

Colonial-nesting Seabirds in the Chesapeake Bay Region: Where Have We Been and Where Are We Going?

DAVID F. BRINKER¹, JAMES M. MCCANN¹, BILL WILLIAMS² AND BRYAN D. WATTS²

¹Natural Heritage Program, Maryland Department of Natural Resources, 580 Taylor Ave., Annapolis, MD 21401

²Center for Conservation Biology, College of William and Mary, Williamsburg, VA 23187-8795
Internet: dbrinker@dnr.state.md.us

Abstract.—Over the past one hundred years, dramatic changes have taken place in populations of colonial-nesting seabirds that breed within Chesapeake Bay and the Maryland-Virginia coastal region. Populations of species that were decimated by extensive market hunting in the late nineteenth century recovered, additional species colonized the region and in the past ten years many species have declined. During 2003, over 72,000 pairs of seabirds of thirteen species bred within the region. Breeding population sizes are presented and population trends evaluated based on benchmark census information from 1977 and regional censuses compiled during 1993 and 2003 by the states of Maryland and Virginia. Since the 1970s, Brown Pelicans (*Pelicanus occidentalis*) and Double-crested Cormorants (*Phalacrocorax auritus*) expanded into the region and now represent six percent of the seabird guild. Gull populations have exhibited important changes and have affected other seabird species. Significant population declines have occurred in Black Skimmers (*Rynchops niger*), Gull-billed Terns (*Sterna nilotica*), Royal Terns (*Sterna maxima*), and Common Terns (*Sterna hirundo*). Since 1993, populations of ten of thirteen seabird species have declined, many significantly. Conservation challenges for seabird species in the region include: 1) habitat change and loss as a result of sea-level rise, 2) increasing mammalian predator populations, 3) competition for colony sites, 4) human infrastructure conflicts, and 5) changing fisheries populations and harvest. Conserving and managing colonial-nesting seabirds in the coming decades as the human population continues to increase in the mid-Atlantic region will present significant challenges to future generations.

Key words.—Chesapeake Bay, colonial-nesting seabirds, Brown Pelican, Double-crested Cormorant, gulls, terns, Black Skimmer, conservation needs, climate change, sea-level rise.

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Seabirds represent a diverse guild (14 species) of primarily fish-eating birds within the Chesapeake Bay and Maryland-Virginia barrier island-coastal bay system. These species are primarily top food-web predators and thus are often used as indicators of ecosystem condition. Seabird populations were seriously reduced by human-related activities associated with settlement of the eastern United States during the 1800s. The millinery trade, egg collecting, habitat destruction, resort development, and pollution all reduced seabird numbers. Little quantitative information on population size is available for any colonial-nesting waterbird in the region for the early part of the twentieth century. Subsequent population increases and breeding range expansions, primarily from the 1940s to the 1970s, were complex and varied among species (Gochfeld and Burger 1994; Pierotti and Good 1994; Parnell *et al.* 1995; Burger 1996; Thompson *et al.* 1997; Good 1998; Hatch and Weseloh 1999; McNicholl *et al.* 2001; Buckley and Buckley 2002; Kushlan *et*

al. 2002; Nisbet 2002; Shields 2002). No systematic region-wide assessment of seabird populations, their breeding status, or breeding locations was available before the mid-1970s. In 1977, Erwin and Korschgen (1979) coordinated a comprehensive federally supported survey of all Atlantic Coast colonial-nesting waterbird species from Maine to Virginia. This survey was the first comprehensive population baseline for mid-Atlantic colonial-nesting seabirds.

To evaluate population changes in seabirds nesting within the region we compared the benchmark effort of Erwin and Korschgen (1979) with subsequent state organized surveys. Region-wide seabird surveys were conducted during 1993 (Brinker *et al.* 1993; Watts and Byrd 1998; Watts 2004), and 2003 (Watts 2004; DFB, unpublished data). These three periods represent the only years when complete surveys of seabird breeding populations were conducted throughout the region. We describe population trends of the region's seabirds from the mid-1970s to the

present, discuss potential threats to, and conservation needs of, these populations, and offer conservation recommendations.

METHODS

Study Area

The study area consists of the Coastal Plain lowlands surrounding the urbanizing Chesapeake Bay and the Maryland-Virginia portion of the Delmarva (Delaware-Maryland-Virginia) Peninsula and Atlantic Ocean coast. Seabird colonies are located throughout the area which encompasses expansive tidal estuarine wetlands, islands, barrier beaches, swamps, upland forests, and agricultural areas. Small offshore islands and tidal wetlands are particularly widespread in Dorchester, Somerset, and Worcester counties, Maryland, and Accomack and Northampton counties in Virginia where the majority of Delmarva Peninsula seabird colonies are located.

Surveys

Building upon the surveys of Erwin and Korschgen (1979), volunteers, academics, numerous staff from The Nature Conservancy and the states of Maryland and Virginia continued periodic surveys of colonial-nesting waterbird species breeding in the study area. The barrier islands of Virginia were surveyed annually from the mid 1970s to the present (Williams *et al.* 2004; BW, unpublished data). Maryland began annual state sponsored surveys in 1985. Surveys were not completed for all species in either state every year. In Maryland, complete censuses were conducted every five years; rare species and those of conservation interest were surveyed annually while more abundant species and species exhibiting relative population stability were partially surveyed every two to three years. In Virginia, barrier island populations were surveyed annually, but marsh-nesting populations and colonies in the Chesapeake Bay were surveyed every five to ten years. Coordinated bi-state surveys of all colonial-nesting waterbird species throughout the Chesapeake Bay and coastal Maryland-Virginia were completed approximately every ten years.

Aerial surveys were used to locate new colony sites and determine activity of sites identified during previous surveys. All waterways, barrier islands, bay islands, and tidal wetlands east of the fall line were searched for nesting colonies. The locations of all colony sites were recorded on 7.5 minute USGS topographic maps and assigned unique identifiers. Breeding aggregations were considered separate colonies when, 1) they were separated from other groups within a continuous habitat by at least 400 m, 2) separated from other groups by a distinctive barrier, or 3) separated from other groups by a significant habitat discontinuity. Surveys of breeding seabirds were conducted from mid-May through June. Breeding chronology varied between seabird species and surveys were timed to census colonies near the peak of incubation, just after hatching had begun for each species.

For each species, population estimates are presented as number of breeding pairs. Methods used to obtain population estimates varied by state, species, habitat preference, and colony size. Most population estimates were based on counts of active nests. Estimates for large colonies, especially gull colonies, were often obtained

from the air and were estimates of the number of adults present. For colonies surveyed using nest counts or estimates, a one-to-one relationship between nests and pairs was assumed. In Virginia, where the size of large colonies was normally estimated from aerial surveys of adults, a one-to-one relationship between adults and pairs was assumed (Erwin and Korschgen 1979; Watts 2004). Therefore, Virginia estimates of breeding pairs may be overestimates and are treated as maximums, especially those for gulls. Detailed discussions of survey and census methodologies can be found in Gates *et al.* (1992), Brinker *et al.* (1993, 1996), Watts and Byrd (1998), and Watts (2004).

Seabird species of conservation interest, Brown Pelicans (*Pelecanus occidentalis*), Double-crested Cormorants (*Phalacrocorax auritus*), Gull-billed Terns (*Sterna nilotica*), Royal Terns (*Sterna maxima*), Common Terns (*Sterna hirundo*), Forster's Terns (*Sterna forsteri*), Least Terns (*Sterna antillarum*), and Black Skimmers (*Rynchops niger*) were surveyed and censused annually in Maryland between 1985 and 2003. Maryland maintains a comprehensive colonial-nesting waterbird database with information on all known colony sites, both current and historical, as well as all historical and post 1985 survey and census data. Maryland's annual survey and census of species of conservation interest consists of checking all known colony sites and performing total counts of nests in all active colonies. This uncommon level of monitoring can be accomplished because of a relatively limited geographic area of interest that requires a modest field effort to survey and census. The Maryland census efforts have been coordinated and conducted by either Brinker and/or McCann every year since 1985. The additional data from species of conservation interest in Maryland are provided to support and/or to clarify regional discussion of population trends.

RESULTS

Significant changes occurred in the seabirds of Chesapeake Bay and coastal Maryland-Virginia between 1977 and 2003 (Table 1). From 1977 to 1993 the breeding populations of all species expanded and the seabirds increased 44%. During the period from 1977 to 2003 the number of simultaneously active colony sites (geographic locations) increased from 152 to 266 (Table 1). Over the last 30 years, the geographic distribution of seabird colonies increased (Fig. 1), primarily from expansion of Double-crested Cormorants and Least Terns on the western shore of the Chesapeake Bay and into the northern sections of the Chesapeake Bay. During the early 1990s two species, Brown Pelicans and Double-crested Cormorants extended their breeding ranges into the Chesapeake Bay. In the region breeding populations of ten of thirteen species declined from 1993 to 2003 and the total seabird popula-

Table 1. Seabird population changes in the Chesapeake Bay and adjacent coastal watersheds of the Maryland-Virginia section of the Delmarva Peninsula between 1977 and 2003. Number of colonies refers to the number of colonies that included each species. Percent change was calculated by ((latter year est./earlier year est.)*100)-100.

Species	1977		1993		Percent change 1977-1993	2003		Percent change 1993-2003	Percent change 1977-2003
	Number of colonies	Estimated number of breeding pairs	Number of colonies	Estimated number of breeding pairs		Number of colonies	Estimated number of breeding pairs		
Brown Pelican	0	0	3	386	N/A	6	1,737	350	N/A
Double-crested Cormorant	0	0	7	686	N/A	15	2,726	297	N/A
Laughing Gull	31	33,856	112	45,389	34	60	44,953	-1.0	33
Herring Gull	21	7,210	58	10,931	52	74	7,484	-32	3.8
Great Black-backed Gull	6	55	41	600	991	61	1,770	195	3,118
Gull-billed Tern	2	105	31	607	478	17	322	-47	207
Caspian Tern	1	1	5	8	700	1	1	-88	0.0
Royal Tern	3	4,734	4	6,586	39	5	3,332	-49	-30
Sandwich Tern	1	5	2	30	500	2	7	-77	40
Common Tern	23	5,288	56	8,130	54	45	3,236	-60	-39
Forster's Tern	29	1,625	84	3,692	127	79	3,484	-5.6	114
Least Tern	22	1,131	42	1,514	34	38	1,476	-2.5	31
Black Skimmer	23	2,904	29	3,359	16	18	1,924	-43	-34
Total	152	56,914	176	81,918	44	266	72,452	-12	27

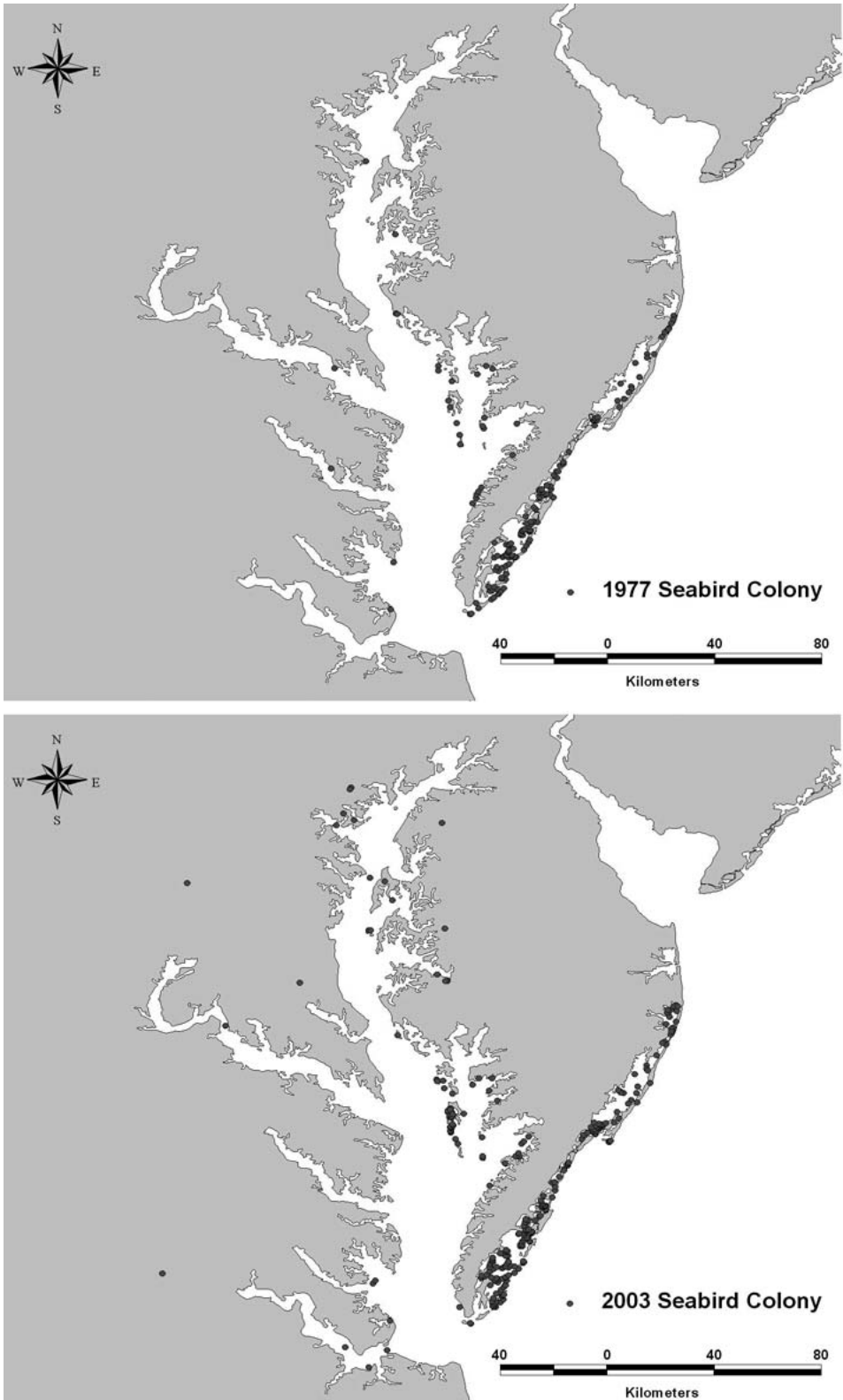


Figure 1. Distribution of known Maryland and Virginia seabird colony sites in 1977 and 2003.

tion fell 12% to 72,452. The only species to substantially increase from 1977 to 2003 that did not show declines between 1993 and 2003 were Brown Pelicans, Double-crested Cormorants and Great Black-backed Gulls (*Larus marinus*). From 1993 to 2003 the number of breeding pairs of Royal Terns, Common Terns and Black Skimmers declined 30-39% below 1977 population levels.

With the exception of a few species-year combinations, Maryland collected annual estimates of breeding population size for seabird species of conservation interest from 1985 to 2003. Breeding population sizes for gulls were collected less frequently, but complete counts were available for more than the three seasons with complete regional census data. In most cases Maryland trends parallel regional population trends observed between 1993 and 2003 (Fig. 2). Within Maryland strong increasing trends were observed for Brown Pelicans, Double-crested Cormorants, Great Black-backed Gulls, and Royal Terns (Fig. 2). Species that declined were Laughing Gulls (*Larus atricilla*), Gull-billed Terns, Common Terns, and Black Skimmers (Fig. 2). There are no apparent long term trends for the remaining seabird species.

Qualitative assessments of 1977-2003 population trends for seabird breeding populations in the Chesapeake Bay and Delmarva Peninsula region are mixed. Brown Pelicans, Double-crested Cormorants, and Great Black-backed Gulls showed substantial increases; Laughing Gulls, Caspian Terns, Sandwich Terns (*Sterna sandvicensis*), Forster's Terns, and Least Terns had variable but generally stable populations; notable declines were observed for Herring Gulls (*Larus argentatus*), Gull-billed Terns, Royal Terns, Common Terns, and Black Skimmers.

DISCUSSION

The Chesapeake Bay and Delmarva Peninsula portion of the middle Atlantic coast is a relatively small region with a diversity of colonial-nesting waterbird species. Fourteen species of seabirds have nested in the region (Murray 1952; Robbins and Blom 1996). For unknown reasons, over the past 100 years the

region has lost one breeding seabird species, the Roseate Tern (*Sterna dougallii*), last known to nest in Virginia in 1927 (Kuerzi 1929) and in Maryland in the late 1930s (Poole 1942). Between 1900 and 2000, four seabird species extended their breeding range into the region. Herring Gulls expanding southward from New England were first recorded breeding in the region during the late 1940s and early 1950s (Buckalew 1948; Kleen 1956). Great Black-backed Gulls followed with first breeding recorded in the 1970s (Scott and Cutler 1970; Boone 1975). Virginia recorded first breeding of Double-crested Cormorants in 1978 (Blem *et al.* 1980), twelve years before breeding was first recorded in Maryland (Robbins and Blom 1996). Brown Pelicans were the most recent species to expand into the region with first breeding records occurring in both Maryland and Virginia in 1987 (Williams 1989; Robbins and Blom 1996). These range expansions reflect population growth in source populations responding to improved environmental conditions over the past 100 years.

The population increases and range expansions exhibited by all seabirds from 1977 to 1993 (Table 1) may represent the culmination of recovery for these species in the Chesapeake Bay and Delmarva region. After over 200 years of settlement, resource exploitation, land, and water abuse, the decades from 1960 through 1990 were marked by landmark efforts to protect wetlands and other wildlife habitat, control and reduce water and air pollution, and otherwise improve environmental conditions. Good recent examples of societal concern with environmental repair are the multi-state Chesapeake Bay Agreement and the Maryland Critical Areas legislation; both were instrumental in working towards improving Chesapeake Bay water quality and related environmental conditions. Efforts towards restoration of submerged aquatic vegetation beds and Eastern Oyster (*Crassostrea virginica*) bars also reflect progress toward improving the health of the Bay ecosystem. These efforts have slowed environmental deterioration in the region despite continued human population growth. A number of wildlife

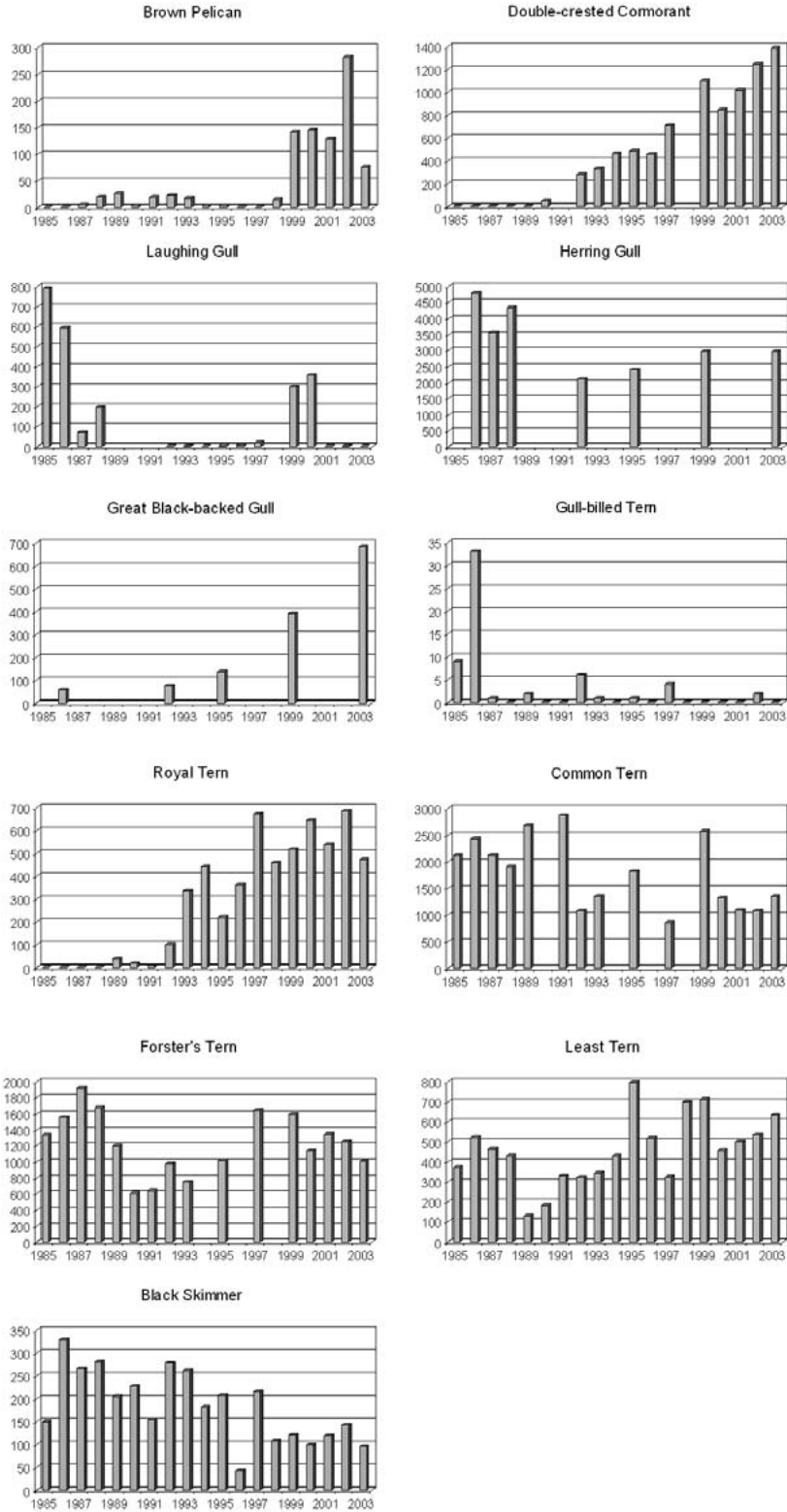


Figure 2. Population trends of seabird species breeding in Maryland during 1985-2003. All populations are complete censuses of all known colonies expressed as number of breeding pairs.

species, for example White-tailed Deer (*Odocoileus virginianus*), Wild Turkey (*Meleagris gallopavo*), and Bald Eagle (*Haliaeetus leucocephalus*), have prospered as a result of better land-use management and stabilizing environmental conditions during the last half of the twentieth century.

With the exception of Brown Pelicans, Double-crested Cormorants, and Great Black-backed Gulls, just over half of the seabird species declined substantially during the period from 1993 to 2003 (Table 1). Royal Terns, Common Terns, and Black Skimmers declined seriously to populations below the estimates of 1977. The importance of regional changes witnessed since 1993 is supported by Maryland seabird population trends (Fig. 2). Seabird breeding in Maryland is limited in geographic extent and as a result of regional differences in habitat availability, Maryland's population trends for Royal Terns and Least Terns do not reflect the trends observed for these two seabird species in Virginia. Regionally, Least Terns appear to be stable, but Royal Terns are declining along the mid Atlantic Coast (S. Emslie *et al.* unpublished data). Least Terns have maintained their populations in the region by utilizing flat gravel roof tops in urban areas of the central and upper Chesapeake Bay, similar to habitat use changes observed in New Jersey and North Carolina (Erwin *et al.* 2003)

Within the Chesapeake Bay and Delmarva Peninsula region, Gull-billed Terns, Royal Terns, Common Terns, Black Skimmers, and possibly Herring Gulls are declining. The recent population decline in Herring Gulls may reflect stabilization of the regional breeding population after initial expansion. Closures and improved landfill management, as well as shifting agricultural practices, may be causing food limitations in some areas. This adjustment to resource limitations may not be a decline that is of serious conservation concern. The Mid-Atlantic/New England/Maritimes (MANEM) Regional Waterbird Conservation Plan (Anonymous 2006; <http://www.fws.gov/birds/waterbirds/MANEM/>) places highest conservation priority on Gull-billed Terns, Common Terns, Least Terns, and Black-Skim-

mers, and high emphasis on Laughing Gulls, Herring Gulls, Forster's Terns, and Royal Terns. The breeding populations of all Chesapeake Bay and Delmarva region seabird species listed as high or highest conservation concern in the MANEM plan declined during 1993-2003. Recent ten-year population declines of over 25% were noted for Herring Gulls, Gull-billed Terns, Royal Terns, Common Terns, and Black Skimmers, with the latter three species declining over 25% from 1977 population levels.

Some of the recent seabird declines in Maryland and Virginia are attributable to either predation or interspecific competition. Erwin *et al.* (2001) considered increased mammalian predation on Virginia's coastal barrier islands the primary factor contributing to declines there. The Nature Conservancy, steward of most of the Virginia coastal barrier islands, has been reducing mammalian predator populations on a few of the Virginia coastal barrier islands and long-term declines of some breeding seabird populations apparently have been halted (B. R. Truitt, The Nature Conservancy, pers. comm.). Increases in populations of avian predators, primarily Fish Crows (*Corvus ossifragus*), American Crows (*Corvus brachyrhynchos*), and Great Horned Owls (*Bubo virginianus*), have seriously reduced reproductive success at several seabird colonies in Maryland (DFB, unpublished data). Increased predation may be partly responsible for the increase in number of colony sites (through fractionation of formerly larger colonies) despite population declines and may indicate habitat loss or deterioration and the need for alternative safe breeding sites (Erwin *et al.* 2003).

During the mid 1980s, Great Black-backed Gulls only infrequently nested in Herring Gull colonies. Great Black-backed Gulls are now forming single species colonies and have driven sensitive species such as Common Terns from several former nesting colonies. In Maryland, increasing populations of Double-crested Cormorants forced two colonies of small herons and egrets to relocate to new colony sites and may be partly responsible for the decline of a third colony. Great Black-backed and Herring Gull preda-

tion caused abandonment of several tern and Black Skimmer colony sites in Maryland. Snow Goose (*Chen caerulescens*) overgrazing of salt marsh grasses on islands in Chincoteague Bay has reduced nesting habitat and accelerated erosion of Big Bay Marsh, a significant multi-species seabird nesting site. Overgrazing of salt marsh islands immediately west of Assateague Island by horses (*Equus caballus*) resulted in colony abandonment by both Laughing Gulls and Common Terns.

Sea-level rise will be the most significant, yet difficult to manage, challenge to conservation of colonial-nesting seabirds in the Chesapeake and Delmarva Peninsula region. Since Erwin and Korschgen's (1979) surveys many of the small islands used as breeding sites in mid 1970s have eroded away. Creation of new islands from mainland headlands through natural shoreline erosion is hindered by landowners practicing shoreline erosion control (Titus *et al.* 1991). The scarcity of breeding sites in some areas has caused habitat switching (Erwin *et al.* 2003), for example roof top-nesting Least Terns, and presents management challenges for resource agencies. Other human influences, such as stabilization of the Ocean City Inlet, have altered the long-term frequency of storm related breaches in Assateague and Fenwick Islands (USACE 1998). In the past periodic breaches created new flood tidal shoal related islands important to nesting seabirds as the storm created inlet closed by long-shore sand transport processes (USACE 1998). Sea levels are predicted to rise more than 40 cm in the 21st Century (IPCC 2007), possibly much faster along the mid-Atlantic coast (Erwin *et al.* 2006a, 2006b). Predicted wetland inundation and losses may cause significant loss of both breeding and foraging habitat for seabird species in the region (Erwin *et al.* 2006b). Increased wetland flooding (Erwin *et al.* 2006b) and coastal island loss is likely throughout Dorchester, Somerset, and Worcester Counties in Maryland (Titus and Richman 2001; Larsen *et al.* 2004; Johnson *et al.* 2006) and Accomack and Northampton counties in Virginia (Titus and Richman 2001; <http://epa.gov/climatechange/effects/coastal/slrmaps.html>). Over

90% of the seabirds nesting in the region breed on lands below 1.5 m in elevation that are at serious risk from rising sea levels (Erwin *et al.* 2006a) (Fig. 3). While the ultimate impact of sea-level rise on breeding seabirds in this region is difficult to predict, it has the potential to devastate populations of seabirds that are dependent upon low elevation estuarine wetlands and islands.

After significant recoveries by all Chesapeake Bay and Delmarva Peninsula seabirds from early twentieth century population lows, a number of species are declining and all seabird species will certainly present conservation challenges. Important challenges to current managers include increases in mammalian predators on barrier islands, avian predation at nesting colonies, competition for colony sites, boating disturbances, fisheries declines and community changes, possible effects of new pesticide contaminants, and perhaps most importantly impacts from the rise of sea level. Population changes in seabirds will be true harbingers of the future for coastal areas in the next 100 years.

RECOMMENDATIONS

To best target conservation efforts that are increasingly constrained by declining funds resource managers must understand seabird population sizes and trends. The paucity of adequate numerical data for colonial seabird species is considered a significant need in the North American Waterbird Conservation Plan (Kushlan *et al.* 2002) and lack of accurate population size and trend data handicaps seabird conservation decision making. This same need is also cited in the Mid-Atlantic/New England/Maritimes regional waterbird conservation plan (Anonymous 2006). Regional censuses should be conducted more frequently than once every ten years to detect population changes while there is still time to take conservation action. At a minimum, complete coordinated multi-state regional censuses of Delaware, Maryland, and Virginia seabirds should be conducted every five years. For seriously declining species, especially those currently being managed to increase productivity, more fre-

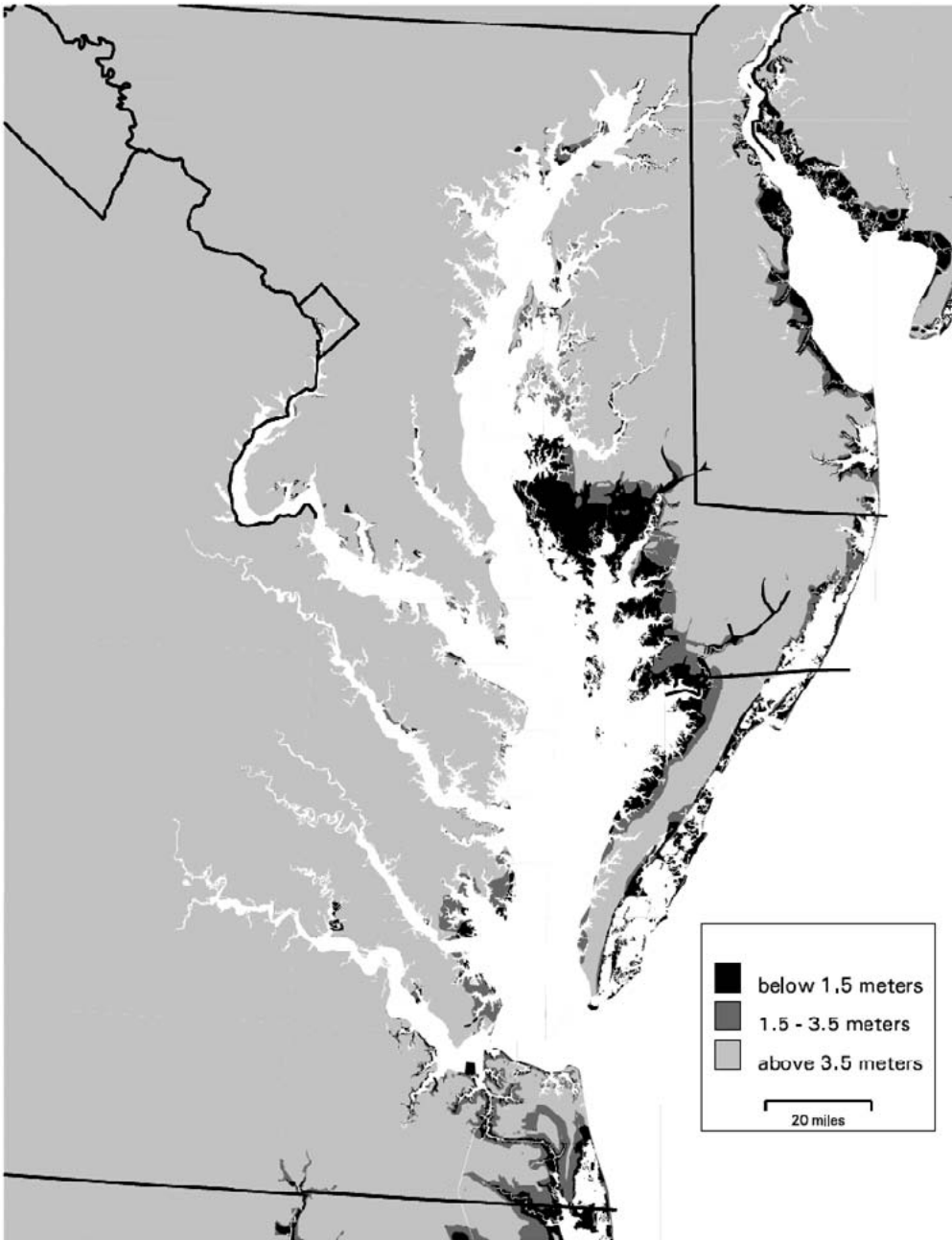


Figure 3. Distribution of low lying land in the Chesapeake Bay and Delmarva Peninsula region, where most of the region's seabird species breed. Land area below 1.5 meters is at significant risk of erosion from rising sea levels. The map is reproduced from Titus and Richman (2001) and is based upon modeled elevations, not actual surveys or the precise data necessary to estimate exact elevations at specific locations. The map is a fair graphical representation of the total amount of land below the 1.5- and 3.5-meter contours; but elevations indicated at particular locations may be different. This map illustrates the land within 1.5 and 3.5 meters of the National Geodetic Vertical Datum of 1929, a benchmark that was roughly mean sea level in the year 1929, but approximately 20 cm below today's sea level.

quent monitoring is essential to adequately evaluate population response to management actions.

The variability in annual census estimates for seabird colonies makes it difficult to obtain quantitative estimates of seabird popula-

tions at regional spatial scales. Complete censuses of limited geographic areas, such as Maryland, can be accomplished with adequate funding. However, it is very difficult and expensive to coordinate and implement surveys at larger scales, such as ecoregions. There is a great need for development of large scale seabird population monitoring schemes (Kushlan *et al.* 2002; Northeast Coordinated Bird Monitoring Partnership, <http://www.nebirdmonitor.org>). Resource managers should think creatively beyond the simple design of annual survey and complete population census to accomplish this task. We should investigate rigorous statistically-based sampling designs similar to multi-state and multi-national efforts used to monitor waterfowl populations. Such designs should incorporate statistically based estimates of the variability that results from potential sources of error, such as observer, time-of-year, reneesting, census method, and species detectability to improve the power of population size and trend estimation. The distribution and sizes of Atlantic coast seabird populations are now well enough understood to be used to evaluate design issues such as sampling frame, sampling frequency, and plot size. The data obtained from regional population trend estimation is the foundation for management response and action. If we initiate rigorous regional population monitoring it will facilitate regional approaches to seabird conservation on the Atlantic coast.

We need increased emphasis on habitat management at seabird nesting colonies in the Chesapeake Bay and on the Delmarva Peninsula. Habitat problems at seabird colony sites include issues such as plant succession, increases in predator populations, interspecific competition, loss to erosion, and conflict with human recreational use. Good habitat management will aid conservation and recovery of declining populations. We need integrated and increased regional management of seabirds by local, state, federal and non-governmental organizations (Erwin 2002; Kushlan *et al.* 2002; Erwin and Beck 2007).

In the face of the predicted rise in sea level (Erwin *et al.* 2006b), innovative ideas and conservation measures need to be taken to

maintain as much seabird habitat as possible. The beneficial use of dredged material to restore Poplar Island and the study of using dredged materials to nourish disappearing wetland complexes like those of Blackwater National Wildlife refuge may become good models of conservation actions that positively benefit seabirds. Island creation, especially of small isolated islands, may be essential to maintaining some seabird populations. As seabird choices of habitat change in response to decline and/or deterioration of habitats, resource managers should investigate any promising, even potentially novel, approaches taken to benefit seabird populations.

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