger, 1977; Burger and Lesser, 2008). In addition, because environmental conditions change as the season progresses, the timing of nest initiation may greatly affect nest retention and success (Burger and Gochfeld, 1988; Spendelow, 1982).

On the central Texas Gulf of Mexico coastline, many tern species use dredge material islands as nesting habitat (Mallach and Leberg, 1999). While these islands can provide terns with suitable nest-

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http://dx.doi.org/10.1016/j.rsma.2016.08.002
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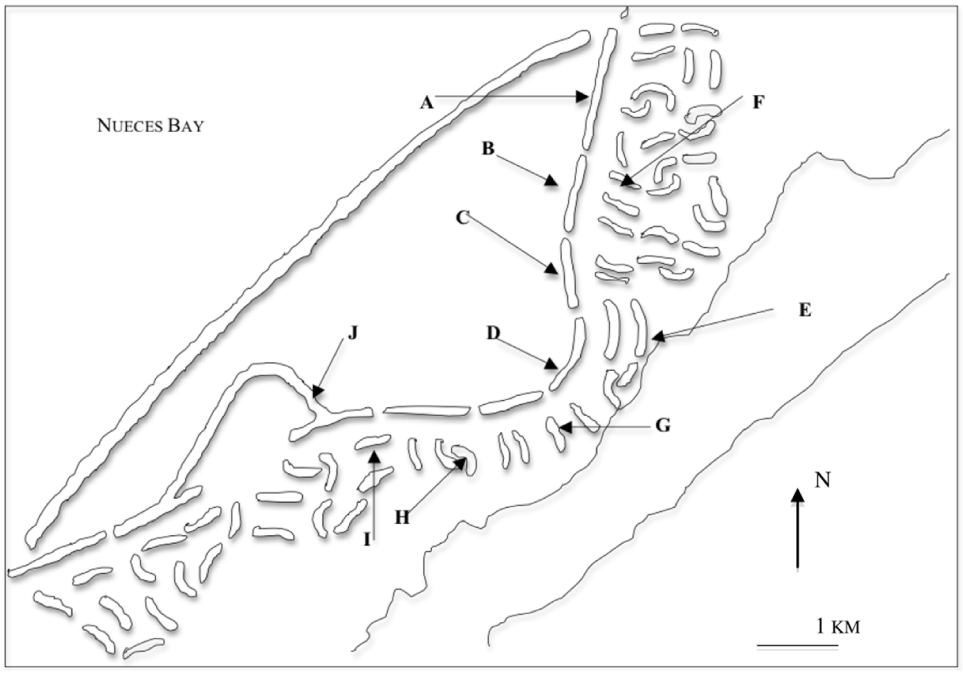

Fig. 1. Map showing the ten islands within site 4, the Nueces Bay Salt Marsh Restoration site that were monitored during the 2012 and 2013 breeding season. Each island was named a letter (A–J) to assign identity.

ing habitat, the quality of the habitat varies depending on elevation, orientation, vegetative cover, and distance to other islands or mainland areas (Thompson and Slack, 1982). Disturbance may be minimal on newer islands but substrates may not be suitable and vegetative cover may be lacking. Islands that have become naturalized, while typically providing better vegetative cover, are often disturbed more frequently and may support predator populations (McNicholl, 1982; Brunton, 1997). If the elevation of a constructed island is not high enough, birds nesting there may be subjected to high tides during storms, while nests on islands that are too near the mainland or other islands are typically subjected to greater predation and/or human encroachment (Thompson and Slack, 1982). Thus, we can expect islands with higher elevations to foster increased hatching success due to a decrease in tidal inundation. Similarly, islands with more Spartina *spp*. coverage can be expected to offer storm-buffering effects to nesting terns, increasing hatching success. In this study we report on hatching success as a function of timing in the breeding season, island area, total vegetative cover, *Spartina* spp. coverage, nest density, and richness of the nesting assemblage in Forster's Terns (*Sterna fosteri*), Gull-billed Terns (*Gelochelidon nilotica*), and Least Terns (*Sternula antillarum*) using newly constructed dredge material islands on the central Texas coast.

2. Methods

The site surveyed in this study was the Portland Causeway Marsh Restoration Project in Nueces Bay, Texas (Nueces Bay Salt Marsh Restoration—NBSR (Fig. 1). The island complex encompassed by this restoration project were newly constructed dredge material islands that provided a diverse selection of vegetation cover, island area, elevation, and nesting bird diversity. These islands were monitored for two consecutive years—the breeding seasons of 2012 and 2013.

2.1. Hatching success

Individual nest success was monitored for all species nesting within colony sites. Nests were marked at initiation using a painted and numbered wooden (∼30.5-cm) marker wedged in the ground roughly 0.5 m from the nest. The species of each nest was recorded as well as the number of eggs and fledglings present at the date of survey. Nesting sites were visited every 8–10 days, frequent enough to capture fledglings in the record but seldom enough to minimize disturbance caused by the sampling (Safina and Burger, 1983). With this data, colony productivity (fledglings produced per colony), hatching success (proportion of nests resulting in at least one fledgling), and mean clutch size per colony were calculated and compared against a gradient of potentially influential factors: elevation (m), island area (ha), % total vegetation cover, % *Spartina* spp. cover, temporal scale, and density (nests/ha^2).

Elevation was measured as a relative to the mean surface level of the water (Nueces Bay) and not to absolute elevation at mean sea level. Since ground nesting birds are particularly susceptible to nest loss due to high tides and storm events (Erwin et al., 1998; Fisk 1975; McNicholl, 1982), using relative elevation provided a more accurate depiction of nest site suitability. Island area was calculated in square hectares using tools in the online software GoogleEarth™.

At each site, percent total vegetation cover and surrounding *Spartina* spp. coverage were estimated by sight. Physical estimations of vegetative characteristics would have been inappropriately invasive due to the density and sensitivity of the nesting seabirds at these sties. Additionally, had the vegetation been sampled at the conclusion of the breeding season, the quick growth rate of these vegetative species would have skewed realistic representations of the state of the islands during breeding. Date of initiation and ultimate outcome (success/failure) for each nest was recorded. Breeding success has been linked in other studies to time of nest initiation within the breeding season (Burger and Gochfeld, 1988).

For each colony, total density (total nests per hectare) was calculated by conducting an accurate ground-count of the number of nests across the total available nesting surface of the island. Richness was measured as an index of assemblage composition: 1 (only a single species present) to 3 (all 3 species were present). An assemblage composition index of 3 can also include another nesting seabird species—usually Black Skimmer *Rynchops*

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