STATUS AND DISTRIBUTION OF COLONIAL WATERBIRDS IN COASTAL VIRGINIA: 2013 BREEDINGSEASON

CENTER FOR CONSERVATION BIOLOGY
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Recommended Citation:

Watts, B. D., B. J. Paxton. 2014. Status and distribution of colonial waterbirds in coastal Virginia: 2013 breeding season. CCBTR-14-03. Center for Conservation Biology, College of William and Mary/Virginia Commonwealth University, Williamsburg, VA 23 pp.

Project Partners:
The Nature Conservancy (Virginia Chapter)
Virginia Department of Game & Inland Fisheries
Virginia Department of Conservation and Recreation
United States Fish and Wildlife Service
United States Geological Survey
Center for Conservation Biology
College of William and Mary

Front Cover: *Double-crested cormorant crèche. Photo by Barton J. Paxton.*

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EXECUTIVE SUMMARY

Colonial waterbirds are highly visible components of coastal avifauna that share the unusual characteristic of nesting in dense assemblages. One consequence of having large portions of populations nesting in few locations is that even restricted disturbance may have profound consequences on a population level. Development of conservation strategies for these sensitive species requires current status and distribution information. In the fall of 1992, a consortium of agencies and individuals agreed that a comprehensive monitoring program for the Virginia colonial waterbird community was needed and that assessments should be made on decadal intervals for trend analyses. Surveys were conducted during the breeding seasons of 1993 and 2003. The 2013 survey reported here is the third in the time series. All of these surveys have systematically covered all 24 species of colonial waterbirds throughout the Coastal Plain province of Virginia.

Nearly 800 surveys were conducted of 496 waterbird colonies during the breeding season of 2013. Colonies supported an estimated 60,604 breeding pairs of 24 species. Gulls were the most abundant group with more than 28,000 breeding pairs. Waders and terns accounted for 14,117 and 10,993 pairs respectively. Laughing gulls were the most abundant species representing nearly 40% of the total waterbird community. The barrier island/lagoon system of the Eastern Shore was the most important region for the majority of colonial species encountered. In 2013, this region supported 23 of the 24 species evaluated. The Eastern Shore accounted for 54.7% and 27.2% of all breeding pairs and colonies respectively. For 15 of the 24 species, the region supported more than 50% of the known coastal population.

The colonial waterbird community in coastal Virginia declined by 36.2% in the years between 1993 and 2013. Population estimates for 19 (79%) of 24 species assessed declined between 1993 and 2013. Declines varied considerably between species with 10 species declining more than 40% and 5 species declining more than 60%. Cattle Egrets showed the highest loss rate (-96.2%), declining from an estimated 1,459 to only 56 pairs. Eight species increased between 1993 and 2008. Dramatic expansions were documented for White Ibis, Great Black-backed Gull, Double-crested Cormorant, and Brown Pelican.

Over the past 20 years, three major forces appear to be shaping the colonial waterbird community in Virginia. These include 1) regional shifts in population centers that are driving population increases in Virginia, 2) habitat degradation related to sea-level rise, and 3) recovery of the bald eagle population. With the exception of Great Egrets, all species that have increased over the past 20 years have experienced ongoing range expansions and are riding a population wave that is progressing through Virginia. This includes Great Black-backed Gull, Double-crested Cormorant, Brown Pelican, and White Ibis. Most of the decline in medium-sized waders is being driven by habitat loss related to erosion of islands. This erosion results from sea-level rise, is ongoing and represents a significant threat to these populations. Several ground-nesting seabirds are likely more directly impacted by increased restriction in viable habitat and demographic impacts related to frequent flooding. The most notable example is the Laughing Gull that has experienced a catastrophic decline in just 10 years. Finally, the dramatic recovery of the Bald Eagle within the Chesapeake Bay has resulted in the species breeding within more than 25% of large wader colonies and may be responsible for the fragmentation of historic colonies and the beginnings of a population decline. This factor may ultimately impact other populations in the future.

BACKGROUND

Context

In Virginia, colonial waterbirds include herons, egrets, ibises, gulls, terns, skimmers, cormorants, and pelicans. These birds share the unusual characteristic of nesting in dense assemblages. The result of this behavior is that they typically breed in very few locations such that the loss of a few breeding areas may have profound consequences on a population level. Due to their position in the aquatic food web, they are considered to be good indicators of ecosystem health. The most significant threats to colonial waterbirds include human disturbance, predation, habitat loss, and contaminants. Protection of sensitive colonies clearly depends on the availability of timely locational information. Development of strategic management plans to protect these species and breeding areas requires a broader understanding of population trends.

For the years prior to the mid-1970s, systematic information on the abundance and distribution of colonial waterbirds in Virginia does not exist. Information during this period is available only from a smattering of nesting records (e.g. Murray 1952), accounts of individual colonies (e.g. Abbott 1955), and area bird lists (e.g. Grey 1950). During the 1975 and 1976 breeding seasons, the first systematic survey of wading bird colonies in coastal Virginia was completed in association with a broad-based survey covering the entire Atlantic Coast (Custer and Osborn 1977). During 1977, the first systematic survey of all colonial waterbird species was conducted in association with the "Maine to Virginia" project (Erwin and Korschgen 1979). In the early 1980s an additional survey was conducted in association with a broad status assessment (Spendelow and Patton 1988). All three of these surveys focused primarily on the coastal fringe and did not attempt to cover the entire Coastal Plain. In 1993, a systematic survey was conducted that covered the entire Coastal Plain from the outer coastline to the fall line (Watts and Byrd 1998). This survey was the most comprehensive assessment to date of the colonial waterbird community in coastal Virginia. The effort covered 446 colonies supporting an estimated 94,947 pairs of 24 species. In 1992, prior to the 1993 survey, a decision was made by the community of agencies and organizations concerned with waterbirds to repeat the survey on ten-year intervals to monitor trends. In keeping with this agreement, the survey was repeated in 2003 (Watts and Byrd 2006). This reports on the second ten-year anniversary assessment conducted during the breeding season of 2013.

Objectives

The purpose of this investigation was to generate population estimates for colonial waterbird species nesting in the Coastal Plain of Virginia in 2013. Information compiled is intended to (1) be integrated into biological databases to be used in the environmental review process, (2) provide information for comparison to past and future

surveys for the purpose of assessing long-term population trends, and (3) be used in the formulation of management recommendations.

METHODS

Field Surveys

An extensive aerial survey was conducted using fixed-wing aircraft in 2013 during early stages of the breeding season. All mainland waterways, barrier islands, Bay islands, and marshlands were overflown and searched for wading bird colonies. Due to their wide distribution and large numbers, only the largest inland reservoirs and farm ponds were surveyed. Because Great Blue Heron colonies often form near the headwaters of small streams, a special attempt was made to follow all tributaries to their origin. Aerial surveys were conducted by systematically flying over areas at an altitude of approximately 100-150 m and searching for evidence of breeding colonies. Once detected, a colony was circled long enough to allow observers to map the colony location and estimate its size. All colonies were given a unique alpha-numeric code and plotted on GPS-enabled laptops loaded with a current aerial imagery. Groups of breeding pairs were considered independent colonies if they were: (1) 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 (e.g. birds in dune grassland adjacent to birds in a patch of deciduous saplings).

Follow-up ground counts were conducted for all locations except inland Great Blue Heron colonies. Great Blue Heron colonies were widespread and often situated in remote locations or over extensive swamps. Financial and logistical constraints did not allow for ground surveys of these sites.

Population Estimates

Colony size estimates were based primarily on counts of active nests, and occasionally on the number of adults present. The number of breeding adults was used when nest counts were impractical or when deemed inappropriate due to colony disturbance. Colony size was based on complete counts whenever possible. However, due to the large size of many colonies, estimates were derived for a large portion of the colonies. All estimates for aerial surveys were performed by the same observer. Many different observers were involved with ground surveys. To reduce observer bias across surveys, data resolution for estimates was reduced by rounding off reported numbers to the nearest value using the following graded scale: nearest 5 for <50, nearest 10 for 50-200, nearest 25 for 200-400, nearest 50 for 400-1,000, nearest 100 for 1,000-2,000, and nearest 200 for >2,000. Complete counts were used when reported without rounding.

Breeding chronology was taken into account when designing the survey. Coastal marshes and islands supporting gulls, terns, and allies were flown between mid-May

and mid-June. Ground counts of urban areas were conducted during April, May, June, and July depending on the species involved. Ground counts of barrier islands, Bay islands, and marshlands were conducted during June and July.

Due to the differences in breeding phenology and circumstances, different surveys were used to generate population estimates for different species. Ground surveys were used for all urban colonies and colonies on barrier and bay islands. Ground surveys were also used for colonies on marshlands with the exception of extensive gull colonies. Gull colonies often cover many hectares making estimation of nest numbers much easier from the air.

Population estimates are presented as breeding pairs. Breeding pairs were estimated on a colony by colony basis and compiled to generate an overall population estimate. For colonies surveyed using nest counts or estimates, a one-to-one relationship between nests and pairs was assumed. For colonies surveyed using count or estimates of adults, a one-to-one relationship between adults and pairs was assumed. The portion of population estimates that were based on nests is provided to allow the reader to recalculate population estimates based on number of adults.

Geographic Regions

For the presentation of gross distribution patterns, the Coastal Plain was broken down into five geographic regions (Figure 1). Regions included were: 1) Eastern Shore seaside – barrier island/lagoon system along seaward margin of the Delmarva Peninsula northward to the Maryland/Virginia boundary line, 2) Bayside and Bay islands – western shoreline of the Delmarva Peninsula to the Maryland/Virginia border, and Chesapeake Bay islands of Virginia, 3) Urban – major urban areas of lower tidewater, including the cities of Virginia Beach, Norfolk, Portsmouth, Chesapeake, Newport News, and Hampton, 4) Western Shore – south shoreline of the Potomac River to the south shoreline of the James River including all areas from the western shore of the Chesapeake Bay west to the fall line, and 5) Southside – lands south of the James River to the Virginia/North Carolina border including all land between the Atlantic Ocean and the fall line (except areas designated as urban).

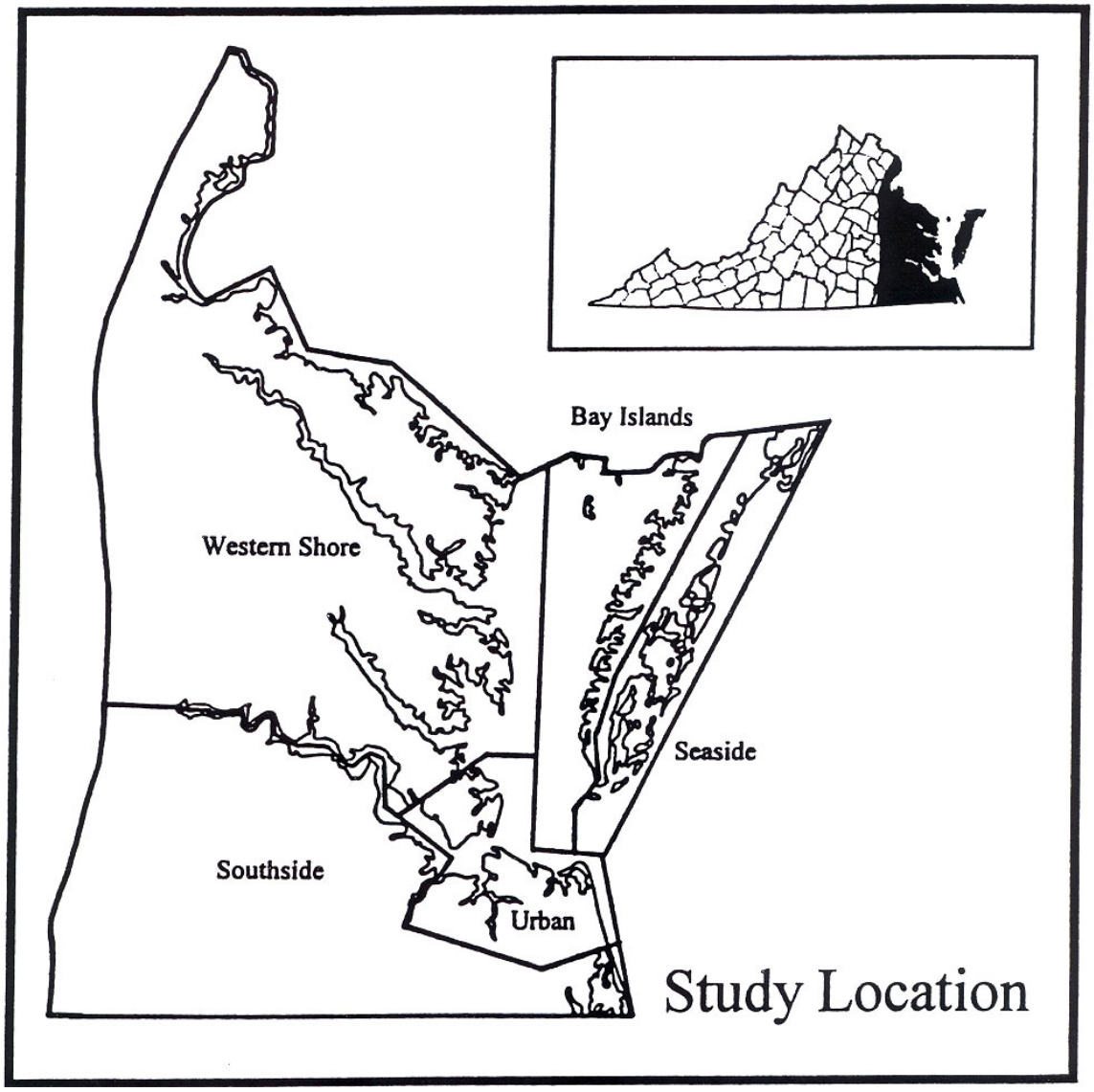

Figure 1. Map of study area. The Coastal Plain was subdivided into geographic regions including (1) seaside, (2) Bay islands, (3) urban, (4) western shore, and (5) southside.

RESULTS

Population Estimates

A total of 496 different waterbird colonies was mapped and surveyed during the 2013 breeding season. Colonies contained an estimated 60,604 breeding pairs of 24 species (Appendix I). Colony size varied from 2 to 8,600 pairs with 87.9% of colonies containing less than 100 pairs and 95.9% containing less than 500 pairs. More than 50% of all colonies larger than 500 pairs were Laughing Gull colonies. The majority (74%) of colonies contained only one species and 92.5% contained three species or less. Nine mixed-species rookeries contained seven species or more.

Abundance varied widely between species and species groups (Table 1). Gulls were the most abundant group with >28,500 breeding pairs. Waders and terns accounted for 14,117 and 10,993 pairs respectively. Although they have declined dramatically, Laughing Gulls continue to be the most abundant species and were three times more abundant than any other species, accounting for nearly 40% of the total waterbird community. Other than Laughing Gulls, only Great Blue Herons, Royal Terns and Herring Gulls exceeded 3,000 breeding pairs. The remaining 20 species accounted for less than 34% of the total breeding pairs.

Geographic Distribution

The barrier island/lagoon system of the Eastern Shore was the most important region for the majority of colonial species encountered (Table 2). In 2013, this region supported 23 of the 24 species evaluated. The only species not documented within this geographic area was the Green Heron. This species does breed within the area but its population is difficult to assess. The Eastern Shore accounted for 54.7% and 27.2% of all breeding pairs and colonies respectively. For 15 of the 24 species, the region supported more than 50% of the known coastal population. Many of these species were found almost exclusively in this region. The number of species supported by the other geographic regions varied widely. The Bay region supported 18 species whereas the urban, western shore and southside supported 15, 5 and 2 species respectively. The Bay region supported 6 species in common with the Eastern Shore that were not found elsewhere. The Bay region was the dominant region for the Forster's Tern, Double-crested Cormorant and the Brown Pelican. Cities included in the urban region supported substantial populations of Royal Terns, Sandwich Terns, Common Terns, Least Terns, Laughing Gulls, Double-crested Cormorants, Great Egrets, Green Herons, and Yellow-crowned Night Herons. The western shore supported significant populations of Great Blue Herons, Great Egrets, and Green Herons.

Population Changes

The colonial waterbird community as a whole in coastal Virginia has declined by 36.2% since1993 (Table 3). There was no change in either the number or type of species breeding in the area. Population estimates for 19 (79%) of 24 species assessed declined between 1993 and 2013. Declines varied considerably between species with 10 species declining more than 40% and 5 species declining more than 60%. Cattle Egrets showed the highest loss rate (-96.2%), declining from an estimated 1,459 to only 56 pairs. Eight species increased between 1993 and 2008. Dramatic expansions were documented for White Ibis, Great Black-backed Gull, Double-crested Cormorant, and Brown Pelican.

Table 1. Estimated number of breeding pairs for all geographic regions combined in 2013. The category "colonies" refers to the number of colonies that included each species. "%Nests" is the portion of the population estimate that was based on counts of nests rather than adults (see Methods).

Species	Colonies	Median	Range	%Nests	Pop. Est.
Waders					
White Ibis	2	-----	13-356	3.5	369
Glossy Ibis	7	71	12-159	19.3	484
Great Blue Heron	258	12	2-1250	100	7809
Great Egret	43	38	1-300	79.5	2894
Snowy Egret	13	25	1-376	28.6	903
Tricolored Heron	10	19	1-266	14.2	718
Little Blue Heron	6	14	2-50	30.9	178
Cattle Egret	3	8	2-46	82.1	56
Green Heron	12	4	1-8	83.3	49
Black-crowned Night Heron	8	21	6-170	10.4	358
Yellow-crowned Night Heron	61	4	1-17	96.3	299
Gulls					
Great Black-backed Gull	36	16	1-259	99.1	1172
Herring Gull	31	25	2-1100	98.9	3326
Laughing Gull	37	80	3-6400	>99.9	24160
Terns					
Gull-billed Tern	9	17	2-120	100	294
Caspian Tern	2	-----	1-8	11.1	9
Royal Tern	8	16	1-5188	99.7	5321
Sandwich Tern	2	-----	5-23	100	28
Forster's Tern	57	17	3-642	98.8	2431
Common Tern	29	18	1-1158	100	1985
Least Tern	28	16	4-261	99.0	925
Others					
Black Skimmer	19	30	2-307	93.4	1506
Double-crested Cormorant	9	183	10-1109	100	2876
Brown Pelican	3	348	36-1128	100	2454
Total	**496**	**15**	**2-8600**	**94.5**	**60604**

Table 2. Summary of species distributions across geographic areas. "Col" refers to the number of colonies within the respective regions. "Prs" indicates the estimated number of breeding pairs within each region. "%" indicates the percentage of the total population found within each region.

	Seaside			Bay Islands			Urban			Western Shore			Southside		
Species	**Col**	**Prs**	**%**	**Col**	**Prs**	**%**	**Col**	**Prs**	**%**	**Col**	**Prs**	**%**	**Col**	**Prs**	**%**
Waders															
White Ibis	2	369	100.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Glossy Ibis	4	384	79.3	3	100	20.7	-----	-----	-----	-----	-----	-----	-----	-----	-----
Great Blue Heron	1	52	0.7	25	311	4.0	14	640	8.2	33	6087	77.9	28	719	9.2
Great Egret	9	692	23.9	5	111	3.8	10	1061	36.7	12	551	19.0	7	479	16.6
Snowy Egret	7	755	83.6	5	115	12.7	-----	-----	-----	1	33	3.7	-----	-----	-----
Tricolored Heron	7	688	95.8	3	30	4.2	-----	-----	-----	-----	-----	-----	-----	-----	-----
Little Blue Heron	4	150	84.3	2	28	15.7	-----	-----	-----	-----	-----	-----	-----	-----	-----
Cattle Egret	2	48	85.7	1	8	14.3	-----	-----	-----	-----	-----	-----	-----	-----	-----
Green Heron	-----	-----	-----	-----	-----	-----	7	23	46.9	5	26	53.1	-----	-----	-----
Black-crowned Night Heron	5	277	77.4	3	81	22.6	-----	-----	-----	-----	-----	-----	-----	-----	-----
Yellow-crowned Night Heron	1	2	0.7	3	9	3.0	57	288	96.3	-----	-----	-----	-----	-----	-----
Gulls															
Great Black-backed Gull	20	868	74.1	15	298	25.4	1	6	0.5	-----	-----	-----	-----	-----	-----
Herring Gull	19	2945	88.5	11	338	10.2	1	43	1.3	-----	-----	-----	-----	-----	-----
Laughing Gull	30	21414	88.6	6	854	3.5	1	1892	7.8	-----	-----	-----	-----	-----	-----
Terns															
Gull-billed Tern	8	255	86.7	-----	-----	-----	1	39	13.3	-----	-----	-----	-----	-----	-----
Caspian Tern	2	9	100.0	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Royal Tern	4	62	1.2	3	71	1.3	1	5188	97.5	-----	-----	-----	-----	-----	-----
Sandwich Tern	1	5	17.9	-----	-----	0.0	1	23	82.1	-----	-----	-----	-----	-----	-----
Forster's Tern	45	1137	46.8	12	1294	53.2	-----	-----	-----	-----	-----	-----	-----	-----	-----
Common Tern	22	694	35.0	6	133	6.7	1	1158	58.3	-----	-----	-----	-----	-----	-----
Least Tern	25	533	57.6	-----	-----	-----	3	392	42.4	-----	-----	-----	-----	-----	-----
Others															
Black Skimmer	14	1135	75.4	4	156	10.4	1	215	14.3	-----	-----	-----	-----	-----	-----
Double-crested Cormorant	4	67	2.3	3	2369	82.4	1	257	8.9	1	183	6.4	-----	-----	-----
Brown Pelican	3	597	24.3	3	1857	75.7	-----	-----	-----	-----	-----	-----	-----	-----	-----
Total	**135**	**33138**	**54.7**	**58**	**8163**	**13.5**	**81**	**11225**	**18.5**	**197**	**6880**	**11.4**	**29**	**1198**	**2.0**

Table 3. Comparison of colony numbers and estimated number of breeding pairs for 1993, 2003 and 2013. Population estimates refer to breeding pairs. Percent change refers to the population change between 1993 and 2013.

Species	1993 Pop. Est.	2003 Pop. Est.	2013 Pop. Est.	% Change
Waders				
White Ibis	3	77	369	+12200.0
Glossy Ibis	1008	818	484	-52.0
Great Blue Heron	9112	9136	7809	-14.3
Great Egret	2520	2720	2894	+14.8
Snowy Egret	2329	882	903	-61.2
Tricolored Heron	767	507	718	-6.4
Little Blue Heron	374	310	178	-52.4
Cattle Egret	1459	166	56	-96.2
Green Heron	154	60	49	-68.2
Black-crowned Night Heron	526	640	358	-31.9
Yellow-crowned Night Heron	388	241	299	-22.9
Gulls				
Great Black-backed Gull	514	1084	1172	+128.0
Herring Gull	8801	4521	3326	-62.2
Laughing Gull	45387	44953	24160	-46.8
Terns				
Gull-billed Tern	606	322	294	-51.5
Caspian Tern	8	1	9	-12.5
Royal Tern	6250	2858	5321	-14.9
Sandwich Tern	30	7	28	-6.7
Forster's Tern	2939	2477	2431	-17.3
Common Tern	6781	1891	1985	-70.7
Least Tern	1171	843	925	-21.0
Others				
Black Skimmer	3098	1828	1506	-51.4
Double-crested Cormorant	354	1338	2876	+712.4
Brown Pelican	368	1661	2454	+566.8
Total	**94947**	**79343**	**60604**	**-36.2**

Seaside Region

The barrier island/lagoon system along the seaward edge of the Delmarva Peninsula is the most important region for colonial waterbirds in Virginia. Since 1993, colonial waterbirds have been systematically surveyed within this geographic area in 1993, 1998, 2003, 2008, and 2013. In the majority of species, comparison of population estimates across these years (Table 4) show consistent trends. Snowy Egret, Cattle Egret, Green Heron, Yellow-crowned Night Heron, Glossy Ibis, Herring Gull, Laughing

Gull, Gull-billed Tern, Royal Tern, Forster's Tern, Common Tern, and Black Skimmer all showed a consistent decline across the five surveys. Only species that have colonized the area since 1970 including White Ibis, Great Black-backed Gull, Double-crested Cormorant, and Brown Pelican have exhibited consistent increases. Patterns for other species were stable or showed weak trends.

Table 4. Population estimates for colonial waterbirds within the barrier island/lagoon system of the Delmarva Peninsula. Values represent estimated number of breeding pairs. Data from 1993 are from Watts and Byrd 1998. Data from 1998 are from Truitt and Schwab 2001. Data from 2003 are from Watts and Byrd 2006. Data from 2008 are from Watts and Paxton 2009.

Species	**1993**	**1998**	**2003**	**2008**	**2013**
Waders					
White Ibis	3	18	77	119	369
Glossy Ibis	779	822	669	521	384
Great Blue Heron	8	10	0	0	52
Great Egret	885	976	467	642	692
Snowy Egret	1862	1212	624	575	755
Tricolored Heron	713	530	456	270	688
Little Blue Heron	330	195	249	137	150
Cattle Egret	854	540	146	95	48
Green Heron	47	3	0	0	0
Black-crowned Night Heron	442	359	590	539	277
Yellow-crowned Night Heron	63	36	2	0	2
Gulls					
Great Black-backed Gull	362	369	720	1206	868
Herring Gull	6106	4653	3417	2182	2945
Laughing Gull	44387	43784	41692	33152	21414
Terns					
Gull-billed Tern	604	478	304	295	255
Caspian Tern	7	4	1	0	9
Royal Tern	3250	3451	2058	2259	62
Sandwich Tern	30	54	7	100	5
Forster's Tern	2169	2426	1521	1527	1137
Common Tern	3247	1727	843	475	694
Least Tern	747	709	703	669	533
Others					
Black Skimmer	2549	1766	1679	1151	1135
Double-crested Cormorant	0	6	10	65	67
Brown Pelican	324	470	454	728	597
Total	**69968**	**64608**	**56689**	**46707**	**33138**

Of particular note within this region was the catastrophic decline in the Laughing Gull population since 2003. The population declined by nearly 50% in only 10 years. Declines were most pronounced within historic strongholds in Northampton County where the decline in both area used for nesting and breeding pairs declined by more than 80% (Figure 2)

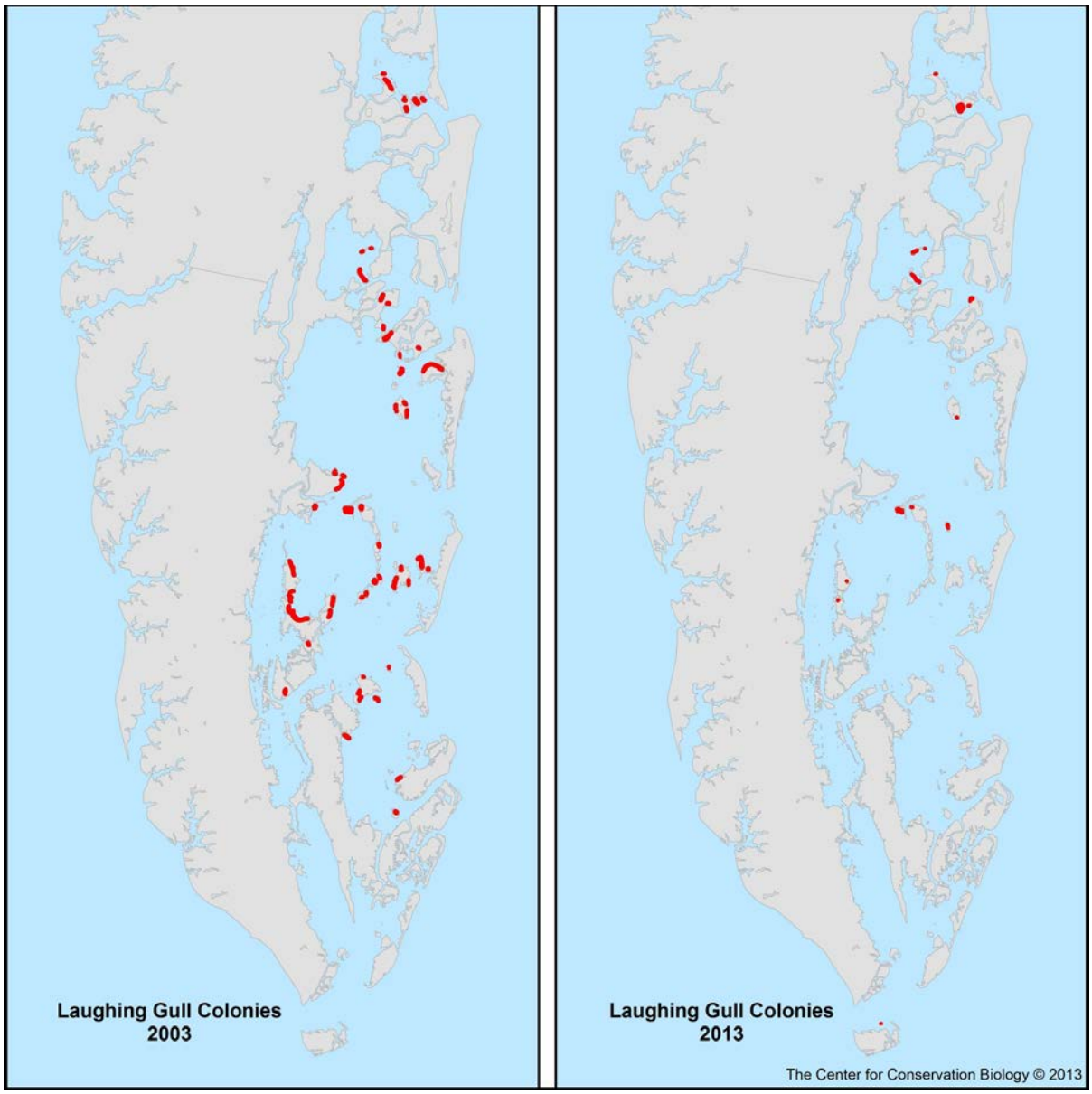

Figure 2. Distribution of Laughing Gull colonies (2003 vs 2013) along the lower seaside.

DISCUSSION

During the 2013 breeding season, coastal Virginia supported a substantial community of colonial waterbirds. The size of this community exceeded estimates from the late 1970s (Erwin and Korschgen 1979) but was less than the 1993 and 2003 estimates (Watts and Byrd 1998, 2006). The seaside of the Delmarva Peninsula continues to be the single most important region for colonial waterbirds in coastal Virginia. However, most populations are experiencing declines within this region. There is a clear need to investigate the role of sea-level rise in declines. The Bay region also supported a diverse community of species but much lower numbers of individuals compared to the seaside. Urban areas supported half of all species with residential areas supporting significant populations of Yellow-crowned Night Herons, Great Egrets, and Green Herons. The Hampton Roads Bridge Tunnel island now supports the most significant seabird colony in the state.

Species Groups

Waders

Collectively, wader species declined 24.3% between 1993 and 2013 from an estimated 18,640 pairs to 14,117 pairs. Most of this overall decline was due to the continued degradation of mixed heronries both on the seaside and bay islands. These declines have been ongoing and represent a loss of some historic colonies during the past two decades. Other sites may be lost in the next decade. Particularly notable were reductions in most mid-sized herons. An interesting development has been the decline in Great Blue Herons despite a considerable increase in colonies. Major colonies have either been lost or have fragmented resulting in a decline in colony size. The influence of bald eagle recovery on colony dynamics requires investigation.

White Ibis – Nesting of the White Ibis was first confirmed in Virginia in 1977 on Fisherman Island (Frohring and Beck 1978). Breeding has been restricted to the barrier islands. Breeding areas have been surveyed each year since 1975 (Williams et al. 1990). Until recent years, birds were associated with a mixed-species heronry on Fisherman Island exclusively with no indication of further expansion (Williams et al. 1992). This heronry was abandoned in 2002 and has not been used since that time. In 2000, this pattern changed when birds appeared in the Cobb-Island heronry (Williams et al. unpublished data). This event was followed in 2001 when the Wreck-Island heronry was colonized. In recent years, White Ibis have colonized the heronry on Chimney Pole Marsh and then the colony on Wire Narrows. The population has grown from 3 pairs in 1993 to 369 pairs in 2013. Further expansion is likely and colonization should be expected in other large heronries along the seaside and possibly within the upper Bay islands.

Glossy Ibis – The Glossy Ibis was first found breeding in Virginia on Hog Island in 1956 (Bock and Terborgh 1957). The breeding population increased dramatically throughout the 1960s reaching a high by the mid-1970s (Custer and Osborn 1977). Since this time

the species has steadily declined on the barrier islands (Williams et al. 1990). By 1993, the coastal plain population had been reduced by more than 50% from historic highs (Watts and Byrd 1998). Between 1993 and 2013, the population has declined by 52%. Of particular importance moving forward is the ongoing erosion of sites supporting mixed heronries on the bay islands.

Great Blue Heron – The Virginia population of Great Blue Herons has increased dramatically since the 1960s. In 1964, only 5 colonies of this species were known for coastal Virginia. In 1975, 15 colonies were surveyed containing more than 2,400 pairs (Custer and Osborn 1977). In 1984, 31 colonies were known supporting nearly 3,600 pairs (Beck unpubl. data). In 1993, 156 colonies were documented supporting more than 9,000 pairs. In 2003, 202 colonies were documented supporting 9,136 pairs. The 2013 survey represents the first time in more than 40 years when a decline has been documented in the number of pairs. The population declined 14.5% since the high of 2003 despite a substantial (165%) increase in the number of colonies since 1993. This pattern is the result of fragmentation of larger colonies and has resulted in a decline in the average colony size. The underlying cause for the fragmentation is unclear but it is notable that in 2011, approximately 25% of colonies supported at least one pair of nesting eagles (Watts, unpublished data). The role of bald eagles in colony dynamics is an area that warrants investigation. In addition to the fragmentation, there has been a loss of historic colonies over the 20-year period. Many major colonies from the 1970s and 1980s are no longer present.

Great Egret – The Virginia population of Great Egrets has increased more than 3 fold in the past 30 years. Trends have been similar to the Great Blue Heron but unlike Great Blues the trend seems to be continuing. This species has historically had a breeding distribution skewed to the coast. Over the past 20 years, an increasing number have colonized inland Great Blue colonies particularly within the extensive swamps of the Chickahominy, Blackwater, Nottoway, and Meherrin drainages. Aside form the advances toward the fall line, population in most other regions are experiencing stress. Several urban colonies have been lost over the past 30 years (Watts, unpublished data) as residential neighborhoods move them out. Although this process is continuing, the birds seem to be resilient and continue to find new places to nest. Declines in both the seaside and on bay islands appear to be solely due to substrate loss related to erosion. This process is continuing and further declines should be expected within these areas if habitat is not stabilized.

Snowy Egret – Historically, Snowy Egrets bred as far north as New England. However, by the turn of the century, demand from the millinery trade had resulted in a contraction of the breeding range down to North Carolina (Ogden 1978). The first evidence of recolonization was in 1941 when birds were discovered breeding on the seaside of the Delmarva (Murray 1952). By the mid-1950s, this species was documented in all geographic areas of coastal Virginia except the southside region (e.g. Grey 1950, Abbott 1955). However, since the 1970s breeding has been restricted to the seaside of the Delmarva and the offshore islands of the upper Bay. Numbers have declined steadily on the barrier islands since the mid-1970s. The coastal plain-wide survey in

1993 was comparable to the surveys of the mid-1970s (Custer and Osborn 1977, Watts and Byrd 1998). Between 1993 and 2013 the population has declined by more than 60%. However, the population was relatively stable between 2003 and 2013. Loss of nesting substrate on the seaside and on bay islands continues to be a concern. The colony surveyed on an islet of the Guinea Marshes of Gloucester County in 2003 was lost before 2008 due to loss of nest substrate. The species continues to nest on Mumford Island on the York River though the island continues to be impacted by storm erosion.

Tricolored Heron – The Tricolored Heron was first documented to nest in Virginia when breeding birds were discovered on the seaside of the Delmarva in 1941 (Murray 1952). Colonization of Virginia was part of a broader, northward range expansion that occurred between the 1940s and 1970s (Ogden 1978). In Virginia, the population apparently increased to a high that reached a plateau during the 1950s through the 1970s (Erwin and Korschgen 1979). The species has declined on the barrier islands since that time (Williams et al. 1990). The population estimate of 1993 (Watts and Byrd 1998) was more than 50% reduced from that of the mid-1970s (Custer and Osborn 1977). Following a decline of 34% between 1993 and 2003, the population has increased 41% bringing it back to within 6.5% of the 1993 estimate. Like the other mid-sized waders, this species is vulnerable to ongoing habitat changes.

Little Blue Heron – Little Blue Herons were one of the most abundant waders along the Atlantic Coast from the 1930s to the 1950s (Ogden 1978). Historic breeding records for this species exist for all of the geographic regions of coastal Virginia (Grey 1950, Murray 1952, Abbott 1955). The species declined dramatically from the 1950s to the 1970s (Erwin and Korschgen 1979) and is now found only on the seaside of the Delmarva Peninsula and within 2 colonies on Chesapeake Bay islands. From 1993 to 2013, Little Blue Herons declined by an estimated 52.4% or an additional 42.5% since 2003. The decline continues to be widespread with very few pairs now on the Bay islands and reduced numbers in most of the seaside strongholds.

Cattle Egret – The Cattle Egret was first found breeding in Virginia in 1961 (Scott and Cutler 1961). Colonization of Virginia was part of a rapid, broad-front range expansion that followed first establishment in North America in 1953 (Crosby 1972, Telfair 1994). The Virginia population increased rapidly during the 1960s. Although there has been considerable year to year variation on the barrier islands, numbers have declined since the mid-1970s and precipitously since the mid-1990s. Cattle Egrets experienced a dramatic decline between 1993 and 2013 within all breeding areas. Only 8 pairs were detected on islands within the Chesapeake Bay. Birds disappeared from the Hopewell colony on the James River in the mid-1990s and have never returned. Birds are now restricted to just 3 colonies in Virginia. It now appears likely that this species will be lost from the state.

Green Heron – Green Herons nest widely throughout the Coastal Plain. Due to their broad distribution and cryptic coloration, none of the colonial waterbird surveys have adequately covered this species. Population estimates are inadequate to assess trends

outside of the heronries that are surveyed regularly. Within the heronries that are surveyed regularly, Green Herons have declined dramatically within both the barrier island/lagoon system and the Chesapeake Bay islands. More moderate declines were documented in the traditional colonies within urban areas.

Black-crowned Night Heron – The breeding population of Black-crowned Night Herons in coastal Virginia declined by an estimated 80% between 1975 (Custer and Osborn 1977) and 1993 (Watts and Byrd 1998). However, the species increased throughout the broader Coastal Plain between 1993 and 2003 and this trend continued through the 2008 survey. Much of this increase may be attributed to expansion of numbers within the Watts Island and Tangier Island colonies since 2003. Between 2003 and 2013, Black-crowns have declined 44% resulting in a 32% decline since 1993. The only stronghold remaining for the species in 2013 were Wreck Island along the Seaside and Watts Island in the Bay.

Yellow-crowned Night Heron – The Yellow-crowned Night Heron likely bred in Virginia in the 1800s but was apparently absent by the early 1900s. The first modern breeding record for Virginia was in 1947 (Darden 1947). This event corresponds with a range expansion from the southeast northward to New England (Watts 1995). In Virginia, Yellow-crowneds increased within urban areas of Norfolk, Hampton, Virginia Beach, and Portsmouth at least through the early 1990s (Watts unpublished data). Since 1993, the population has declined by 23%. This decline is primarily due to the loss of birds within seaside heronries and to a lesser extent on Bay islands. Despite disruption by residents within urban areas that have caused distribution shifts, the species appears to be doing well in lower Tidewater.

Gulls

As a group gulls declined by more than 47.6% over the 20-year period from an estimated 54,702 breeding pairs in 1993 to 28,658 in 2013. This decline was due almost entirely to the catastrophic decline in Laughing Gulls between 2003 and 2013. Herring Gulls continue their long decline. Great Black-backed Gulls increased dramatically over the period.

Great Black-backed Gull – In 1970, the Great Black-backed Gull was found breeding on Fisherman Island (Scott and Cutler 1970). This event was part of a broader range expansion that began in the early 1900s and has moved down the Atlantic Coast (Good 1998). Since the 1970s, this species has rapidly colonized other locations on both the seaside and Chesapeake Bay islands. Between 1993 and 2013, the population has more than doubled in size and continued to expand in distribution. Although the stronghold continues to be within the seaside, 15 colonies now occur within the Virginia portion of the Chesapeake Bay. Colonization of the Hampton Roads Tunnel Island since 2003 represents the first toe hold in the lower portion of the Bay. The colony located in 2008 on a small islet along the Guinea Marshes in Gloucester County was not occupied in 2013. The islet has experienced considerable storm erosion.

Herring Gull – A single Herring Gull nest was found on the seaside near Cobb Island in 1948 (Murray 1952). By 1977, 9 colonies containing more than 2,900 pairs were reported (Erwin and Korschgen 1979). The 1993 survey located 35 colonies supporting an estimated 8,800 pairs. The breeding population on the barrier islands apparently reached a high in the late 1980s and has shown evidence of a decline since that time (Williams et al. unpublished data). Between 1993 and 2013 the Coastal Plain population declined by an estimated 62.2% or an additional 26% since 2003. Consistent declines were observed in both regions where breeding was documented in 1993. New colonies have been recorded in the lower Bay since 2003 including on the Hampton Roads Tunnel Island and near the mouth of the York River (Watts and Byrd 2006). The colony on the islet along the Guinea Marshes was not occupied in 2013.

Laughing Gull – Virginia has apparently been a stronghold for breeding Laughing Gulls for centuries. This species has been the numerically dominant colonial waterbird during all comprehensive surveys conducted of the Coastal Plain. Between 1977 and 1993 there was a considerable increase in population estimates. Between 1993 and 1998, there was a very small decline in numbers on the seaside of the Delmarva Peninsula (Truitt and Schwab 2001). The barrier island population exhibited considerable variation after the mid-1970s but estimates over the past 20 years have consistently represented only 20-30% of those during the late 1980s. The population decline between 2003 and 2013 was catastrophic and the most significant result of the 2013 survey. Historic colony sites within the southern portion of the Delmarva seaside have now been abandoned for several years. Evidence of stress is now being seen within the topographically higher colonies in Accomack County along the Chincoteague Causeway. Collectively, the patterns of decline suggest impacts by tidal flooding that require further investigation.

Terns

As a group, terns declined 38.2% over the 20-year from an estimated 17,785 to 10,993 breeding pairs. There were not exceptions to the general pattern. All species experienced declines ranging from 6 to 70%.

Gull-billed Tern – The Gull-billed Tern has experienced extreme population swings in coastal Virginia over the past 200 years (Parnell et al. 1995). In the mid-1800s this species was considered to be abundant along the barrier islands. By the late 1800s and early 1900s they had been reduced to very low numbers by hunters supplying the millinery trade (Bailey 1913). Throughout the early 1900s numbers remained very low (Austin 1932). By the mid-1970s numbers appear to have recovered to those comparable with the 1800s. By 1993, the population had declined once again to approximately 20% of 1970s levels (Watts and Byrd 1998). Between 1993 and 2013 the number of occupied colonies declined from 30 to 8 and the number of breeding pairs declined by 51.5%. The species is now nearly restricted to shell piles within the barrier island/lagoon system and to a single colony on the Hampton Roads Bridge Tunnel.

Caspian Tern – There is some evidence that Caspian Terns once bred in greater numbers along the Virginia barrier islands than they have from 1900 to present (reviewed by Weske et al. 1977). Egging and hunting apparently reduced their numbers in the 1880s to a low from which they have never fully recovered. Since 1900, Caspians have been documented in very low numbers breeding in scattered locations along the seaside and occasionally on Chesapeake Bay islands. They appear to be present consistently since the mid-1970s. In 1993 only 7 pairs were documented in 5 locations. During the 2003 survey, only a single pair was documented. In 2008, 2 pairs were documented on Clump Island in the upper Bay. In 2013, pairs were found only within the northern portion of the barrier island/lagoon system. Although the Virginia population of Caspians appears to be very small in recent decades, it is also likely that this species is not well surveyed. Unlike Royal and Sandwich Terns that nest in large conspicuous colonies, Caspians often nest as single pairs on shell piles in the lagoon system or within small colonies of other smaller terns.

Royal Tern – In Virginia, Royal Terns have apparently always been the most abundant of the large terns. Like many of the other terns, their numbers have fluctuated widely through the years due to natural and human perturbations. This species also appears to move over a larger spatial scale such that local population patterns may reflect movements rather than population changes. This possibility is supported by wide fluctuations in adjacent states (D. Brinker, S. Cameron unpublished data). Royal Terns have declined on the barrier islands since the early 1980s (Williams et al., unpublished data). The population estimate for the broader Coastal Plain in 1993 was comparable to estimates from the mid-1970s (Erwin and Korschgen 1979). Since 1993, the number of breeding pairs has declined 14.9%. Since 2003, numbers have increased due entirely to the establishment of birds on the Hampton Roads Bridge Tunnel Island. In 2013, this site supported 97.5% of the state population.

Sandwich Tern – Virginia and occasionally Maryland represent the northern range limit for breeding Sandwich Terns. There is no evidence that this species was ever a common breeder in Virginia. Scattered records in the late 1800s and early 1900s imply that this species was an uncommon nester associated with Royal Tern colonies on the barrier islands (records reviewed by Weske et al. 1977). There is a paucity of reports throughout the middle 1900s until the late 1960s when the species was discovered nesting again on the barrier islands (Buckley and Buckley 1968). Breeding has been consistent on the barrier islands since the mid-1970s but has involved relatively few individuals. Numbers documented during the annual barrier island survey have fluctuated widely since the mid-1970s (Williams et al. unpublished data). The change from 30 pairs in 1993 to 7 pairs in 2003 to 100 pairs in 2008 and back to 28 pairs in 2013 reflect the dynamics of their occurrence in Virginia.

Forster's Tern – Like many of the other colonial species that nested historically in coastal Virginia, Forster's Terns were greatly impacted by market hunting from the 1870s though approximately 1910 (Howell 1911, Austin 1932). Due to their nesting habits, the status of Forster's Terns was less known compared to other tern species. Forster's nest in scattered colonies within the lagoon system on wrack deposited in the

marshes or on other topographic highs. Their distributions are subject to change depending on the availability of nesting substrate. This makes them difficult to survey effectively. The first comprehensive survey of Forster's was in 1977 (Erwin and Korschgen 1977). By 1993, numbers appeared to have doubled (Watts and Byrd 1998). Between 1993 and 2013 estimated population size declined by 17.3%. The concentration of large colonies on Bay islands is a trend that is continuing.

Common Tern - Historically, the Common Tern nested throughout coastal Virginia wherever there was suitable substrate away from predators. Like many of the other species, Common Terns were hunted to very low numbers by the turn of the 20th century but there were signs of recovery by the early 1930s (Austin 1932). Since the 1960s Common Tern colonies have been documented in many areas of the Coastal Plain. However, over the past 20 years colonies have disappeared from the western shore and lower tidewater. Since the 1980s, Common Terns have shown consistent declines on the barrier islands (Williams et al. unpublished data). However declines on the islands were compensated for by the formation of the largest colony in the state on the Hampton Roads Tunnel Island such that estimates from 1977 (Erwin and Korschgen 1979) and 1993 (Watts and Byrd 1998) were comparable. Between 1993 and 2013, Common Terns declined by 70.7% in coastal Virginia. Considerable declines have been documented in all 3 geographic regions that supported colonies in 1993. Much of the overall decline was accounted for by the recent losses within the tunnel island colony. The invasion of Laughing Gulls within this site prior to the 2003 survey reduced the Common Tern population by more than 75%. As of 2013, this loss has not been absorbed in other regions.

Least Tern – Historically, Least Tern colonies have been documented throughout many areas of coastal Virginia including up major tributaries to near tidal fresh waters. Abundant on the barrier islands this species was hunted relentlessly during the late 1800s to near extirpation. After release from hunting pressures, Least Terns rebounded rapidly. Numbers appear to have reached a high in the early 1980s and then declined steadily over the next 20 years (Beck et al. 1990). Between 1993 and 2013 the population declined 21% from 1171 to 925 breeding pairs. In 2008, for the first time in Virginia, colonies were located on roof tops in urban areas. Colonies have been located on both Lynnhaven and Patrick Henry Malls (this site was not documented as active in 2013). The formation of roof top colonies has been reported throughout the southeast and has been anticipated for many years in Virginia. It is possible that additional colonies exist within lower tidewater or elsewhere that have not been discovered. Such colonies are subject to severe heat stress and active management is required to improve productivity.

Others

As a group, the three remaining waterbird species have increased more than 179% from 3,820 to 6,836 breeding pairs. This overall increase reflects the fact that both Double-crested Cormorants and Brown Pelicans are recent colonizers that are rapidly expanding. This increase masks the substantial decline in Black Skimmers.

Black Skimmer – The Black Skimmer appears to have been a common nester on the barrier islands for as far back as records are available. Due to their coloration, skimmers were not valued in the millinery trade and so were not hunted as actively as many of the other beach-nesting species. They also were favored by the locals and so did not experience the same degree of pressure from eggers. From most accounts, Black Skimmers were one of the numerically dominant species on the barrier islands throughout most of the 20th century. However, between the mid-1970s and the 1990s numbers on the barrier islands were reduced by 70%. This decline continued between 1993 and 2013 as the coastal population declined 51.4% from an estimated 3,098 to 1,506 breeding pairs. The population along the barrier islands appears to have stabilized between 2008 and 2013.

Double-crested Cormorant – Breeding of the Double-crested Cormorant in Virginia was first confirmed in 1978 on a small vegetated island in the James River near Hopewell (Scott 1978). Range wide cormorants have experienced wide fluctuations in numbers and distribution throughout the 20th century (Hatch 1984). Colonization of Virginia represents an expansion beyond the historic range following a low during the DDT era (1940s-1972) (Hatch and Weseloh 1999). After 1984, the Virginia population expanded rapidly to 5 colonies by 1995 containing more than 400 pairs (Watts and Bradshaw 1996). The seaside of the Delmarva was not colonized until 1995. Between 1993 and 2013 the population increased by 712% from 354 to 2,876 pairs. Most of this increase is accounted for by the rapid expansion of the Shanks Island colony. The colony has expanded from 6 pairs in 1993 to 907 pairs in 2003 to 1, 636 in 2008 to 2,369 in 2013. Four colonies now exist on the seaside including 3 on duck blinds in Chincoteague Bay. It seems likely that this species will expand on the seaside as the breeding of brown pelicans expands.

Brown Pelican – The Brown Pelican was first found breeding in Virginia on Fisherman Island in 1987 (Williams 1989). During this same year, birds were also found nesting on Metompkin Island (Williams 1989). Since that year, breeding on the barrier islands has been restricted to Fisherman Island. In 1992, an additional colony was formed in the upper Chesapeake Bay on Shanks Island north of Tangier (Brinker, pers. Comm..). In recent years, a colony has formed on Sandy Island near the north end of Hog Island on the seaside. Colonization of Virginia represents a northward range expansion from North Carolina that extends beyond the historic range and follows recovery of southeastern populations from contaminants. Since its discovery, the Shanks Island colony has grown exponentially apparently fueled by continued immigration. In 1993, there were only 53 pairs documented in this colony (Watts and Byrd 1998). By 1999, the colony supported 913 breeding pairs (Watts 1999). Between 1993 and 2013 the Virginia population increased 567% from an estimated 368 to 2,454 breeding pairs. Growth in the Shank's Island colony has slowed in the past few years suggesting that it may be reaching capacity. Distribution along the barrier islands is dynamic with colonies shifting between years.

ACKNOWLEDGMENTS

Many individuals and organizations contributed to the success of the 2013 colonial waterbird survey in Virginia. We very much appreciate and admire the broad commitment by agencies and individuals to this bird community. Captain Fuzzzo Shermer and Jim Reed provided expert flying services. We thank the many observers who participated in ground surveys, including R. Boettcher, A. Wilke, R. Beck, K. Birker, M. Byrd, E. Carsen, M. Charlesworth, B. Farmer, J. Harvic, J. Joeckel, E. Larson, K. Lewicki, J. Lewis, A. Lipford, R. Lukei, J. McClain, B. Miller, C. Miller, E. Mojica, L. Moore, S. Rice, J. Tamuatee, J. Tarwater, M. Watts, and S. Whealton. Erica Lawler provided fiscal management from the College of William & Mary. Financial support was provided by the Virginia Department of Game & Inland Fisheries, The Center for Conservation Biology, The Nature Conservancy, the Virginia Department of Transportation, and the U.S. Army Corps of Engineers. Additional agency partners include the U.S. Fish and Wildlife Service and the Natural Heritage Program of the Virginia Department of Conservation and Recreation.

LITERATURE CITED

Abbott, J. M. 1955. The Hollis Marsh Island heronry, Westmoreland County, Virginia. Raven 26:102-103.

Austin, O. L., Jr. 1932. Cobb Island. Bird-Banding 8:12-25.

Bailey, H. H. 1913. The birds of Virginia. J.P. Bell, Col, Inc. Lynchburg, VA.

Beck, R. A., J. W. Akers, J. W. Via, and B. Williams. 1990. Status and distribution of the Least Tern in Virginia – 1975 to 1988. Virginia Journal of Science. 41:404-418.

Bock, W. and J. Terborgh. 1957. Breeding of the Glossy Ibis in Virginia. Bird Banding 28:38.

Buckley, P. A. and F. G. Buckley. 1968. The current status of certain birds in the Virginia Capes area. II. April 1967-July 1968 observations. Raven 39:27-40.

Crosby, G. T. 1972. Spread of the Cattle Egret in the Western Hemisphere. Bird Banding 43:205-212.

Custer, T. W. and R. G. Osborn. 1977. Wading birds as biological indicators: 1975 colony survey. U.S. Fish and Wildlife Service Special Scientific Report – Wildlife No. 206. 28 pp.

Darden, C. W. 1947. Nest of a Yellow-crowned Night Heron. Raven 18:25-26.

Erwin, R. M. and C. E. Korschgen. 1979. Coastal waterbird colonies: Maine to Virginia, 1977. An atlas showing colony locations and species composition. U.S. Fish and Wildlife Service FWS/OBS-79/08.

Frohring, P. C. and R. A. Beck. 1978. First breeding record of the White Ibis (Eudocimus albus) in Virginia. American Birds 32:1.

Good, T. P. 1998. Great Black-backed Gull (Larus marinus). In The Birds of North America, No. 330 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Grey, J. H., Jr. 1950. Birds of the Cape Henry area. Raven 21:30-69.

Hatch, J. J. 1984. Rapid increase in Double-crested Cormorants nesting in southern New England. American Birds 38:899-902.

Hatch, J. J., and D. V. Weseloh. 1999. Double-crested Cormorant (Phalacrocorax auritus). In The Birds of North America, No. 441 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Howell, A. B. 1911. A comparative study at Cobb's Island, VA. Auk 28:449-453.

Murray, J. J. 1952. A checklist of the birds of Virginia. Virginia Society of Ornithology.

Ogden, J. C. 1978. Recent population trends of colonial wading birds on the Atlantic and Gulf Coastal Plains. Pp. 137-154 in: Wading birds. National Audubon Society Research Report No. 7 (A. Sprunt IV, J. C. Ogden, and S. Winckler, Eds.) National Audubon Society, New York, New York.

Parnell, J. F., R. M. Erwin, and K. C. Molina. 1995. Gull-billed Tern (Sterna nilotica). In The Birds of North America, No. 140 (A. Poole and F. Gill, Eds.). The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.

Scott, F. R. and D. A. Cutler. 1970. Middle Atlantic Coast region. American Birds 24:688-670.

Spendelow, J. A. and S. R. Patton. 1988. National atlas of coastal waterbird colonies in the contiguous United States: 1976-1982. U.S. Fish and Wildlife Service Biological Report 88(5).

Telfair, R. C. II. 1994. Cattle Egret (Bubulcus ibis). In The Birds of North America, No. 113 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D. C.: The American Ornithologists' Union.

Truitt, B. R. and D. J. Schwab. 2001. 1998 Eastern Shore seaside barrier island/lagoon colonial waterbird survey. Raven 72:126-131.

Watts, B. D. 1995. Yellow-crowned Night Heron (Nyctanassa violacea). In The Birds of North America, No. 161 (A. Poole and F. Gill, Eds.) Academy of Natural Sciences, Philadelphia, PA and the American Ornithologists Union, Washington, D.C.

Watts, B. D. and D. S. Bradshaw. 1996. Population expansion by Double-crested Cormorants in Virginia. Raven 67:75-78.

Watts, B. D. and M. A. Byrd. 1998. Status and distribution of colonial waterbirds in coastal Virginia. *The Raven* 69:20-31.

Watts, B. D. 2000. A study of waterbirds in Shanks Creek: An investigation on Smith Island, MD. Center for Conservation Biology Technical Report Series, CCBTR-00-12. College of William and Mary, Williamsburg, VA. 30 pp.

Watts, B. D. and B. J. Paxton. 2004. Digital atlas of colonial waterbirds in coastal Virginia:2003 breeding season. CCBTR-04-05. Center for Conservation Biology, College of William and Mary, Williamsburg, VA.

Watts, B. D. and M. A. Byrd. 2006. Status and distribution of colonial waterbirds in coastal Virginia: The 2003 breeding season. *The Raven* 77:3-22.

Watts, B. D., B. J. Paxton. 2009. Status and distribution of colonial waterbirds in coastal Virginia: 2009 breeding season. CCBTR-09-03. Center forConservation Biology, College of William and Mary/Virginia Commonwealth University, Williamsburg, VA 21 pp.

Weske, J. S., R. B. Clapp, and J. M. Sheppard. 1977. Breeding records of Sandwich and Caspian Terns in Virginia and Maryland. Raven 48:59-65.

Williams, B. 1989. The first breeding record of the Brown Pelican in Virginia: A chronology. Raven 60:1-3.

Williams, B., R. A. Beck, B. Akers, and J. Via. 1990. Longitudinal surveys of the beach nesting and colonial waterbirds of the Virginia barrier islands. Virginia Journal of Science. 41:380-388.

Williams, B., B. Akers, R. Beck, J. Via, and S. Rottenborn. 1992. The 1991 Virginia barrier islands beach-nesting and colonial waterbird survey. Raven 63:96-101.

Williams, B., B. Akers, M. Beck, R. Beck, and J. Via. 2000. The 1998 survey of the beach-nesting waterbirds of the Virginia barrier islands. Raven 71:42-45.

Williams, B., B. Akers, M. Beck, R. Beck, and J. Via. 2002. A summary report of the 2001 Virginia barrier islands beach-nesting and colonial waterbirds survey. Raven 73:10-16.

APPENDIX I: List of colonial waterbird species surveyed in coastal Virginia along with A.O.U. alpha codes.

Species	**Alpha Code**	**Scientific Name**
Great Black-backed Gull	GBBG	*Larus marinus*
Herring Gull	HERG	*Larus argentatus*
Laughing Gull	LAGU	*Larus atricilla*
Gull-billed Tern	GBTE	*Sterna nilotica*
Caspian Tern	CATE	*Sterna caspia*
Royal Tern	ROYT	*Sterna maxima*
Sandwich Tern	SATE	*Sterna sandvicensis*
Forster's Tern	FOTE	*Sterna forsteri*
Common Tern	COTE	*Sterna hirundo*
Least Tern	LETE	*Sterna antillarum*
Black Skimmer	BLSK	*Rynchops niger*
Double-crested Cormorant	DCCO	*Phalacrocorax auritus*
Brown Pelican	BRPE	*Pelecanus occidentalis*
White Ibis	WHIB	*Eudocimus albus*
Glossy Ibis	GLIB	*Plegadis falcinellus*
Great Blue Heron	GBHE	*Ardea herodias*
Great Egret	GREG	*Ardea alba*
Snowy Egret	SNEG	*Egretta thula*
Tricolored Heron	TRHE	*Egretta tricolor*
Little Blue Heron	LBHE	*Egretta caerulea*
Cattle Egret	CAEG	*Bubulcus ibis*
Green Heron	GRHE	*Butorides virescens*
Black-crowned Night Heron	BCNH	*Nycticorax nycticorax*
Yellow-crowned Night Heron	YCNH	*Nyctanassa violacea*