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# Ground-Nesting Waterbirds and Mammalian Carnivores in the Virginia Barrier Island Region: Running out of Options

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**ABSTRACT**

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We examined changing patterns of distribution of two large mammalian predators, the raccoon (*Procyon lotor*) and red fox (*Vulpes vulpes*), and beach-nesting terns and Black Skimmers (*Rynchops niger*) along ca. 80 km of the Virginia barrier island landscape between the periods 1975–1977 and 1998. Based on evidence from trapping, scent stations, den observations and sightings of the two predators, there has been a marked increase in their island ranges. In 1975–77, only 6 of the 11 surveyed barrier islands definitely harbored at least one of the two mammals, but by 1998, 11 of 14 islands showed evidence of one or both during the spring and summer. Concurrently, annual beach-nesting bird surveys have been conducted since the mid 1970s during June. From 1977 to 1998, the number of colonies of terns [Common (*Sterna hirundo*), Gull-billed (*S. nilotica*), Least (*S. antillarum*), Royal (*S. maxima*), and Sandwich (*S. sandvicensis*)] and Black Skimmers declined from 23 colonies on 11 barrier islands to 13 colonies on 10 islands. In addition, the populations decreased dramatically for all species except the marginal Sandwich Tern and Least Tern. This pattern suggests that mammalian predation may be a major factor in colony site selection or success, although we have no data on success at most locations. The only consistently large colony over the years has been the Royal Tern colony on Fisherman Island, one of the few with no resident large mammals. Because these declining waterbirds appear to be running out of options for safe colony sites in coastal Virginia, we discuss the prospects of conducting limited predator removals on certain islands. In addition, considerations of strict management and enforcement of protection at critical manmade colony sites that now attract large numbers of certain species, are timely. Lastly, where dredged material disposal projects are planned, providing nesting sites for these colonial species and roosting sites for migrant birds may be appropriate.

**ADDITIONAL INDEX WORDS:** *Barrier islands, mammalian predation, waterbirds.*

## INTRODUCTION

The role of predatory mammals, trophic cascades and effects on avian diversity in fragmented habitats has received recent attention (CROOKS and SOULE, 1999). Mammalian predation has long been established as one of the key selective forces in the evolution of coloniality in birds (LACK, 1968; NELSON, 1979; WITTENBERGER and HUNT, 1985; KHARITONOV and SIEGEL-CAUSEY, 1988; ROLLAND *et al.,* 1998). More recently, the role of predatory mammals and trophic cascades and their effects on avian diversity in fragmented habitats have been revealed. In addition to its evolutionary implications, it has become a growing management concern to seabird conservation biologists as nonindigenous or native mammals are introduced or spread in many parts of the world, often causing reproductive failure in colonies (see chapters in CROXALL *et al.,* 1984; NETTLESHIP *et al.,* 1994). Predation on nesting seabirds by rats (*e.g., Rattus norvegicus*) in Europe (MOLLER, 1983) and New Zealand (MOORS *et al.,* 1989) and larger mammals such as red fox (*Vulpes vulpes*) and Arctic fox (*Alopex lagopus*) in both Europe (LARSON, 1960) and North America (JONES and BYRD, 1979; MACCARONE and MONTEVECCHI, 1981) are but examples of a ubiquitous global problem. Along the Atlantic Coast of the United States, a third widespread predator, the raccoon (*Procyon lotor*) is a common member of the mammalian community on coastal islands (PATTERSON *et al.,* 1990). Recent indications are that raccoons may be an increasing threat to ground-nesting birds in a number of mid- and south Atlantic coastal areas (in Virginia, PATTERSON *et al.,* 1990; in South Carolina, P. WILKINSON, South Carolina Wildlife and Marine Resources, pers. comm.; and in eastern

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Florida, H.T. SMITH, Florida Department of Environmental Protection, pers. comm.).

In coastal Virginia, a number of species of ground-nesting colonial waterbirds including Common Terns (*Sterna hirundo*), Gull-billed Terns (*S. nilotica*), Royal Terns (*S. maxima*), Sandwich Terns (*S. sandvicensis*), Least Terns (*S. antillarum*), and Black Skimmers (*Rynchops niger*) are prominent members of the breeding community of waterbirds. However, in the past two decades, populations of these species seem to have declined (except Royal Terns) considerably on the barrier islands (WILLIAMS *et al.,* 1990). Some combination of storm and tidal flooding, food limitation, competition with larger gulls, as well as mammalian predators, is probably at play to explain these declines (BURGER and GOCHFELD, 1990, 1991; ERWIN *et al.,* 1998). In this paper, we focus on landscape-scale changes in the distribution of raccoons and foxes as dominant mammalian predators on the barrier islands and compare corresponding changes of these ground-nesting seabirds. We test the following hypothesis: Changes in the distribution of red foxes and/or raccoons on the Virginia barrier islands has had no effect through time on the distribution and/or colony sizes of beach-nesting terns and Black Skimmers.

## METHODS

We obtained information on the June to August 1975–77 (4069 trap-nights) distribution (presence/absence) of red foxes and raccoons on seven Virginia (Accomac and Northampton counties) barrier islands from previously published accounts (DUESER *et al.,* 1979) and from field records from U.S. Fish and Wildlife Service (USFWS) personnel (Fisherman Island) (Figure 1). Data were collected based on sightings, trapping, and from den observations. The islands from Assawoman to Cedar were not trapped for mammals during 1975–77, however 1977 field records of Gerald Hennessey, former Director of the Virginia Coast Reserve/The Nature Conservancy (for Assawoman and Metomkin islands), and one of us (BRT in 1977 on Metomkin Island) were reviewed for track records of raccoons and foxes during the period May–August (for Metomkin). Cedar Island and Ship Shoal Island were not surveyed at all for large mammals during this period. Comparisons of beach surveys for tracks with trapping results indicate that, at least for presence/absence data, beach surveys are equally effective at detecting presence of these two large mammals (R.D. DUESER, Utah State University, unpubl.). From October 14 to 21, 1998, surveys of foxes and raccoons were conducted over an eight day period by one of us (JEJ), using the scent station technique (see WILSON *et al.,* 1996). During March 13–18, 1999, additional week-long beach surveys (tracks only) were conducted at the same sites by JEJ and colleagues. Evidence of mammal presence on the barrier islands was based on finding tracks (at either scent stations or anywhere along the beach berm/overwash flats between stations) at seven barrier islands (surveyed by JEJ) as well as searches of the entire lengths of the four northern islands for tracks and/or den sites in April–May 1998 by I. Ailes (USFWS) and B.R. Truitt. While these methods are not directly comparable between the two time periods, we feel the thoroughness of the surveys should be sufficient to document at least the presence of the two large mammal species given the ease with which track detection on narrow sandy beaches can be made (R.D. DUESER, pers. comm.).

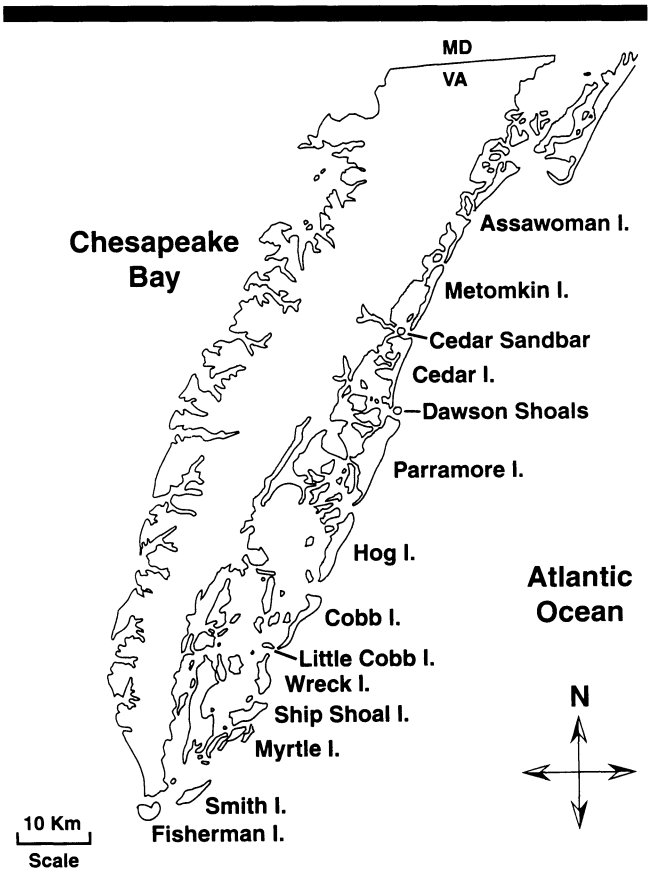


Figure 1. Map of the coastal barrier island study area in Virginia.

Bird nesting colony information was obtained from the USFWS records and The Nature Conservancy-sponsored barrier island bird surveys conducted annually since 1975 from Fisherman Island to Assawoman Island (*e.g.*, see ERWIN and KORSCHGEN, 1979; WILLIAMS *et al.,* 1990). From these data and from maps, we determined the number of colonies of terns and Black Skimmers, estimated the combined abundance of all species in the colonies (many are mixed-species colonies), and then for display, categorized these into three size groups: small (<100 birds, or 50 pairs), medium (100 to 300 birds), and large (>300 birds). We compared average colony size changes between 1977 and 1998 using a Wilcoxon two-sample test for Common Terns, Black Skimmers, and Least Terns, the ones with large enough samples for analyses. As in earlier publications (ERWIN and KORSCHGEN, 1979), we define colony sites as nesting assemblages that are at least 200 m distant from the next nearest assemblage.

## RESULTS

The distribution of large mammals and birds has clearly changed from 1977 to 1998 (Table 1, Figure 2). Raccoon pres-

Table 1. *Recent surveys of mammalian predators and beach-nesting waterbirds on barrier islands in coastal Virginia, 1977 and 1998. Mammals are fox (F) or raccoon (R) only. Bird colonies categorized into small (S = <100 birds), medium (M = 100–300), and large (L > 300 birds) sizes. NA (not applicable) indicates that the island did not exist in 1977.*

| | 1977 | | 1998 | |
|---|---|---|---|---|
| Island | Mammals[a] | Birds[b] | Mammals[c] | Birds[d] |
| Assawoman | R, F | 0 | F | 0 |
| Metomkin | U | L | F | S |
| Cedar sandbar | NA | NA | F | L |
| Cedar | ? | S | F | M |
| Dawson Shoals | 0 | 0 | 0 | L |
| Parramore | R, F | S | R, F | 0 |
| Hog | R, F | M | R | S |
| Cobb | R | S | R | 0 |
| Little Cobb | R | L | ? | L |
| Wreck | 0 | S | R | L |
| Myrtle | 0 | M | R | M |
| Ship Shoal | ? | M | R | 0 |
| Smith | R | L | R, F | 0 |
| Fisherman | 0 | L | 0 | L |
| Totals[e] | 6 (11) | 23 colonies | 11 (14) | 13 cols. |

[a] Survey data from Dueser et al. 1979 for surveys from Parramore south to Smith Islands; the Assawoman to Dawson Shoals segment was not included in the trap survey. See Methods for details. A "U" indicates "unlikely" mammal occupancy; a "?" indicates that the island was not surveyed for mammals. Fisherman Island was surveyed by USFWS refuge personnel. Cedar Sandbar did not exist in 1977 whereas Dawson Shoals is an exposed sandy shoal that has no cover to support any mammals.
[b] Bird survey data from Erwin and Korschgen 1979; some islands have more than one colony site.
[c] Survey data from marking stations by J. Jimenez, (unpubl. data) for islands from Parramore to Fisherman Island. Northern islands (Assawoman to Parramore) surveyed by B. Truitt and I. Ailes.
[d] Bird survey data from B. Williams, unpubl. data.
[e] Totals indicate numbers of islands with predators (and total islands) and numbers of bird colonies on all the islands in that year (with > 10 individuals).

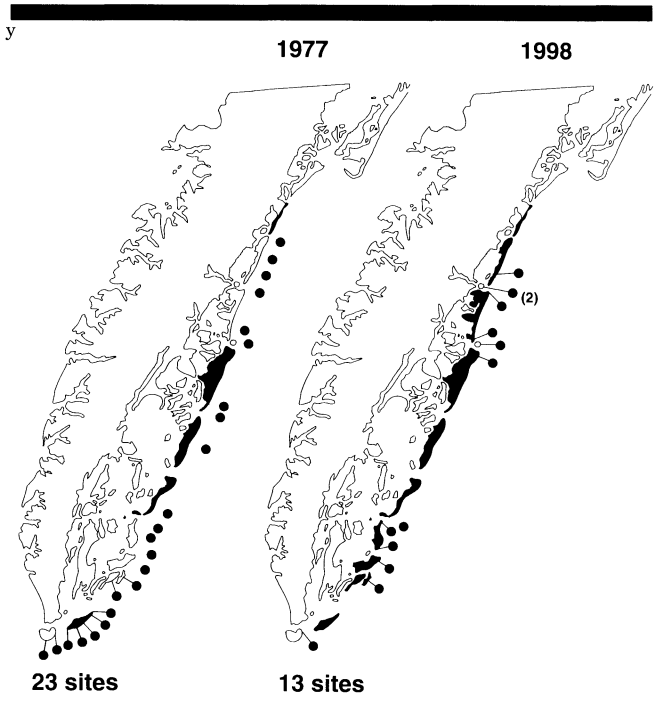


Figure 2. Contrast of large mammal (red fox and raccoon) distribution (mammal presence shown as solid islands) from the periods 1975–77 and 1998 along the barrier islands of Virginia. Superimposed on this pattern is the colony site location of beach-nesting terns and Black Skimmers during the same periods. Total number of bird colony sites are indicated for the two time periods.

ence on barrier islands increased from six (probable) to seven islands in that period, while foxes increased from (probably) three in 1977 to six in 1998. In 1977, fox locations included the one published location (Hog Island, DUESER *et al.*, 1979), in addition to sightings of fox and raccoon sign (referred to as "probable") by Mr. Gerald Hennessey, former Director of the Virginia Coast Reserve, on Assawoman Island, and finding an active fox den by B.R. Truitt on Parramore Island in February 1977. Of 13 barriers available in 1977, fox or raccoon presence was definite at only six of the 11 surveyed (Cedar and Ship Shoal not surveyed). In 1998, however, 11 of 14 surveyed islands were occupied by at least one of the two mammals (Table 1, Figure 2).

Concurrently, beach-nesting waterbirds were reduced from 23 colonies on 11 islands in 1977 to only 13 colonies on 10 islands in 1998 (Table 1, Figure 2). The most noteworthy changes were the losses of several large colonies on Smith and Metomkin islands. In general, where foxes occur, there are no large colonies that persist for the entire nesting season. When we compared population sizes, we noted large decreases in all species except the ephemeral Sandwich Tern and Least Tern (Table 2). Average sizes of colonies declined for Common Terns and Black Skimmers. The mean colony size declined from 404 to 124 birds for Common Terns (Wilcoxen test, $Z = -1.90$, $P = 0.05$), and from 365 to 200 for Black Skimmers, although because of the limited sample size and large variation, this decline was not statistically significant (Wilcoxen test, $Z = -1.23$, $P = 0.22$). For Least Terns, the mean changed only slightly from 30 to 32 in the two periods (Wilcoxen test, $Z = -0.37$, $P = 0.71$).

## DISCUSSION

Although patterns of distributional changes between taxa do not demonstrate causation, the expansion of foxes and raccoons and the abandonment of former colony sites strongly implicates mammalian predation as a major forcing function in colony site selection and/or subsequent nesting success (see

Table 2. *Changes in the estimates of numbers of breeding adults and numbers of colonies (in parentheses) on Virginia barrier islands of beach-nesting waterbirds, 1977 and 1998.*

| Species | 1977[a] | 1998[b] |
|---|---|---|
| Common Tern | 5660 (14) | 872 (7) |
| Gull-billed Tern | 210 (2) | 51 (4) |
| Least Tern | 300 (5) | 255 (8) |
| Royal Tern | 4600 (1) | 3380 (1) |
| Sandwich Tern | 10 (1) | 54 (1) |
| Black Skimmer | 4480 (14) | 1402 (7) |

[a] Data from Erwin and Korschgen 1979; estimates of adults made by multiplying the estimate of pairs by 2.
[b] Data from B. Williams, unpublished field records (1998).

review by BURGER and GOCHFELD, 1994; ROLLAND *et al.,* 1998). It appears that where foxes especially are present, large colonies either do not become established or if nesting begins, they fail early in the nesting cycle (Table 1). Such a pattern was noted earlier in Gull-billed Terns at Metomkin and Cedar Sandbars in the mid 1990s (ERWIN *et al.,* 1998). A predator removal experiment would be an effective way to determine more directly the role of predation on colony establishment, or colony restoration (see MANAGEMENT IMPLICATIONS section below).

Unfortunately we do not have data on the fate of all colonies surveyed in 1977 and 1998. The only consistency over the past twenty years has been the large (>2000 pairs) Royal Tern colony at Adams Island, the eastern portion of Fisherman Island, which is one of the few islands that has not had large mammalian resident predators during that period.

The extent to which the declines in the species in Table 2 can be attributed to predators is unknown. Food limitation has been implicated in the past for Black Skimmers (ERWIN, 1977), however, no data are available on population changes of forage fishes over the entire region that most of the terns and skimmers depend upon during spring and summer. The only exceptions noted in species declines are Sandwich Terns and Least Terns. The Sandwich Tern is a species on the edge of its range which only nests with Royal Terns in very small numbers in Virginia. Least Terns, in contrast, have always been widespread in coastal Virginia (ERWIN, 1979). In the face of mammalian predation, they are probably better adapted than the other tern species because they are more cryptic in their nesting, their nests are widely separated, they readily renest following nest failure, and their colony sites tend to have low site fidelity among years (ERWIN, 1978; BURGER, 1984; THOMPSON *et al.,* 1997).

Further evidence that predation is a major factor in colony site change is the founding of a new colony during the early 1980s at a manmade "island" at the Hampton Roads Bridge-Tunnel ca. 60 km southwest of Fisherman Island at the southern margin of Chesapeake Bay. This site has no large mammals in residence. More than 1000 Common Terns and 120 Black Skimmers were nesting at this newly founded site in the 1982–84 period, about the time when the predator expansion started along the coast (KAIN, 1985). By 1998, a major increase had occurred with more than 6000 Common Terns, about 400 Black Skimmers, and 120 Gull-billed Terns nesting (R. Beck, College of William and Mary, unpubl. data). Another manmade site, Craney Island, a dredged material site, has become an important nesting area for Least Terns (R. Beck, *pers. comm.*). These observations suggest that at least for several species, especially for Common Terns, a major consolidation has occurred as well as a shift from a wide barrier island distribution to one in a major bay tributary.

## MANAGEMENT IMPLICATIONS

Unless a major epidemic or hurricane is effective at reducing the numbers of raccoons and foxes on the barrier islands, the current pattern of occupation appears to be inimical to the future of ground-nesting waterbirds in coastal Virginia. Although a few species are adaptable to shifting to other habitats *e.g.,* manmade islands (ERWIN, 1980; ERWIN *et al.,* 1998; BURGER and GOCHFELD, 1990, 1991), many species are more limited in their nest or colony site choices (BUCKLEY and BUCKLEY, 1972). Unlike North Carolina where there are a number of dredged material (manmade) islands as colony site alternatives to natural barrier islands (PARNELL and SOOTS, 1979), there are far fewer options for waterbirds in coastal Virginia. Future dredging activities in coastal Virginia should strongly consider building several islands, or at least adding to existing sand/shell bars for waterbirds.

Such a pessimistic outlook for waterbirds argues for considering limited predator controls, at least at a few selected islands. We realize that large-scale predator control is neither effective in general nor is it politically or ethically acceptable in contemporary society (CROOKS and SOULE, 1999). Also, a recent review of predator control studies reveals that, although local reproductive success may be enhanced with predator removal, there is seldom an effect on the overall breeding population size of the species being protected (COTE and SUTHERLAND, 1996).

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## LITERATURE CITED

BUCKLEY, P.A. and BUCKLEY, F.G., 1972. The breeding ecology of royal terns *Sterna (Thalasseus) maxima maxima. Ibis,* 114, 344–359.

BURGER, J., 1984. Colony stability in least terns. *Condor,* 86, 61–67.

BURGER, J. and GOCHFELD, M.G., 1990. *The Black Skimmer: Social Dynamics of a Colonial Species.* New York: Columbia University Press, 355p.

BURGER, J. and GOCHFELD, M.G., 1991. *The Common Tern: Breeding Behavior and Biology.* New York: Columbia University Press, 413p.

BURGER, J. and GOCHFELD, M.G., 1994. Predation and effects of humans on island-nesting seabirds. *In:* NETTLESHIP, D.N.; BURGER, J., and GOCHFELD, M.G. (eds.), *Seabirds on Islands: Threats, Case Studies, and Action Plans.* Cambridge, England: Birdlife International, pp. 39–67.

COTE, I.M. and SUTHERLAND, W.J., 1997. The effectiveness of removing predators to protect bird populations. *Conservation Biology,* 11, 395–405.

CROOKS, K.P. and SOULE, M.E., 1999. Mesopredator release and avifaunal extinctions in a fragmented system. *Nature,* 400, 563–566.

CROXALL, J.P.; EVANS, P.G.H., and SCHREIBER, R.W., (eds.), 1984. *Status and Conservation of the World's Seabirds.* Cambridge, England: International Council for Bird Preservation, Technical Publ. 2, 778p.

DUESER, R.D.; BROWN, W.C.; HOGUE, G.S.; MCCAFFREY, C.; MCCUSKEY, S.A., and HENNESSEY, G.J., 1979. Mammals on the Virginia barrier islands. *Journal of Mammalogy,* 60, 425–429.

ERWIN, R.M., 1977. Black skimmer breeding ecology and behavior. *Auk,* 94, 709–717.

ERWIN, R.M., 1978. Population and colony site dynamics in selected

Massachusetts waterbirds. *Proceedings of the 1977 Meeting of the Colonial Waterbird Society,* 1, 19–25.

ERWIN, R.M., 1979. *Coastal Waterbird Colonies: Cape Elizabeth, Maine to Virginia.* Washington, D.C.: U.S. Fish & Wildlife Service, FWS/OBS 79/08, 212p.

ERWIN, R.M., 1980. Breeding habitat use by colonially nesting waterbirds in two mid-Atlantic U.S. regions under different regimes of human disturbance. *Biological Conservation,* 18, 39–51.

ERWIN, R.M. and KORSCHGEN, C.E., 1979. *Coastal Waterbird Colonies: Maine to Virginia, 1977—An Atlas Showing Colony Locations and Species Composition.* Washington, D.C.: U.S. Fish & Wildlife Service, FWS/OBS 79/10, 647p.

ERWIN, R.M.; NICHOLS, J.D.; EYLER, T.B.; STOTTS, D.B., and TRUITT, B.R., 1998. Modeling colony-site dynamics: a case study of gull-billed terns (*Sterna nilotica*) in coastal Virginia. *Auk,* 115, 970–978.

JONES, R.D. and BYRD, G.V., 1979. Interactions between seabirds and introduced mammals. U.S. Fish & Wildlife Service, *Wildlife Research Report,* 11, 221–226.

KAIN, T., 1985. Common terns nest on a man-made island at Hampton. *Raven,* 56, 43–44.

KHARITONOV, S.P. and SIEGEL-CAUSEY, D., 1988. Colony formation in seabirds. *Current Ornithology,* 5, 223–227.

LACK, D., 1968. *Ecological Adaptations for Breeding in Birds.* London, England: Methuen, 316p.

LARSON, S., 1960. On the influence of the Arctic fox *Alopex lagopus* on the distribution of Arctic birds. *Oikos,* 11, 276–305.

MACCARONE, A.D. and MONTEVECCHI, W.A., 1981. Predation and caching of seabirds by red foxes (*Vulpes vulpes*) on Baccalieu Island, Newfoundland. *Canadian Field-Naturalist,* 95, 352–353.

MOLLER, A.P., 1983. Damage by rats, *Rattus norvegicus* to breeding birds on Danish islands. *Biological Conservation,* 21, 5–18.

MOORS, P.J.; ATKINSON, I.A.E., and SHELLEY, G.H., 1989. Prohibited immigrants: the rat threat to island conservation. Wellington: Report of the World Wildlife Fund of New Zealand.

NELSON, B., 1979. *Seabirds: Their Biology and Ecology.* New York: A & W Publishers, 220p.

NETTLESHIP, D.N.; BURGER, J., and GOCHFELD, M.G., 1994. *Seabirds on Islands: Threats, Case Studies, and Action Plans.* Cambridge, England: BirdLife International, 318p.

PARNELL, J.F. and SOOTS, R.F., 1979. *Atlas of Colonial Waterbirds of North Carolina Estuaries.* Raleigh, North Carolina: UNC Sea Grant Publication UNC-SG-78-10, 269p.

PATTERSON, M.E.; FRASER, J.D., and ROGGENBUCK, J.W., 1990. Piping plover ecology, management, and research needs. *Virginia Journal of Science,* 41, 419–426.

ROLLAND, C.; DANCHIN, E., and FRAIPONT, M., 1998. The evolution of coloniality in birds in relation to food, habitat, predation and life-history traits: a comparative analysis. *American Naturalist,* 151, 514–529.

THOMPSON, B.C.; JACKSON, J.A.; BURGER, J.; HILL, L.A.; KIRSCH, E.M., and ATWOOD, J.L., 1997. Least tern (*Sterna antillarum*). *In:* POOLE, A. and GILL, F. (eds.), *The Birds of North America, no. 290.* Philadelphia, Pennsylvania, and Washington, D.C.: The Academy of Natural Sciences, and The American Ornithologists' Union, pp. 1–32.

WILLIAMS, B.; AKERS, J.W.; VIA, J.W., and BECK, R.A., 1990. Longitudinal surveys of the beach nesting and colonial waterbirds of the Virginia barrier islands, 1975–1987. *Virginia Journal of Science,* 41, 381–388.

WILSON, D.E.; COLE, F.R.; NICHOLS, J.D.; RUDRAN, R., and FOSTER, M.S., (eds.), 1996. *Measuring and Monitoring Biological Diversity. Standard Methods for Mammals.* Washington, D.C.:Smithsonian Institution Press, 409p.

WITTENBERGER, J.F. and HUNT, G.L., 1985. The adaptive significance of coloniality in birds. *In:* FARNER, D.S.; KING, J.R., and PARKES, K.C. (eds.) *Avian Biology, no. 8.* New York: Academic Press, pp. 1–79.