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Aspects of Forster's Tern (*Sterna forsteri*) Reproduction on Cobblestone Islands in Southcentral Washington

Abstract

Reproductive variables of the Forster's tern (*Sterna forsteri*), a species normally found nesting in marshes, were studied during the 1985 breeding season on cobblestone islands on the Hanford Reach of the Columbia River in southcentral Washington. In a colony of 81 active nests, average clutch size was 2.9 ($\pm$0.39; 1 S.D.). Nesting success, based on successful chick hatchings (at least 1 chick per nest), was 71.6 percent and exceeded that reported for marsh studies.

Introduction

The Forster's tern (*Sterna forsteri*) has been described in relation to its breeding behavior as a bird that nests principally in marshes, and only on occasion on gravelly or sandy beaches or bars (Bent 1921, McNicholl 1971). On the Hanford Reach of the Columbia River in southcentral Washington, Forster's terns nest on cobblestone islands. This situation provides an opportunity to compare data on reproductive success obtained from a dry-land colony to that obtained from marsh-nesting colonies.

Study Area

Hanford Reach Islands Nos. 18, 19, and 20 have a history of nesting site use by Forster's terns (Thompson and Tabor 1981)(Figure 1). Because these islands are in the McNary National Wildlife Refuge, public access is restricted to them from 1 February to 30 June. During the 1985 nesting season, two Forster's tern colonies, 18A and 18B, were located on Island No. 18 and one on Island No. 19. These islands consist mostly of cobble substrate (Fickeisen *et al.* 1980) and at low river levels are approximately 37.2 and 50.9 ha in size, respectively (Dewaard 1981). Island No. 18 often is split into two islands during the spring when upstream Priest Rapids Dam maintains high river flows. The colonies were located on the upstream ends of the islands, just above the high water mark resulting from dam operation. Colony 18B was located on the upstream end of the split-off portion of Island No. 18 and was adjacent to a mixed colony of ring-billed gulls (*Larus delawarensis*) and California gulls (*L. californicus*). When river levels lowered, gulls also flocked at the extreme upstream tip of the islands.

Several plant communities exist on each of the islands (Hanson and Eberhardt 1971, Fickeisen *et al.* 1980, Dewaard 1981). At all three colony locations terns nested mainly in areas of scattered vegetation dominated by absinthe (*Artemisia absinthium*), northern buckwheat (*Eriogonum compositum*), and Columbia River grindelia (*Grindelia columbiana*). Small amounts of lupine (*Lupinus* sp.) and mulberry (*Morus alba*) were also present. Later in the breeding season, as river levels lowered and chicks left the colony nesting area, willow (*Salix exigua*), that earlier in the season were generally inundated, became important as cover.

Methods and Materials

During May through July 1985, colony 18A was visited on an almost daily basis. Data were obtained both from ground surveys and approximately 145 hours of observations from an elevated blind. Because visits to the other two colonies were less frequent, they were excluded from data analysis. The active nest count at colony 18A represented nests containing at least one egg. A scaled map showing nest locations was made to aid identification and assess colony structure for comparison with marsh colonies (Figure 2). The map includes some nests of incomplete construction that were abandoned prior to egg laying. Internest distances were measured from the nearest edge of each nest. Nest spatial relationships were assessed using the method of Clark and Evans (1954).

Average clutch size per nest was determined using nests only with completed clutches. Nests

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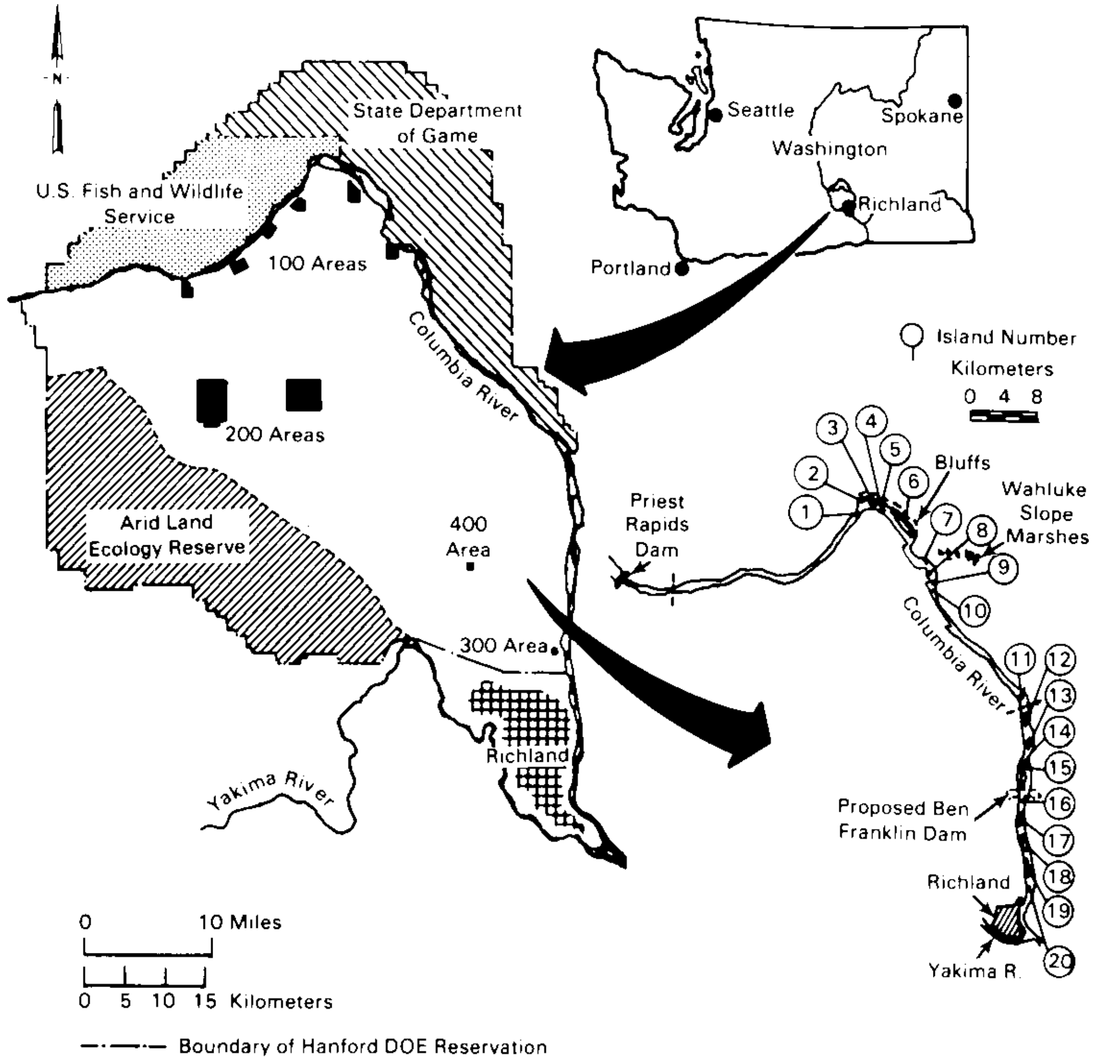

Figure 1. Hanford Reach of the Columbia River.

considered to have incomplete clutches appeared partially constructed and were unoccupied. Hatching success of each egg and the fate of each chick prior to its leaving the colony were recorded. Productivity was calculated as the proportion of chicks that were reared successfully up to the time of leaving the colony nesting areas per number of eggs layed in the colony. Comparisons between the productivity data of this study and those of a marsh study (McNicholl 1971) were made using the goodness of fit G-test of Sokal and Rohlf (1981).

Results

Colony 18A consisted of 81 active nests. More than half of the nests were constructed directly atop only the cobble substrate. Others were constructed in association with some of the scattered vegetation, principally northern buckwheat. Nest density varied with location in the colony and ranged from approximately 0.01-0.05 nests per m^2; nest density appeared to be associated with vegetation density (Figure 2). The mean internest (nearest neighbor) distance was 3.5 ± 1.9 m (1 S.D.), with a range of 0.9-12.7 m. The minimum

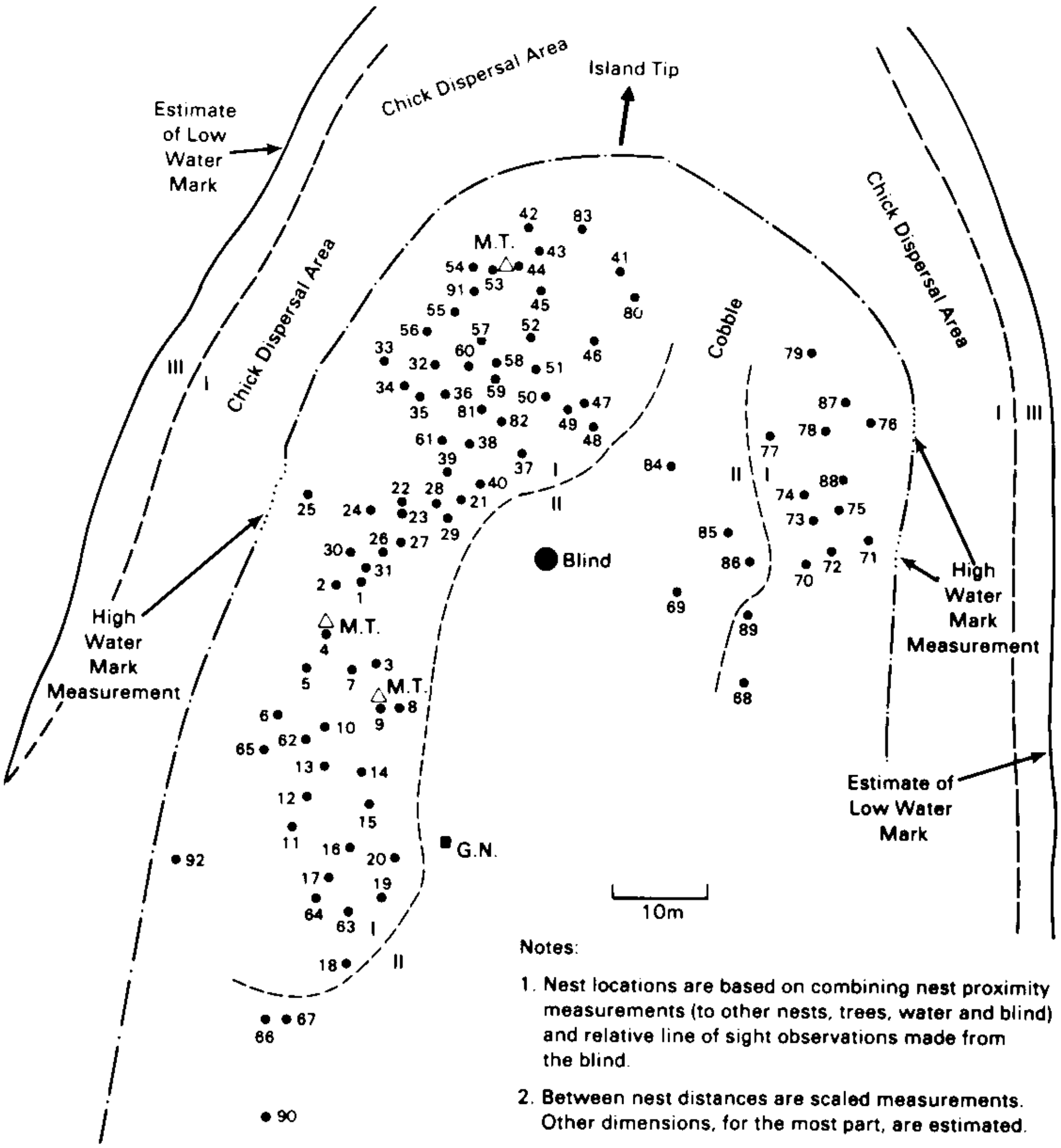

Figure 2. Relative nest locations at colony 18A. Legend: I = absinthe community; II = northern buckwheat community; III = willow community; G.N. = ring-billed gull nest; and M.T. = mulberry tree.

distance measured (0.9 m) involved an unoccupied nest; whereas, the minimum distance between two adjacent occupied nests was 1.8 m.

Mean clutch size and various indices of reproductive success are presented in Table 1. At colony 18A, the most frequent clutch size was three (61 nests). The mean incubation time was 24 days (based on 4 nests and 6 eggs; range 23-26 d). The incubation period for the colony extended for roughly eight weeks with most chicks (86%) hatching within a two week interval. Young stayed in the nest vicinity for an average of four days. Thereafter, they were led by adults to areas outside the colony proper (Figure 2) where they were cared for until fledging (Hall 1988). From observations of newly fledged chicks, fledging

TABLE 1. Productivity data of Forster's terns nesting on a cobblestone island and in a marsh.

Variable	Present Study Number	Present Study Percent	McNicholl (1971) Number	McNicholl (1971) Percent
Colony Size (nests)	81		85	
Eggs Laid	220	100.0	217	100.0
Clutch Size (S.D./N)	2.9 (±0.39/74)		2.7 (±0.47/77)	
Eggs Hatched	154	70.0	33	15.2
Eggs Not Hatched (cause independent of predation)	66	30.0	168	77.4
Eggs Lost to Predation	0	0.0	16	7.3
Chick Mortality Prior to Leaving the Colony	25	16.2	18	54.5
Chick Productivity Prior to Leaving the Colony	129	58.6	15	6.9
Successful Nests[a]	58	71.6	14	16.5

[a]Nests that hatched at least 1 chick, whether or not the chick survived to fledge.

was estimated to take place four to five weeks after hatching. Productivity based on the number of chicks fledging was not obtained, as fledging occurred away from the immediate nesting area.

Discussion

In the marsh, Forster's terns build their nests predominantly atop muskrat (*Ondatra zibethica*) houses, active and inactive, and floating vegetation, with frequently more than one nest located on a substrate (Bergman *et al.* 1970, McNicholl 1971). Both Bergman *et al.* and McNicholl found evidence of social nesting where nest-site selection appeared dependent on social attraction and not just nest-site availability. McNicholl determined mean internest (center to center) distances of 0.8 m and 6.8 m, for nests on muskrat houses and floating rafts of mostly dead vegetation, respectively; but more significant was his finding that nests floating independently were still only a mean distance of 6.7 m away from nests on muskrat houses and rafts. The terns that nested independently, nested in closer association to the nests on the muskrat houses and rafts than would be expected based on the amount of available nesting sites (McNicholl 1971). At colony 18A, the density of nests varied and was perhaps somewhat related to the density of the vegetation and the cover it provided. Mean internest distances were approximately halfway between those reported by McNicholl.

The spatial relationship of nests within a Forster's tern colony appears to be constrained by both physical and social features of the environment. Social attraction causes the terns to aggregate together as a colony; whereas, the availability of suitable nest sites and the existence of maximum and minimum acceptable distances to a neighbor determines whether the tern nests will exhibit an aggregated, random, or uniformly spaced distribution (Clark and Evans 1954). In colony 18A where low nest density occurred (0.01 nests per m^2), nests tended to be aggregated; whereas, at high nest density (0.05 nests per m^2), the tendency was for nests to be uniformly spaced. Thus, social attraction appears to be important, but in high nest density situations the terns attempt to achieve maximum spacing.

McNicholl (1971) obtained similar results for colony size, total eggs laid, and average clutch size for Forster's terns nesting in a marsh (Table 1); although, in his colony the terns bred asynchronously so that the colony size at any one time was smaller than that listed in Table 1. McNicholl's average clutch size is based on data from two nesting seasons and also reflects eliminating nests that had incomplete clutches (generally only 1 egg present). Clutch size distributions between this study and McNicholl's were not different ($G = 2.415$, $df = 2$, $P > 0.1$).

McNicholl believed clutch sizes of greater than three reflected the work of more than one female. My only nest with four eggs supported this observation. Two eggs were layed at least five days later than the first two eggs. The mean incubation time obtained in the present study (24 days) is the same interval obtained by Bergman *et al.* (1970) and McNicholl (1983). Thus, terns do not appear to make any adjustments in clutch size or incubation time dependent on nesting in different habitats.

There was a difference in the proportion of eggs hatched between the two studies ($G = 142.404$, $df = 1$, $P < 0.001$). In the present study, egg predation was not observed until colony size was reduced to six active nests and only included those eggs of nests already unoccupied. Prior to this, the adult terns effectively mobbed potential aerial predators, principally gulls. Additionally, the swift current and depth of the Columbia could act as a barrier to the movement by ground predators onto the islands. Causes for abandoning nests still containing eggs were not determined, but could have involved desertion caused by disturbance or mortality of one or both of the incubating adults. In the marsh, predation (mostly mink, *Mustela vison*) accounts for some of the egg loss; however, the bulk of the loss (138 eggs) is a direct result of wave action (McNicholl 1971).

I could not assign any chick mortality directly to predation (Table 1). Chicks found dead in the colony were generally only a day or so old, still present in the nest cup, and without signs of physical abuse. The most probable cause of death was hypothermia due to exposure during disturbances. During a period of cold, wet weather, disturbance pressure caused by gulls and my own presence possibly led to nest inattentiveness by the adults at a time when the young chicks had not developed an adequate ability to thermoregulate. As with egg loss, chick mortality in the marsh is also proportionately high when compared to the present study ($G = 19.119$, $df = 1$, $P < 0.001$). In the marsh, 10 of the 18 chicks found dead were killed by predators and six died during a storm (McNicholl 1971).

Overall, productivity was greater in the present study than in the marsh. Of the 220 eggs layed in colony 18A, 58.6 percent (129) survived as chicks to leave the nesting area compared to 6.9 percent in McNicholl's (1971) marsh study. In the marsh study of Bergman *et al.* (1970), nesting success was only 12 percent (13 of 107 nests). In this latter study, nesting success was based on the hatching of at least one chick at a nest site whose continued presence was noted during subsequent weekly surveys. The causes of nesting failure were similar to those reported by McNicholl. A similar measure of nesting success, calculated for the present study, was 71.6 percent; whereas, McNicholl reported only 16.5 percent.

Water appears to play a key role in nest site selection and the subsequent reproductive success of the Forster's tern. For large marshes, McNicholl (1971) indicated nests tended to be constructed facing open water; whereas, the terns avoided small marshes (see also Bergman *et al.* 1970). The open water situation allows exposure to the action of wind and waves. McNicholl identified weather as the most important factor determining tern nesting success. Because of the proximity of the tern nests to water in a marsh, they are quite susceptible to wave damage (McNicholl 1971). On the Hanford Reach, the dam-regulated, early spring high river levels can be a larger problem than weather. Depending on how long high river levels are maintained, initial nesting attempts could be hindered and the chances of successful re-nesting diminished by reducing the amount of available nesting habitat and destroying early nests and eggs. For the 1985 nesting season, however, water levels did not appear to interfere with nesting. Thus, although they were nesting in what is considered for them an atypical habitat, Forster's terns on the Hanford Reach islands had a greater nesting success than reported for this species in marsh habitat.

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