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THE JUNE 2014 VSO FORAY: KING & QUEEN AND MIDDLESEX COUNTIES

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INTRODUCTION

This year, the annual VSO Breeding Bird Foray took place in Middlesex and King & Queen Counties. These counties were chosen partly because they border the ecologically precious Dragon Run, a pristine swamp in the middle peninsula of Virginia. Dragon Run is navigable by kayak in the spring, but is too dry for that in June when this foray took place (June 7 - 15). However, there was still opportunity to survey by water by boat or kayak. A number of areas on the Rappahannock, Piankatank and Mattaponi Rivers (Figure 1) were forayed in this way.

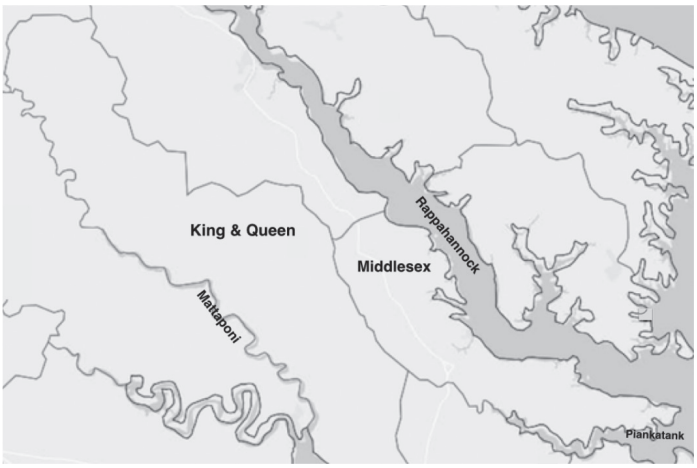

FIGURE 1. Map of Foray Counties. The outlines of King & Queen and Middlesex Counties are shown, with the bordering rivers labeled.

There were also abundant opportunities for foraying on land, including a large piece of public land, the 9562-acre Dragon Run State Forest (http://www.dof.virginia.gov/stateforest/list/dragon-run.htm). In addition, landowners were generous in allowing forayers on their private property. Friends of Dragon Run (http://www.dragonrun.org), a nonprofit organization dedicated to the protection of the Dragon Run watershed, was also generous in providing guides to give us access to their restricted lands.

With the exception of a few parts of Middlesex, these counties are not heavily populated, so that birding on public roads was also very productive. King and Queen County has 22 people per square mile, about 1/10 the state average. Middlesex is smaller (130 vs. 315 square miles), but has more people per square mile (84).

The weather was favorable, with very little rain. Days were sunny and temperatures were in the upper eighties during the first part of the foray. This was 5-10 degrees above average for this time of year. June 12 and 13 were rainy part of the day, lowering temperatures to the upper 70's to lower 80's for the rest of the foray. The 14th was windy, but it and the 15th were otherwise sunny and beautiful.

METHODS

A total of 46 forayers in 20 groups achieved fairly complete coverage of the two foray counties (Figure 2). More detail is available at https://sites.google.com/a/umich.edu/2014-vso-foray/. The forayers submitted 152 checklists to eBird (94 from King & Queen, 58 from Middlesex), which are available under the username VSOforay2014.

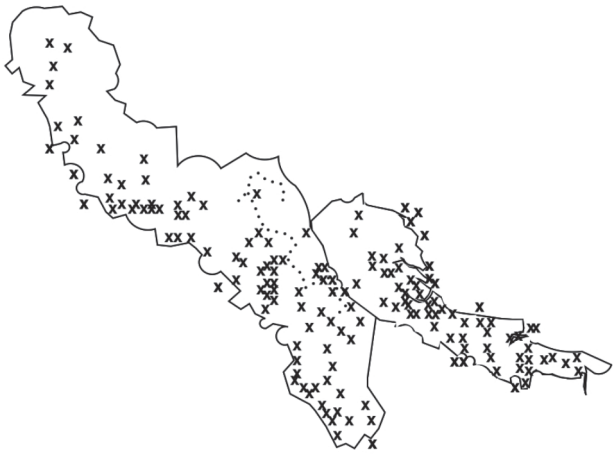

Figure 2: Coverage of Foray Counties. The approximate starting point of each of the 152 checklists is indicated by an X. This gives only an approximate idea of the coverage, as some of the checklists covered up to five miles. X's outside the county borders represent checklists done by boat or kayak. The dotted line indicates the path of the BBS done by Fred Atwood.

Forayers traveled a total of 395 miles (53.9 miles on foot, 284.6 miles by car, 33.7 miles by boat and 22.8 miles by kayak). They spent a total of 167.2 hours (64.4 hours on foot, 58.1 by car, 20.5 hours by boat and 24.2 hours by kayak). Table 1 shows the breakdown by county. There was approximately twice as much effort in King & Queen (roughly the same amount of effort as for Middlesex when adjusted for area), but with a heavier bias toward walking as opposed to driving.

RESULTS

Table 1: Hours and Miles of Effort. The numbers spent by individuals in each county group are given, along with the totals for each of the two counties.

forayers in Hiddlesex	miles walking	miles driving	miles boating	miles kayaking	Total miles	hours walking	hours driving	hours boating	hours kayaking	Total hours
Portlock& Sheldon			14					6.5		
Youker	10.5	69				7.5	14			
Taber	0.1					0.5				
Coleman		16.9					3.2			
Jensen et al	1					2				
Flanders	0.4			4.2		0.5			4.5	
Saunders		16.6					2.8			
Browns	0.5			6.5		0.7			4.9	
TOTALS	12.5	102.5	14	10.7	139.7	11.2	20	8.5	9.4	49.1
forayers in King & Queen										
Bryan et al	1					2.2				
Williams ± Taber	2	29				4.6	9			
Ake & Davis			9.2					8		
Taber et al	2					5.5				
Atwood ± et al	10.5	44.5				12.3	7.6			
Coleman & Schiavo			10.5					4		
Adams				3.5					4.3	
Bells et al		18.4					6.7			
Jensen et al	2					3				
Lott & Goehring	3					6.5				
Flanders	3.4	3.7		4.6		5	1.3		5	
Nasca		78.4					10			
Taylor et al	5	0.6				6.6	1			
Devan & Jacobson	1.5	2.3				1.5	1.5			
Hodge	11	5.2				6	1			
Browns				4					5.5	
TOTALS	41.4	182.1	19.7	12.1	255.3	53.2	38.1	12	14.8	118.1

105 species were reported (102 for King & Queen and 94 for Middlesex) for a total of 7634 + 3513 = 11,148 individual birds (Table 2). Some differences in abundance between the two counties were seen (Table 2). Differences were minimal (zero to three-fold) for ducks, herons, some flycatchers, corvids, most swallows, parids (titmice and chickadees), mimids, sparrows, and cardinalids, among others. However, some species or even families showed a pronounced bias (at least a seven-fold difference) between the two counties: for example, King & Queen had more nightjars, cliff swallows, and warblers, whereas Middlesex had more larids and some other water birds. Nuthatches were a mixed story. Possible reasons for these biases will be discussed below.

DIFFERENCES BETWEEN THE TWO COUNTIES

The warblers show the most noticeable family difference between the two counties. Most of the 16 species of warblers reported during the Foray are more numerous in King & Queen (Table 2). The difference is marked to extreme (6- to at least 49-fold) for nine of the warblers: Worm-eating, Black-and-White, Hooded, Yellow, and Prairie Warblers; Louisiana Waterthrush; Northern Parula; Common Yellowthroat; and Yellow-breasted Chat. The warblers were spread throughout King & Queen County; they weren't all concentrated in one location.

Other birds showing a seven-fold or greater "enrichment" in King & Queen County include Northern Bobwhite, Wild Turkey, Black Vulture, Red-shouldered Hawk, the nightjars, Northern Flicker, Yellow-throated Vireo, Cliff Swallow, White-breasted Nuthatch, and Eastern Towhee. Some of these differences are easily explained. For example, the likely reason that nightjars were only reported from King and Queen is that almost all the night-time surveys were carried out there. The cliff swallows were found in great numbers, but only at two bridges along the Mattaponi River.

Other differences are harder to account for. As mentioned above, the warbler family shows striking differences. Since many of the warblers showing the most

Table 2: Species Totals. Checklists were tallied to give the total number of individuals of each species, by county. The fold difference between the counties was listed for each species that differed by more than three-fold (except for low-abundance species). The column labeled "K&Q>M" shows how many fold greater the number of individuals is in King and Queen, as compared to Middlesex, and "M>K&Q" the reverse.

SPECIES	King & Queen	Middle-sex	K&Q>M	M>K&Q	SPECIES	King & Queen	Middle-sex	K&Q>M	M>K&Q
Canada Goose	90	137			Tree Swallow	20	8		
Wood Duck	4				Bank Swallow		2		
Mallard	19	14			Barn Swallow	81	85		
Northern Bobwhite	85	3	28		Cliff Swallow	174		>174	
Wild Turkey	13	1	13		Carolina Chickadee	87	45		
Double-crested Cormorant	3	15		5	Tufted Titmouse	188	88		
Great Blue Heron	52	53			White-breasted Nuthatch	18	1	18	
Green Heron	8	11			Brown-headed Nuthatch		17		>17
Yellow-crowned Night-heron	1				House Wren	1	1		
Black Vulture	88	13	7		Carolina Wren	173	83		
Turkey Vulture	201	83			Blue-gray Gnatcatcher	161	30	5	
Osprey	36	168		5	Eastern Bluebird	103	114		
Cooper's Hawk	3	2			Wood Thrush	82	24		
Bald Eagle	29	31			American Robin	29	72		
Red-shouldered Hawk	22	3	7		Gray Catbird	7	3		
Red-tailed Hawk	28	7			Brown Thrasher	43	28		
hawk sp.	1				Northern Mockingbird	59	74		
Killdeer	28	19			European Starling	44	194		
Laughing Gull	19	137		7	Cedar Waxwing	28	9		
Herring Gull	3	17		6	Ovenbird	277	58	5	
Royal Tern		16		>16	Worm-eating Warbler	26		>26	
Rock Pigeon	1	17		17	Louisiana Waterthrush	15	1	15	
Mourning Dove	175	107			Black & White Warbler	49	1	49	
Yellow-billed Cuckoo	54	13			Prothonotary Warbler	78	18		
Eastern Screech-Owl	1				Kentucky Warbler	2			
Barred Owl	10	2	5		Common Yellowthroat	123	15	8	
Chuck-will's-widow	17		>17		Hooded Warbler	154	9	17	
Eastern whip-poor-will	45		>45		American Redstart	9	7		
Chimney Swift	49	27			Northern Parula	139	13	10	
Ruby-throated Hummingbird	36	9			Yellow Warbler	6	1	6	
Belted Kingfisher	17	4			Pine Warbler	149	42		
Red-headed Woodpecker	13	6			Yellow-throated Warbler	52	13		
Red-bellied Woodpecker	58	43			Prairie Warbler	190	27	7	
Downy Woodpecker	42	10			Yellow-breasted Chat	156	10	16	
Hairy Woodpecker	17	3	6		Eastern Towhee	94	5	19	
Northern Flicker	25	3	8		Chipping Sparrow	248	140		
Pileated Woodpecker	36	15			Field Sparrow	83	18	5	
Eastern Wood-pewee	101	23			Grasshopper Sparrow	11	16		
Acadian Flycatcher	155	35			Song Sparrow	12	13		
empid sp.	1				Summer Tanager	102	35		
Eastern Phoebe	22	7			Scarlet Tanager	39	10		
Great Crested Flycatcher	66	41			Northern Cardinal	194	123		
Eastern Kingbird	46	22			Blue Grosbeak	100	30		
White-eyed Vireo	218	50			Indigo Bunting	398	170		
Yellow-throated Vireo	95	7	14		Dickcissel	1			
Red-eyed Vireo	344	66	5		Red-winged Blackbird	231	75		
Blue Jay	64	43			Eastern Meadowlark	8	17		
American Crow	238	182			Common Grackle	256	94		
Fish Crow	6	10			Brown-headed Cowbird	120	29		
Crow sp.	2	26		13	Orchard Oriole	25	7		
Horned Lark	7	4			House Finch	14	28		
No. Rough-winged Swallow	25	5	5		American Goldfinch	174	50		
Purple Martin	51	23			House Sparrow	30	27		

extreme differences are "forest" birds, we considered the possibility that a difference in the amount and/or type of forest in the two counties might account for some of these differences. Several other "forest" birds such as Yellow-throated Vireo and White-breasted Nuthatch are also enriched in King and Queen. This county has 2.7 times as much forest as Middlesex (Table 3), in line with the 2.4-fold difference in the area of the two counties (above). However, if one looks at forest type, bigger differences are seen (Table 3).

Table 3: Areas in acres of forest types in King & Queen and Middlesex Counties. Categories and areas are from a FIA Standard Report of the US Forest Service (http://apps.fs.fed.us/fido/standardrpt.html), generated by FIDO.

COUNTY	Forest-type group					TOTAL
	Loblolly/ shortleaf pine	Oak/pine	Oak/ hickory	Oak/ gum/ cypress	Elm/ash/ cottonwood	
Middlesex (M)	18,592	5,446	18,836	5,505	1,449	49,828
King & Queen (KQ)	45,250	29020	45,635	4,347	11,591	135,843
KQ/M	2.4	5.3	2.4	0.8	8.0	2.7

Furthermore, we do not appear to have surveyed forested areas as thoroughly in Middlesex County. The part of Middlesex north of Urbanna is more forested (see Figure 3 on page 7), and fewer checklists come from these northern areas that appear most forested (compare Figure 3 to Figure 2). In King & Queen on the other hand, a fair amount of effort was spent on the heavily forested Dragon Run State Park (~20 checklists).

Forest differences can't account for all the differences between the two counties, however. The Wood Thrush, a rather strict forest bird, is only about three-fold more numerous in King and Queen, a difference that can be almost completely accounted for by the difference in effort in the two counties. On the other hand, the Yellow-breasted Chat, a scrubland bird, is 16-fold more numerous in King & Queen (about an 8-fold difference in abundance when corrected for effort).

Another possible factor is the degree of sub/urbanization in the two counties. As mentioned above, population density in King & Queen is one-fourth that in Middlesex. Furthermore, we may have accentuated the difference by where we surveyed. The part of Middlesex north of Urbanna (which was surveyed less; see above) is not only more forested, but also less urban. This might explain the enrichment of some non-forest as well as forest birds in King & Queen. The forest birds that are not enriched may be more tolerant of development; for example, wood thrushes can nest in wood lots in suburbia.

Other birds (Double-crested Cormorant, Osprey, Laughing and Herring Gull, Royal Tern, Rock Pigeon, Brown-headed Nuthatch, and European Starling) were more numerous in Middlesex than in King & Queen. Some of these would also be expected in a more urban setting. Most of the rest are "coastal", and would be more likely along the Rappahannock River which borders Middlesex (rather than the smaller and less saline [http://www.virginiaplaces.org/watersheds/] Mattaponi River which borders King & Queen).

EVIDENCE OF BREEDING

Table 4 (see page 9) lists the breeding evidence for King & Queen County. We obtained probable or confirmed evidence of breeding for 67 of the 105 species reported. These data were compared (see Table 5 on page 10-11)) with data for King & Queen County in the first Breeding Bird Atlas of Virginia, 1985 - 1989 (http://www.pwrc.usgs.gov/bba/index.cfm?fa=explore.ProjectHome&BBA_ID=VA1985). There are 16 species identified during this year's foray that the Atlas did not report. All of these species were low incidence (a total of four or fewer individuals reported), except Canada Goose, Green Heron, Red-shouldered Hawk, Red-tailed Hawk, Laughing Gull, Northern Rough-winged Swallow, and Yellow Warbler. It is possible that a number of these species were seen as flyovers only and not reported. (Yellow Warbler may, instead, be a matter of low incidence - only 6 individuals were seen.) On the other hand, there were four species that we did not report (Clapper Rail, Barn Owl, Great Horned Owl, Marsh Wren) that were reported as possible breeders in the 1985-1989 Atlas. Dramatic differences in the number of probable or confirmed breeding evidence were not seen (although they weren't necessarily the same species). We reported 41 confirmed and 26 probable breeders, whereas the Atlas reported 38 confirmed and 24 probable breeders.

Table 4 also lists the breeding evidence for Middlesex County. We obtained probable or confirmed breeding evidence for 25 of the 94 species we reported. There are 25 species that the Atlas did not report. Eliminating those which are low incidence or might have been seen as flyovers, there are still 11 species not reported in Middlesex County in the 1985-1989 Atlas: Mallard, Wild Turkey, Laughing Gull, Herring Gull, Royal Tern, Red-headed Woodpecker, Fish Crow, Brown-headed Nuthatch, Cedar Waxwing, American Redstart, and Yellow-throated Warbler. Thus there is a much bigger discrepancy than in King & Queen County. Perhaps Middlesex was less thoroughly surveyed for the Atlas than King & Queen. The only species reported by the Atlas that we did not encounter in Middlesex was Chuck-will's-widow, but we made only one night-time attempt to hear them in this county. We obtained 17 confirmed and 8 probable breeders for Middlesex, whereas the Atlas obtained 11 confirmed and 10 probable breeders (Table 5).

Figure 3: Forested areas of Middlesex County. The county border is shown in white. Forested areas on this google map are dark gray, whereas farmer's fields are a lighter gray.

SPECIES ACCOUNTS

Some of the birds identified during the Foray deserve further comment, either because of their low numbers, or differences in distribution between the two counties:

WOOD DUCK: Three were seen on June 7, 8, &14 by three different groups in northern King & Queen. This is a "common transient and summer resident in freshwater areas" of coastal Virginia (Rottenborn and Brinkley, 2007).

YELLOW-CROWNED NIGHT-HERON: Lou Schiavo and Joe Coleman saw one individual on June 12 in King & Queen County, while surveying by boat on the Mattaponi River near West Point. This was a first report to eBird of this species in the foray counties. And in fact few have ever been seen west of the Chesapeake, except near its mouth. It is classified as an "uncommon and local transient and summer resident near (the Atlantic) coast, rare further inland" (Rottenborn and Brinkley, 2007).

COOPER'S HAWK: This species was seen by four different groups. It is an uncommon to rare summer resident (Rottenborn & Brinkley, 2007).

NIGHT BIRDS: Eight checklists (on June 7, 8, 10, 14, 15) resulted from nighttime/very early morning surveys in King & Queen County. 45 EASTERN WHIP-POOR-WILL, 17 CHUCK-WILLS-WIDOW, and one EASTERN SCREECH-OWL were found. Most of these lists were started between 3:15 and 5 AM, variously by Bill Williams, Brian Taber, Nick Flanders, and Fred Atwood; one started at 9:10 PM. Two of the checklists submitted by Atwood were done for the Nightjar Survey sponsored by the Center for Conservation Biology, and another was done for the Breeding Bird Survey of the USGS.

In addition, Dave Youker spent about 45 minutes listening for owls and nightjars at the end of Whippoorwill Lane in Middlesex County. This was in the evening of June 9, starting at about 8:45 pm. None were heard, and a checklist was not submitted.

BARRED OWL: Ten were identified by various groups (8 lists), with 6 of these lists from King & Queen. The two from Middlesex (one at Mascot Bridge, the other at Ware's Bridge) were at the border between the two counties. Some of these owls were reported on lists that started before sunrise, and others a bit later in the morning.

BANK SWALLOW: Two birds were seen by James Shelton and Bill Portlock in Parrot's Cove in Middlesex County on

June 7, while they were surveying the Rappahannock by boat. This bird breeds in the foray area; one or more nesting colonies have been reported in this county (Rottenborn & Brinkley, 2007).

BROWN-HEADED NUTHATCH: This species is found in pine forests in the southeastern US. In Virginia, which is at the northern edge of its range, it is mostly found close to the western edge of the Chesapeake Bay or a ways up the large rivers (see eBird range map).

Essentially all of the birds reported were near the Rappahannock River (fifteen at the Regent Point Marina and at the mouth of the neighboring Locklies Creek by Nick Flanders on June 14; one at Harry George Creek by Bill Portlock and James Shelton on June 7; one at Lover's Lane near Jackson Creek at the mouth of the Piankatank River by Dave Youker on June 9. All of the sightings were in Middlesex County. PINE WARBLER, another pine specialist, did not show this bias; it was three times more abundant in King and Queen County, and not restricted to locations near big bodies of water (although many of the Pine Warblers seen in Middlesex County did show a near-water location bias).

HOUSE WREN: Two were reported. One on June 12 on Watson's Landing Road near Saluda in Middlesex County by Joe Coleman and one from route 610 in King & Queen County on June 15 by Meredith and Lee Adams and John and Marilyn Adair. House Wren is an "uncommon to fairly rare summer resident; apparently declining in many areas (of coastal Virginia) in recent decades, though high breeding densities still occur in some areas (e.g., in forested areas along the upper edges of tidal salt marshes)" (Rottenborn and Brinkley, 2007).

KENTUCKY WARBLER: Fred Atwood and members of the Northern Virginia Teen Bird Club saw two individuals on Mintner Lane and a nearby private property in Walkerton, King & Queen County, on June 7. This species is an "uncommon to fairly common summer resident" (Rottenborn & Brinkley, 2007).

DICKCISSEL: One was heard by Bob Ake while he and Brad Davis were surveying by boat along the Mattaponi on June 8. "The 'dick, dick, cis, cis, cis' song was heard clearly many times. The bird was up on the bluff above the river so couldn't be seen." This bird is found mainly in the midwest, but occurs in Virginia as well.

ACKNOWLEDGEMENTS

Many thanks to the forayers, who often spent long hours and traveled many miles: John and Marilyn Adair, Natty Abrahams, Lee Adams, Bob Ake, Fred Atwood, Steve Baum, Meredith and Lee Bell, Elizabeth and Bob Bevins, Wes and Susan Brown, Allen Bryan, Joe Coleman, Brad and Ethan and Nate Davis, Shirley Devan, Gary Driscole, Anne Ducey-Ortiz, Leslie Fellows, Nick Flanders, Jim Goehring, Joel Goetz, Tim Hodge, Teri Holland, Cheryl Jacobson, John Jensen, Teta Kain, Eli Karush, Phil Kenny, Mike Lott, Sayed Malawi, Paul Nasca, Bill Portlock, Lou Schiavo, James Shelton, Sam Simon, Tom and Sylvia Saunders, Brian Taber, Russ Taylor, Ethan Waldman, Bill Williams, and Dave Youker. Thanks, in addition, to the homeowners and others who provided us with access to private or restricted property. Special thanks to Teta Kain and Fred Atwood, who were ***de facto*** co-leaders of the Foray. Teta previewed the counties with me a year beforehand, was the contact with Friends of Dragon Run, and organized that part of the Foray. She also suggested I contact Fred Atwood, whose advice and many suggestions were invaluable.

REFERENCE

Rottenborn, S. and E. Brinkley. 2007. Virginia's Birdlife: An Annotated Checklist, 4th edition.

Table 4: Breeding Evidence. Breeding codes from all checklists were listed by county: CF = carrying food, CS = carrying fecal sac, FL = recently fledged, FY = feeding young, NE = nest with eggs, NY = nest with young, and ON = occupied nest are codes that confirm breeding, and A = agitated behavior, C = courtship, N = visiting probable nest site (hole nesters), NB = nest building (not wrens), and P = pair are codes that indicate probable breeding.

Species	King & Queen	Middlesex
Canada Goose	FL	2 FL
Mallard	FL	
Northern Bobwhite	3P	
Wild Turkey	P	
Great Blue Heron	NY	
Osprey	5 ON, NY	6 ON, 4 NY, NB
Bald Eagle	NY	
Red-shouldered Hawk	A, P	
Red-tailed Hawk	FL, P	
Killdeer	NE	A
Mourning Dove	4P	
Yellow-billed Cuckoo	C	
Chimney Swift	C	
Belted Kingfisher	C	
Red-headed Woodpecker	2N	
Red-bellied Woodpecker	2P, N	NB
Downy Woodpecker	2P	
Northern Flicker	NY	
Pileated Wood pecker		NB
Acadian Flycatcher	CF, P	P
Eastern Phoebe	CF, ON, P	CF
Great Crested Flycatcher	CF	
Eastern Kingbird	CF	A
White-eyed Vireo	4P, FY, NB, FL	
Red-eyed Vireo	2CF, 4P, FL	CF
Blue Jay	CF, P	
American Crow	FL, P	
Horned Lark		P
No. Rough-winged Swallow	ON	
Purple Martin	CS	2 N
Tree Swallow	ON	
Barn Swallow	2 ON, FL, 4P, NY	ON
Cliff Swallow	ON	
Carolina Chickadee	FL, P	
Brown-headed Nuthatch		N
Carolina Wren	P	

Species	King & Queen	Middlesex
Blue-gray Gnatcatcher	3P	
Eastern Bluebird	4FL, 6P, C	FL
Wood Thrush	CF	
Brown Thrasher	CF	
Northern Mockingbird	P, A	
European Starling	2 FL	FY
Cedar Waxwing		FL
Ovenbird	2 FL, A, P	FL
Worm-eating Warbler	FL, P	
Black-and-white Warbler	FL	
Louisiana Waterthrush	P	
Prothonotary Warbler	CF, NY, FL, P	
Common Yellowthroat	2P	
Hooded Warbler	3P, CF, A, FL	
American Redstart	FY, CF, 2P	
Northern Parula	NB	
Pine Warbler	2 CF, 2 FL, 2 P	
Prairie Warbler	4P, 2FL, FY	
Yellow-breasted Chat	2P	
Eastern Towhee	4P, C	
Chipping Sparrow	FL, 6P, CF	FL
Field Sparrow	3P, A	
Grasshopper Sparrow		CF
Summer Tanager	2A, 2P, C	CF, C
Scarlet Tanager	P	
Northern Cardinal	3P, CF	FL
Blue Grosbeak	9P	P
Indigo Bunting	11 P	
Red-winged Blackbird	A	
Eastern Meadowlark	P	
Common Grackle	FL, NB	
Brown-headed Cowbird	5P, FL	
Orchard Oriole	P	CS, CF
House Finch	2P	ON
American Goldfinch	3P, FY	
House Sparrow	FL	N

Table 5: Breeding evidence from this Foray compared with the 1985-1989 Virginia Breeding Bird Atlas. The "best evidence" (i.e., the best of PO = possible, PR = probable, or CO = confirmed evidence) of breeding in Table 4 was converted and listed by county, side-by-side with the evidence from the 1985-1989 Atlas.

	King & Queen County		Middlesex County	
Species	2014	1985 - 1989	2014	1985 - 1989
Canada Goose	CO		CO	
Wood Duck	PO	CO		
Mallard	CO	CO	PO	
Northern Bobwhite	PR	PR	PO	PO
Wild Turkey	PR	CO	PO	
Double-crested Cormorant	PO		PO	
Great Blue Heron	CO	CO	PO	CO
Green Heron	PO		PO	
Yellow-crowned Night-heron	PO			
Osprey	CO	CO	CO	CO
Cooper's Hawk	PO		PO	
Bald Eagle	CO	CO	PO	CO
Clapper Rail		PO		
Red-shouldered Hawk	PR		PO	
Red-tailed Hawk	CO		PO	
Killdeer	CO	CO	PR	PO
Laughing Gull	PO		PO	
Herring Gull	PO		PO	
Royal Tern			PO	
Rock Pigeon	PO	PR	PO	PO
Mourning Dove	PR	CO	PO	PO
Yellow-billed Cuckoo	PR	PO	PO	PO
Barn Owl		PO		
Eastern Screech-Owl	PO			
Great Horned Owl		PO		
Barred Owl	PO	PO	PO	
Chuck-will's-widow	PO	PO		PO
Eastern whip-poor-will	PO	PO		
Chimney Swift	PR	PO	PO	PO
Ruby-throated Hummingbird	PO	PO	PO	PO
Belted Kingfisher	PR	PO	PO	PO
Red-headed Woodpecker	PR	CO	PO	
Red-bellied Woodpecker	PR	CO	CO	PO
Downy Woodpecker	PR	PO	PO	PO
Hairy Woodpecker	PO	PO	PO	
Northern Flicker	CO	PR	PO	PO
Pileated Woodpecker	PO	CO	CO	PO
Eastern wood-Pewee	PO	PR	PO	CO
Acadian Flycatcher	CO	PR	PR	PO
Eastern Phoebe	CO	CO	CO	PO
Great Crested Flycatcher	CO	CO	PO	PO
Eastern Kingbird	CO	CO	PR	PO
White-eyed Vireo	CO	CO	PO	PO
Yellow-throated Vireo	PO	PR	PO	PR
Red-eyed Vireo	CO	CO	CO	PR
Blue Jay	CO	PO	PO	PO
American Crow	CO	CO	PO	CO
Fish Crow	PO	PO	PO	
Horned Lark	PO	PR	PR	PO

Species	King & Queen County		Middlesex County	
	2014	1985 - 1989	2014	1985 - 1989
Northern Rough-winged Swallow	CO		PO	CO
Purple Martin	CO	CO	PR	PO
Tree Swallow	CO	PO	PO	
Barn Swallow	CO	CO	CO	CO
Bank Swallow			PO	CO
Cliff Swallow	CO	PO		
Carolina Chickadee	CO	CO	PO	PO
Tufted Titmouse	PO	CO	PO	PO
White-breasted Nuthatch	PO	PO	PO	CO
Brown-headed Nuthatch			PR	
House Wren	PO		PO	
Carolina Wren	PR	PR	PO	PO
Marsh Wren		PO		
Blue-gray Gnat catcher	PR	PR	PO	PO
Eastern Bluebird	CO	CO	CO	CO
Wood Thrush	CO	CO	PO	PO
American Robin	PO	PR	PO	PO
Gray Catbird	PO	PO	PO	
Brown Thrasher	CO	CO	PO	PR
Northern Mocking bird	PR	CO	PO	PO
European Starling	CO	CO	CO	PO
Cedar Waxwing	PO	PO	CO	
Ovenbird	CO	PR	CO	PO
Worm-eating Warbler	CO	PO		
Louisiana Waterthrush	PR	PR	PO	
Black-and-white Warbler	CO	PR	PO	
Prothonot-ary Warbler	CO	PO	PO	PR
Kentucky Warbler	PO	PR		

Species	King & Queen County		Middlesex County	
	2014	1985 - 1989	2014	1985 - 1989
Common Yellow throat	PR	CO	PO	PO
Hooded Warbler	CO	PR	PO	PO
American Redstart	CO	PO	PO	
Northern Parula	CO	PR	PO	PO
Yellow Warbler	PO		PO	
Pine Warbler	CO	CO	PO	PO
Yellow-throated Warbler	PO	PO	PO	
Prairie Warbler	CO	CO	PO	PO
Yellow-breasted Chat	PR	PR	PO	PO
Eastern Towhee	PR	PR	PO	PO
Chipping Sparrow	CO	CO	CO	CO
Field Sparrow	PR	CO	PO	PO
Grasshopper Sparrow	PO	PO	CO	PO
Song Sparrow	PO	PO	PO	PO
Summer Tanager	PR	CO	CO	PO
Scarlet Tanager	PR	CO	PO	PO
Northern Cardinal	CO	CO	CO	PR
Blue Grosbeak	PR	CO	PR	PR
Indigo Bunting	PR	PR	PO	PR
Dickcissel	PO			
Red-winged Blackbird	PR	PR	PO	PO
Eastern Meadow lark	PR	PR	PO	PO
Common Grackle	CO	CO	PO	PR
Brown-headed Cowbird	CO	PR	PO	PR
Orchard Oriole	PR	CO	CO	PO
House Finch	PR	PR	CO	PO
American Goldfinch	CO	PR	PO	PO
House Sparrow	CO	CO	PR	PR

STATUS AND DISTRIBUTION OF COLONIAL WATERBIRDS IN COASTAL VIRGINIA: 2013 BREEDING SEASON

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ABSTRACT

We conducted a systematic survey of colonial waterbirds in coastal Virginia during the 2013 breeding season. Nearly 800 surveys of 496 waterbird colonies were conducted. 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 seaside of the Eastern Shore accounted for 54.7% and 27.0% of all breeding pairs and colonies, respectively. For 14 of the 24 species, the region supported more than 50% of the known coastal population.

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

INTRODUCTION

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 often in habitats that are physiographically fragile and dynamic. 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). In 1975 the Virginia Coast Reserve of the Nature Conservancy completed the first comprehensive survey of all of Virginia's Atlantic barrier islands colonial nesting waterbirds and compiled a complete review of all of the known literature regarding this diverse avian community (Williams 1976). During the 1975 and 1976 breeding seasons, a 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). In 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). From 1975 through 2005, annual surveys of waterbirds were conducted on all of the Virginia coastal barrier islands by Williams et al. (2006). All of these surveys focused primarily on the coastal fringe and did not cover the entire Coastal Plain. In 1993, a systematic survey was conducted, covering 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. 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 paper reports on the second ten-year anniversary assessment conducted during the 2013 breeding season.

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 (1) to be integrated into biological databases to be used in the environmental review process, (2) to provide information for comparison to past and future surveys for the purpose of assessing long-term population trends, and (3) to be used in the formulation of management recommendations.

METHODS

Field Surveys – An extensive aerial survey was conducted using a fixed-wing aircraft during early stages of the 2013 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 origins. 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. 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 in units of 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 counts 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 the 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).

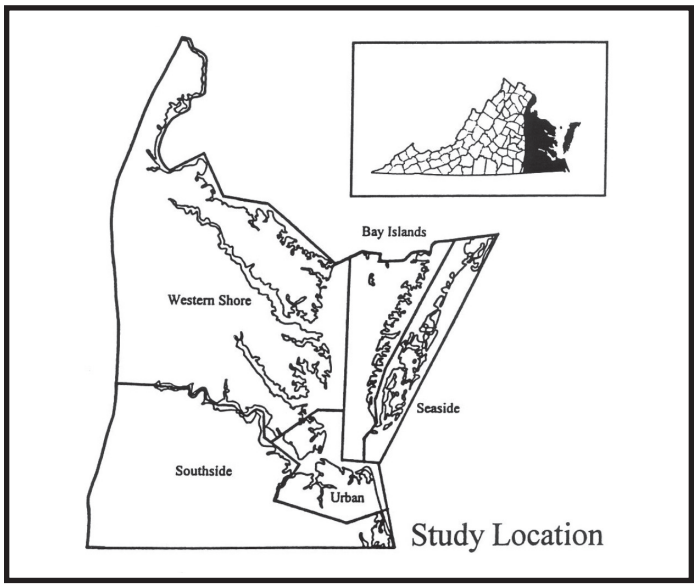

Figure 1. Map of study area. The Coastal Plain of Virginia was subdivided into geographic regions including (1) seaside, (2) Bay islands, (3) urban, (4) western shore, and (5) southside.

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 (see Appendix, p. 25, for the species list). 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 fewer. Nine mixed-species heronries contained seven or more species.

Abundance varied widely among species and species groups (see Table 1, p. 21). 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 colonial nesting 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 nesting species encountered (see Table 2, p. 22). 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 27.0% of all breeding pairs and colonies, respectively. For 14 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 regions supported 14, 5 and 2 species, respectively. The Bay region supported 7 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% since 1993 (see Table 3, p. 23). 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 among 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. Five species increased between 1993 and 2013. Dramatic expansions were documented for White Ibis, Great Black-backed Gull, Double-crested Cormorant, and Brown Pelican.

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. Colonial waterbirds have been systematically surveyed within this geographic area in 1993, 1998, 2003, 2008, and 2013. In the majority of species, comparisons of population estimates across these years (see Table 4, p. 24) 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, Least Tern, and Black Skimmer all showed an overall 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 mostly consistent increases. Patterns for other species were stable or showed weak trends.

Of particular note within this region was the nearly 50% decline in the Laughing Gull population since 2003. This catastrophic change was most pronounced within historic strongholds in Northampton County, where the decline in both area used for nesting and number of breeding pairs was greater than 80% (Figure 2).

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

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 southeast island now supports the most significant seabird colony in the state, consisting of breeding Great Black-backed Gulls, Herring Gulls, Laughing Gulls, Gull-billed Terns, Royal Terns, Sandwich Terns, Common Terns, and Black Skimmers.

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, 2006). Until recent years, birds were associated exclusively with a mixed-species heronry on Fisherman Island, with little indication of further expansion (Williams et al. 1992). This heronry was abandoned in 2002 (Williams et al. 2003) and has not been used since. In 2000, this pattern changed when birds appeared in the Cobb-Island heronry (Williams et al. 2001). This event was followed in 2001 when the Wreck-Island heronry was colonized (Williams et al. 2002). In 2005, White Ibis colonized the heronry on Chimney Pole Marsh (Williams et al. 2006) and then the colony on Wire Narrows (Williams 2010). 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; Watts and Byrd 2006). 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 unpublished 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 that 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 Bald Eagles (Watts, unpublished data). The role of Bald Eagles in colony dynamics 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 from the advances toward the fall line, the population in most other regions is 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 on 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 (Montagna and Wimsatt 1942, 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 during the 1950s then plateaued, remaining at that size 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%, including a 42.5% decline 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, with precipitous declines 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 by 44%, resulting in a 32% decline since 1993. The only strongholds 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 1944 in King William County (F.M. Jones unpublished report). 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.

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 (Williams et al. 2006) and Chesapeake Bay islands (Brinker et al. 2007) 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 toehold 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 had experienced considerable storm erosion.

Herring Gull – A single Herring Gull nest was found on the seaside near Cobb Island in 1948 (Buckalew 1948). 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. 2006, Watts and Byrd 2006). 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 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.

As a group, terns declined 38.2% over the 20-year period from an estimated 17,785 to 10,993 breeding pairs. There were no 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 and were comparable to those of 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. 2006). 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. Many of the pairs of Royal Terns currently breeding on the Hampton Roads Bridge Tunnel Island are likely pairs that formerly bred on the barrier islands. In 2013, the Hampton Roads Bridge Tunnel Island 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 reflects the dynamics of their occurrence in Virginia. Since 2010 this species has successfully nested among Royal Terns on the Hampton Roads Bridge Tunnel (Williams 2010, 2011, 2012, 2013).

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 overall declines on the barrier islands (Williams et al. 2006). 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 (Chapman 1899, Howell 1911). 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 2007, rooftop nesting was confirmed at Patrick Henry Mall and Lynnhaven Mall; the latter site had apparently been utilized by nesting Least Terns for the previous six years (Williams 2007). The formation of rooftop 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 and have not been discovered. Such colonies are subject to severe heat stress and active management is required to improve productivity.

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 (Blem et al. 1980). Throughout the 20th century, cormorants experienced wide fluctuations in numbers and distribution throughout their range (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, and by 1995 there were 5 colonies 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 in the Chesapeake Bay. 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 the effects of 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 2000). 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.

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Table 1. Estimated number of breeding pairs for all geographic regions within the Coastal Plain of Virginia 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		9
Royal Tern	8	16	1-5188	99.7	5321
Sandwich Tern	2	-----	5-23	11.1	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 within the Coastal Plain of Virginia in 2013. "Col" = the number of colonies within the respective regions. "Prs" = the estimated number of breeding pairs within each region. "%" = 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 estimated number of breeding pairs in coastal Virginia for 1993, 2003 and 2013. 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**

Table 4. Population estimates for colonial waterbirds within the barrier island/lagoon system of the Delmarva Peninsula. Values represent estimated numbers 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**

APPENDIX I: List of 24 colonial waterbird species surveyed in coastal Virginia, along with their 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*

RECOVERY OF BREEDING BALD EAGLES ALONG THE LOWER DELMARVA PENINSULA

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ABSTRACT

The nesting Bald Eagle (***Haliaeetus leucocephalus***) population has increased dramatically throughout the lower Chesapeake Bay since the early 1970s. On the lower Delmarva Peninsula, breeding pairs nest in two distinct habitats. The western shoreline borders the polyhaline waters of the Chesapeake Bay and is part of the bay's tremendously productive ecosystem. The eastern shoreline abuts the highly saline Atlantic Ocean and is part of a coastal bay ecosystem. Using data collected during aerial surveys, we examined the repopulation of nesting Bald Eagles along the lower Delmarva Peninsula (1977 - 2011) and compared reproductive success and productivity of pairs nesting on the bayside and seaside of the peninsula (1990 - 2011). The population of nesting Bald Eagles increased 60-fold during the study period, with an average annual increase of 16%. More than 50% of the 727 young produced on the peninsula during the study period were produced after 2004 as a result of the increasing number of nesting pairs. There was no significant difference in either productivity (1.28 ± 0.84 and 1.04 ± 0.61 young/nest) or nesting success (0.79 ± 0.50 and 0.71 ± 0.36) of pairs on the bayside and seaside, respectively (means ± SD). The results, however, do suggest a trend toward higher productivity in nests located along the bayside of the peninsula. The dramatic increase in the number of nesting Bald Eagles on the Delmarva Peninsula during the study period is similar to population-wide trends throughout the lower Chesapeake Bay estuary as well as continental trends throughout North America.

INTRODUCTION

The recovery of Bald Eagles (***Haliaeetus leucocephalus***) throughout the species' breeding range following the 1972 ban on DDT and similar compounds has been one of the greatest conservation success stories of our time. The Chesapeake Bay is believed to have played an important role in the recovery of Bald Eagles in eastern North America because it is a site of convergence of three geographically distinct populations. The Chesapeake Bay supports a resident breeding population as well as migratory populations from the northeastern and southeastern United States. Similar to range-wide recovery patterns (72 FR 37346), the resident population in the lower Chesapeake Bay has exhibited dramatic growth since the 1970s, expanding from 60 pairs in the early 1970s to 646 pairs by 2001, with an average doubling time of 8.2 years (Watts et al. 2006, 2008). The eagle population in the bay has continued to increase since the release of Watts et al.'s 2008 report (Watts et al. unpub. data). Breeding pairs currently nest at unprecedented numbers throughout the Chesapeake Bay estuary from the Atlantic Ocean to the fall line, and the population is estimated to be approaching saturation (Watts et al. 2007, 2008).

The lower Delmarva Peninsula, commonly known as the eastern shore of Virginia, supports a growing subpopulation of nesting Bald Eagles. Pairs nesting along the western and eastern shorelines of the peninsula are part of two distinct ecosystems. The western side of the Delmarva Peninsula is adjacent to the polyhaline waters of the Chesapeake Bay and is thus referred to as the bayside of the peninsula. The bayside is part of the great ecosystem of the bay, with numerous inlets and rivers providing habitats that support abundant populations of fish, a preferred food source for Bald Eagles in the lower Chesapeake Bay (Markham 2004, Markham and Watts 2008). The eastern side of the peninsula, referred to as the seaside, meets the highly saline Atlantic Ocean and is part of a coastal bay ecosystem. The seaside of the Delmarva Peninsula hosts over 100,000 shorebirds annually and has been designated as a Western Hemisphere Shorebird Reserve with international status (Watts and Truitt 2000). In addition to being a critical shorebird staging area, the seaside of the peninsula provides the most important habitat for colonial waterbirds in Virginia (Watts and Byrd 1998, 2006). Because breeding Bald Eagles forage within 3 km of nesting sites (Buehler et al. 1991), the foraging ecology of eagle pairs nesting on the bayside and seaside of the eastern shore may be influenced by the distinct features of their respective ecosystems.

The purposes of this report are (1) to describe the growth of the nesting Bald Eagle population on the lower Delmarva Peninsula (1977 - 2011) and (2) to compare reproductive rates of the subpopulations nesting on the bayside and seaside of the peninsula (1990 – 2011).

METHODS

Since 1977, the lower Delmarva Peninsula has been systematically surveyed for nesting Bald Eagles following a standard two-flight approach including a survey flight and a productivity flight (Fraser et al. 1983; Watts et al.

2006, 2008). Survey flights were conducted from late February to early March with the purpose of finding new nests, checking known nests, and documenting breeding attempts. Productivity flights were conducted from late April to mid-May with the intention of determining nesting success, the number of offspring produced, and brood age (Watts et al. 2006, 2008). We used a high-wing Cessna 172 aircraft to overfly the land surface between the shoreline and a distance of 1-3 km inland at an altitude of approximately 100 m to survey the most probable nesting locations.

Repopulation of the lower Delmarva Peninsula – We examined changes in the size of the population of nesting Bald Eagles on the eastern shore using survey data (1977 - 2011). Numbers of occupied territories and active nests were used to estimate the size and growth of the breeding population. A territory was considered occupied if a pair of eagles was observed in association with the nest and there was evidence of nest maintenance. An active nest was one at which a breeding attempt was documented, identified by the presence of eggs or young in the nest. Productivity and success rate were used to assess reproductive rates. Productivity was calculated as the number of young produced per active nest. Success rate was the number of nests that produced at least one young out of the total number of active nests. Nests with unknown outcome were excluded from the analysis.

Comparison of bayside and seaside nests – We used survey data to compare reproductive success and productivity of Bald Eagle pairs nesting on the bayside and seaside of the eastern shore from 1990 to 2011. This time frame was selected because it is believed to be beyond the period of biocide-induced reproductive suppression (Wiemeyer et al. 1984, 1993; Buehler 2000), and the survey was discontinued after 2011. The study sample included 69 bayside nests and 59 seaside nests. For cases in which a nest was active but the results of the breeding attempt were unknown, that attempt was necessarily excluded from the calculation of the nest's average success rate and productivity.

Statistical analyses were completed with R software (R Core Team 2013). Average productivity and breeding success rate were calculated for each nest according to the aforementioned definitions. Welch's ***t***-test was used to compare success rates and productivity of nests on the bayside and seaside of the eastern shore. Sensitivity analyses were conducted to assess potential impacts of breeding attempts with undetermined results. Primary statistical analyses were repeated, independently substituting the range of possible outcomes for each undetermined result while keeping all other values constant. Possible outcomes included nest failure or survival of one, two, three, or four young. Welch's ***t***-test statistic and corresponding probability values were compared between the primary analyses and the sensitivity analyses to assess potential impacts. All values are reported as mean ± standard deviation.

RESULTS

Repopulation of the lower Delmarva Peninsula – Between 1977 and 2011, the population of Bald Eagles on the lower Delmarva Peninsula increased at an exponential rate from 1 nesting pair to over 60 pairs (Figures 1, 2).

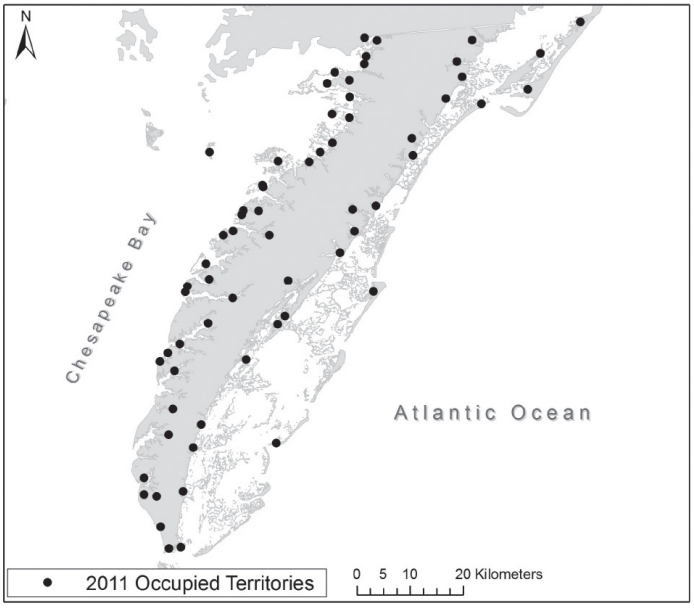

Figure 1. Map of occupied breeding territories of Bald Eagles on the Delmarva Peninsula in 2011.

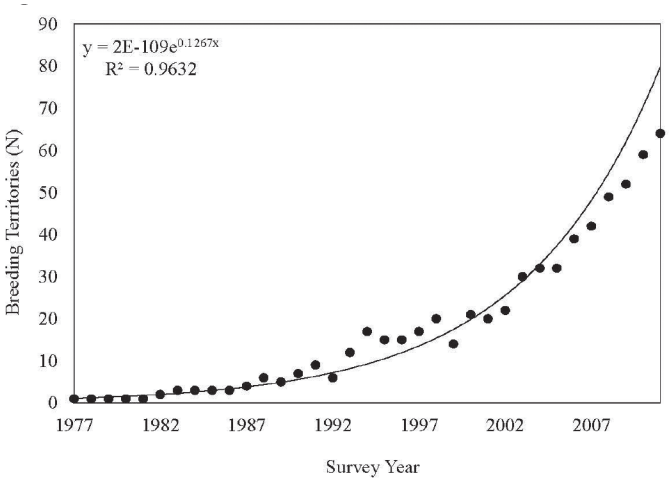

Figure 2. Number of known occupied breeding territories of Bald Eagles documented during aerial reproductive surveys of the Delmarva Peninsula (1977-2011).

Though there have been several years during which the nesting population declined from the previous year, overall there has been a 16% average annual increase in the number of nesting pairs. From 1977 to 2011, pairs nesting on the eastern shore of Virginia produced a total of 727 young. Disproportionately more young were produced in later years as the nesting population expanded, with over 50% of young, overall, produced after 2004 (Figure 3). Per capita reproductive rate averaged 1.24 ± 0.38 young/active nest and did not show a drastic increase over the study period (Figure 4). Annual success rate fluctuated between 0.5 and 1.0 over the study period with the exception of 1978, when the only nest active in that year failed (Figure 5). The average annual success rate over the study period was 0.80 ± 0.20.

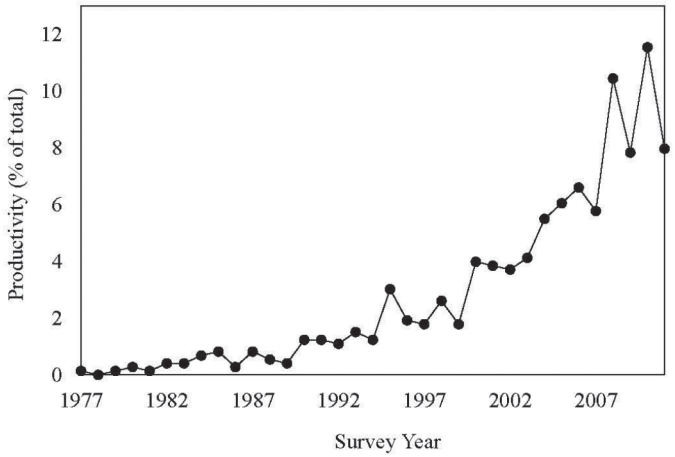

Figure 3. Accumulation curve for productivity of Bald Eagles nesting along the lower Delmarva Peninsula expressed as the percent of total young produced between 1977 and 2011. Total productivity over the study period was 720 young.

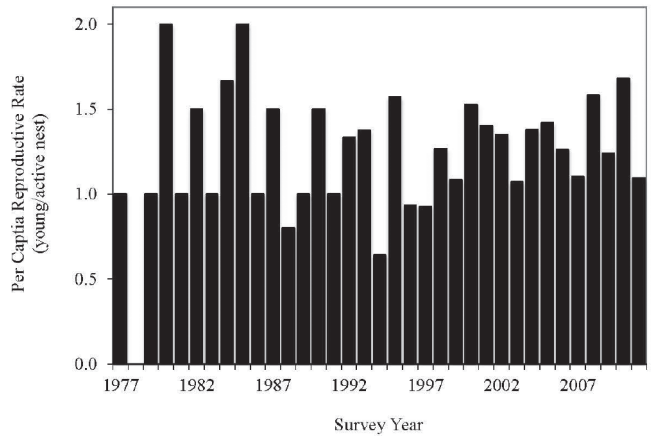

Figure 4. Per capita reproductive rate of Bald Eagles nesting along the lower Delmarva Peninsula (1977 - 2011).

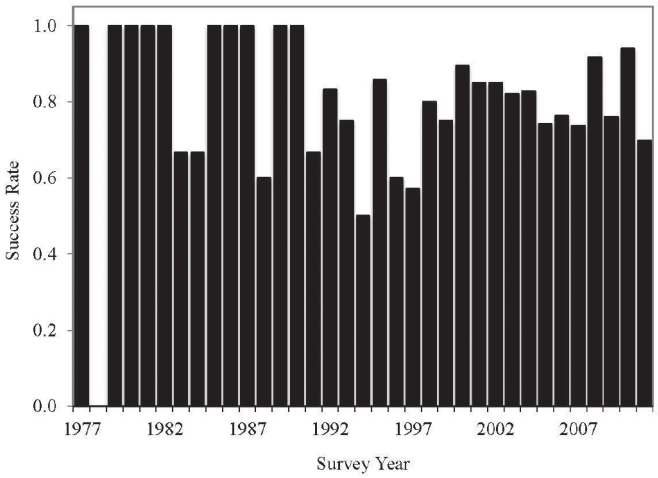

Figure 5. Nesting success rate for Bald Eagle pairs nesting along the lower Delmarva Peninsula (1977 – 2011). Success rate was calculated as the number of nests producing at least one young divided by the total number of active nests.

Comparison of bayside and seaside nests – There were no significant differences in the reproductive parameters of Bald Eagle pairs nesting on the bayside and seaside of the lower Delmarva Peninsula (1990 – 2011). The average number of young fledged per year at bayside nests was 1.28 ± 0.84, whereas seaside nests fledged an average of 1.04 ± 0.61 young per year (t = 1.8612, df = 122.6, P = 0.065). The average success rate in bayside nests was 0.79 ± 0.50, while the average seaside nest success rate was 0.71 ± 0.36 (t = 0.9888, df = 122.0, P = 0.325).

Out of 554 documented breeding attempts at the 128 study nests, only 3 breeding attempts had undetermined outcomes. Two of these attempts occurred at seaside nests and one occurred at a bayside nest. Sensitivity analyses indicate that these unknown outcomes did not affect the results of the comparison of average success rate in bayside and seaside nests (all $t < 1.2043$, $P > 0.231$). The results of the productivity analyses were affected by the undetermined outcomes in two possible scenarios. If the seaside nests experienced failures and the bayside nest produced one or more young, then the study-wide difference in the productivity of bayside and seaside nests would become significant (all $t > 2.0154$, $P < 0.046$). The productivity comparison would also be affected if all of the attempts with unknown outcomes resulted in failures (t = 1.9896, df = 123.6, P = 0.049). All other possible outcomes of unresolved breeding attempts had no effect on the significance of the productivity comparison (all $t < 1.9572$, all $P > 0.053$).

DISCUSSION

The results of this study are consistent with regional (Watts et al. 2007, 2008) as well as continental (72 FR 37346) changes in Bald Eagle population numbers during the study time period. Breeding Bald Eagles have repopulated

the eastern shore rapidly over the 35-year study period. From 1977 to 2011, there has been a sixty-fold increase in the number of occupied breeding territories and over 720 young produced on the lower Delmarva Peninsula. Five breeding pairs have established nesting territories on the barrier islands. Data from recent years suggest that the breeding population has continued to increase on the eastern shore.

Relative to the shoreline along the four major tributaries of the Chesapeake Bay, the lower Delmarva Peninsula is thought to offer low quality nesting habitat for Bald Eagles. This is supported by the relatively low nesting density on the eastern shore of Virginia. However, reproductive data from nests on the lower Delmarva Peninsula provide no evidence of an effect of local habitat quality on productivity and success of nesting Bald Eagles. Watts et al. (2008) examined the recovery of the nesting Bald Eagle population throughout the Chesapeake Bay estuary from 1977 to 2001. The study reported a population-wide average annual reproductive rate of 1.19 ± 0.55 (mean ± SE) and an average success rate of 0.707 ± 0.212. During that time frame, the annual reproductive rate of pairs on the Delmarva Peninsula averaged 1.20 ± 0.09 (mean ± SE) and success rate averaged 0.812 ± 0.047. These data suggest that nesting Bald Eagles in the Chesapeake Bay population may not be significantly impacted by local habitat differences. That said, the reproductive parameter values reported by Watts et al. (2008) incorporated data from all nests throughout the lower Chesapeake Bay, including nests on the Delmarva Peninsula as well as in other low density, presumably low quality sites. Therefore, higher nest success and productivity rates in certain areas within the Chesapeake Bay may be diluted in the population-wide dataset, potentially masking geographic differences in reproductive parameters.

Despite representing two distinct ecosystems, there were no significant differences in the nest success and productivity of nests located along the bayside and seaside shorelines of the lower Delmarva Peninsula. However, in the productivity comparison the p-value of 0.065 suggests a trend toward bayside nesting pairs producing more young per breeding attempt. Breeding attempts with undetermined outcomes made up 0.5% of total documented breeding attempts in the study and affected 3.4% and 1.4% of seaside and bayside nests, respectively. Sensitivity analyses indicate that undetermined outcomes of breeding attempts did not significantly affect the comparison of success rate in bayside and seaside nests. Although unresolved outcomes of breeding attempts may have influenced the significance of the productivity comparison, they did not affect the general trend. Both the primary and sensitivity analyses indicate trends toward higher productivity in bayside nesting pairs.

Past studies of pairs nesting along the major tributaries of the Chesapeake Bay have indicated that the type and abundance of local prey species affect reproductive success (Markham and Watts 2008). Pairs nesting on either shoreline of the Delmarva Peninsula are part of distinct ecosystems and as a result may provision offspring differently. On the western side of the Delmarva Peninsula, pairs are part of the great ecosystem of the bay. The numerous inlets and rivers on the bayside provide habitat that make fish, a preferred food source for Bald Eagles in the lower Chesapeake Bay (Markham 2004, Markham and Watts 2008), readily available to foraging eagles. The seaside of the peninsula is part of a different type of ecosystem known as a coastal bay. The seaside is a critical staging area for shorebirds (Watts and Truitt 2000, 2011) and supports the majority of the colonial waterbirds in the state (Watts and Byrd 1998, 2006). Anecdotal evidence suggests that eagles are generalist foragers that feed opportunistically on a variety of prey types including fish, turtles, mammals, and other birds (e.g. Clark 1982, Mersmann et al. 1992). Pairs nesting on the seaside may supplement a larger portion of their diets with waterbird species.

The results of this study suggest that reproductive success and productivity of the nesting Bald Eagle population in the lower Chesapeake Bay are fairly robust in the face of spatial variation in nesting density, habitat, and food sources. Continued monitoring of the nesting population along the major tributaries of the Chesapeake Bay and the lower Delmarva Peninsula is necessary to track potential changes in reproductive parameters as the population approaches carrying capacity.

ACKNOWLEDGMENTS

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THE BIRDS OF COLLEGE CREEK

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A few places in Virginia host a particularly wide variety of birdlife (Taber 2008). The College Creek site is one such hotspot. Because of its habitat diversity and its position near a water-crossing site during migration,it hosts a high concentration of birds. A total of 227 species has been recorded there.

College Creek itself is approximately five kilometers long and flows from Lake Matoaka, on the campus of the College of William and Mary in Williamsburg, into the James River, about three kilometers southeast of Williamsburg on Virginia's coastal plain, in James City County. The College Creek site is at the creek's mouth where there are two vehicle pull-offs on the Colonial National Parkway about 200 meters apart. One faces a brackish marsh. The other, on a river beach, faces Hog Island Wildlife Management area, about four kilometers to the south across the James River in Surry County. The 50 kilometer long Parkway is designated on the Virginia Birding and Wildlife Trail as destination CLP04, and the College Creek site is located at distance markers K 26 and K 27.

A description of the diverse habitat types found at the College Creek site has been published (Williams 2012). These include a riparian section of the James River and a brackish water marsh, both easily accessed from the parking areas. The northeast projection of the Hog Island peninsula from the south side of the James River may serve to direct northbound migrating birds to the site and occasionally, especially during or after the passage of tropical storms, the prevailing winds may direct birds, including pelagic species,against the wooded shoreline inside the mouth of the creek. In winter, after a snowfall of several inches, birds gather alongside the roadway, jumping out from heavy understory and fields to feed where the snow melts first.

The author has spent a great deal of time over several decades regularly observing birds at the site. This site is also included in the count circle for the annual Christmas Bird Count and in the annual Spring Count conducted by the Williamsburg Bird Club. More recently, records have been added into the eBird system, developed by Cornell University and the National Audubon Society.

In October 2012, the Willliamsburg Bird Club published "The Birds of Virginia's Colonial Historic Triangle," edited by Bill Williams. The book covers James City County, York County, the City of Williamsburg, and Hog Island Wildlife Management Area. It contains many significant records from College Creek.

College Creek Hawkwatch has operated for 18 consecutive seasons, from about 10 February to about 31 May from the parking lot on the river beach (Taber 2007). It is sponsored by Coastal Virginia Wildlife Observatory (www.cvwo.org) . The protocol is to count birds as they cross the river heading north. Hawkwatch counters are careful to make sure local breeders exhibit migratory behavior and are not hunting and attending to nesting duties.The data is available on the Hawkcount.org website, operated by the Hawk Migration Association of North America.

Seventeen species of vultures and hawks have been documented at the hawkwatch. The fourteen regularly-occurring species are listed in Table 1.

Table 1: College Creek Hawkwatch Results, 1997-2014

Species	Season average	Season high	Record daily high (date)
Black Vulture	51	117	50 (3/11/06)
Turkey Vulture	898	1729	167 (3/20/09)
Osprey	159	289	54 (4/01/14)
Mississippi Kite	1	10	9 (5/12/07)
Bald Eagle	78	150	34 (5/19/10)
Northern Harrier	33	47	10 (4/03/11)
Sharp-shinned Hawk	63	109	38 (5/05/99)
Cooper's Hawk	13	41	8 (3/10/10)
Red-shouldered Hawk	6	13	5 (4/04/14)
Broad-winged Hawk	10	34	7 (4/20/05)
Red-tailed Hawk	41	68	12 (3/11/14)
American Kestrel	26	59	24 (3/23/03)
Merlin	3	7	5 (4/04/12)
Peregrine Falcon	1	4	4 (5/09/06)

Three other species [Northern Goshawk (***Accipiter gentilis***), Swainson's Hawk (***Buteo Swainsoni***), and Golden Eagle (***Aquila chrysaetos***)] are represented by three, one and four records respectively. Swallow-tailed Kite (***Elanoides forficatus***), though expected, has not been seen during the hawkwatch. The only College Creek record is of a bird seen from Hog Island on 28 August 1991, flying north across the river and over the site.

Turkey Vultures (***Cathartes aura)*** comprise about two-thirds of the flights at the hawkwatch. They are seen migrating throughout the entire season. Black Vultures (***Coragyps atratus***) are much less common than Turkey Vultures at the site. Ospreys (***Pandion haliaetus***) breed at the site, with several nests usually visible.The closest nest, on a duck blind about 100 meters from the hawkwatch, is monitored regularly to determine when chicks hatch. Twenty-five of the 29 local Mississippi Kite (***Ictinia mississippiensis***) records are from College Creek, including one from 5 September 1999, following Tropical Storm Dennis.

In addition to seasonally-migrating Bald Eagles (***Haliaeetus leucocephalus***), there are usually several resident pairs that breed and use the area for summering and wintering. Efforts have been made to document eagle ages, though distance and backlighting have made accuracy difficult.

Northern Harriers (***Circus cyaneus***) migrate throughout the entire season, though in small numbers. Sharp-shinned Hawk (***Accipiter striatus***) is regular at the site, while Cooper's Hawk (***Accipiter cooperii***) is uncommon. Red-shouldered Hawks (***Buteo lineatus***) are local residents and breeders, but a few are usually seen migrating across the river during the hawkwatch season. Broad-winged Hawks (***Buteo platypterus***) are not seen in flocks at this site, and generally only a few individuals are seen per season. The only spring record of Swainson's Hawk (***Buteo swainsoni***) for Virginia is from this hawkwatch, on 22 April 2001 (Taber, 2001). Red-tailed Hawks (***Buteo jamaicensis***) migrate early in the season, often with few records after early April and, as with other nesting species, are counted when crossing the river exhibiting migratory behavior. American Kestrel (***Falco sparverius***) has become quite uncommon at the site and the species is undergoing decline in large areas of its range. Merlin (***Falco columbarius***) and Peregrine Falcon (***Falco peregrinus***) are both rare migrants at the site.

Significant storm systems, hurricanes and tropical storms, have displaced seabirds to the site (Brinkley, 2001), in particular the systems named David (September 1979), Bertha (July 1996), Fran (September 1996), Dennis (September 1999) and Ernesto (September 2006). Species included Sooty Shearwater (***Puffinus griseus***), Wilson's Storm-Petrel (***Oceanites oceanites***), White-faced Storm-Petrel (***Pelagodroma marina***), Magnificent Frigatebird (***Fregata magnificens***), Red-necked Phalarope (***Phalaropus lobatus***), Sooty Tern (***Onychoprion fuscatus***), Bridled Tern (***Onychoprion anaethetus***), Black Tern (***Chlidonias niger***), with a peak of 175 and Sandwich Tern (***Thalasseus sandvicensis***). A Brown Noddy (***Anous stolidus***) was observed by Taber after hurricane Ernesto (September 2006), but the record was not accepted by the Virginia Avian Records Committee of the Virginia Society of Ornithology, although the species was also reported downstream on the James River and at the mouth of Chesapeake Bay during that storm. Tropical Storm Hannah (September 2008) produced a small, dark shearwater or "gadfly petrel," which was not identified. The "hurricane/northeaster/Super Storm" Sandy (2012), displaced six Cave Swallows (***Petrochelidon fulva,***), which were photographed along with hundreds of Tree Swallows (***Tachycineta bicolor***) seeking shelter in the Wax Myrtle bushes on the site.

Additional significant records of birds attracted to the food-rich shore and marsh areas include the only local Black-headed Gull (***Chroicocephalus ridibundus***) record and the only local James River Northern Gannet (***Morus bassanus***) record; Glaucous Gull (***Larus hyperboreus***); Anhinga (***Anhinga anhinga***); the local Common Loon (***Gavia immer***) peak count of 43; American Oystercatcher (***Haematopus palliatus***); Whimbrel (***Numenius phaeopus***); Black-necked Stilt (***Himantopus mexicanus***); large Tundra Swan (***Cygnus columbianus***) flights in March, with a local high count of 1374; American White Pelicans (***Pelecanus erythrorhynchos***), some of which stayed more than a month over the site and at Hog Island; Least Bittern (***Ixobrychus exilis***); American Bittern (***Botaurus lentiginosus***); Black-crowned Night-Heron (***Nyticorax nyticorax***); Yellow-crowned Night-Heron (***Nyctanassa violacea***); all four local Sandhill Crane (***Grus canadensis***) records; White-winged Dove (***Zenaida asiatica***); LeConte's Sparrow (***Ammodramus leconteii***); Snow Bunting (***Plectrophenax nivalis***) and Lapland Longspur (***Calcarius lapponicus***). An "Audubon's" Yellow-rumped Warbler (***Setophaga coronata***) was found there in January 2014, a first local record.

While there are small scrub-shrub margins along the river, creek and marsh, there are only relatively small forest patches, which have accounted for only 17 of the common warblers and no record for Eastern Screech-Owl (***Megascops asio***), Acadian Flycatcher (***Empidonax virescens***), Scarlet Tanager (***Piranga olivacea***) or for three rare vireos: Blue-headed (***Vireo solitarius***), Warbling (***Vireo gilvus***) and Philadelphia (***Vireo philadelphicus***).

There is a heronry for Great Blue Herons (***Ardea herodias***) at the creek mouth, with 20 pairs in 2013 (Ruth Boettcher, pers. comm.). Great Egrets (***Ardea alba***) have been observed carrying sticks near the site, though there has been no evidence of successful breeding. At the small beach adjacent to the heronry, Least Terns (***Sternula antillarum***) nested from 1957-1966 (Williams 2012). According to Fred Scott, "there appeared to be about 60 adults around the nesting area…one nest with two eggs was found…[and]…

the colony was situated on the northern side of a recently dredged sand fill" (Scott 1957). Scott was concerned about preserving the site with the new traffic pattern. The area is now regularly crowded with beach-goers and there is no nesting, though Least Terns are seen regularly on the river in April.

The very cold winter of 2013-2014, which froze northern lakes, brought great waterfowl diversity, including rare species, to the site, where the river remained unfrozen: Long-tailed Duck (***Clangula hyemalis***), White-winged Scoter (***Melanitta fusca***), Red-necked Grebe (***Podiceps grisegena***) and a local record of more than 1,000 scaup (***Aythya*** sp.) were observed on a number of dates.

Further illustrating the bird variety around this site, a number of other rare species have been seen within sight of College Creek, at neighboring Kingsmill housing area to the east, and at Hog Island, south across the river. These include Greater White-fronted Goose (***Anser albifrons***), Great Cormorant (***Phalacrocorax carbo***), Wood Stork (***Mycteria americana***), Hudsonian Godwit (***Limosa haemastica***), Ruff (***Philomachus pugnax***), Iceland Gull (***Larus glaucoides***), Common Ground-Dove (***Columbina passerina***), Short-eared Owl (***Asio flammeus***), Scissor-tailed Flycatcher (***Tyrannus forficatus***) and Western Kingbird (***Tyrannus verticalis***).

Additional species may yet be found as birders explore the diverse and productive habitats at the site.

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Appendix: Species Recorded at College Creek

Snow Goose (***Chen caerulescens***)
Brant (***Branta bernicla***)
Cackling Goose (***Branta hutchinsii***)
Canada Goose (***Branta canadensis***)
Mute Swan (***Cygnus olor***)
Tundra Swan (***Cygnus columbianus***)
Wood Duck (***Aix sponsa***)
Gadwall (***Anas strepera***)
American Black Duck (***Anas rubripes***)
Mallard (***Anas platyrhynchos***)
Blue-winged Teal (***Anas discors***)
Northern Shoveler (***Anas clypeata***)
Northern Pintail (***Anas acuta***)
Green-winged Teal (***Anas crecca***)
American Wigeon (***Anas americana***)
Canvasback (***Aythya valisineria***)
Redhead (***Aythya americana***)
Ring-necked Duck (***Aythya collaris***)
Greater Scaup (***Aythya marila***)
Lesser Scaup (***Aythya affinis***)
White-winged Scoter (***Melanitta fusca***)
Surf Scoter (***Melanitta perspicillata***)
Long-tailed Duck (***Clangula hyemalis***)
Bufflehead (***Bucephala albeola***)
Common Goldeneye (***Bucephala clangula***)
Hooded Merganser (***Lophodytes cucullatus***)
Common Merganser (***Mergus merganser***)
Red-breasted Merganser (***Mergus serrator***)
Ruddy Duck (***Oxyura jamaicensis***)
Northern Bobwhite (***Colinus virginianus***)
Wild Turkey (***Melagris gallopavo***)
Red-throated Loon (***Gavia stellata***)
Common Loon (***Gavia immer***)
Pied-billed Grebe (***Podilymbus podiceps***)
Horned Grebe (***Podiceps auritis***)
Red-necked Grebe (***Podiceps grisegena***)
Sooty Shearwater (***Puffinus griseus***)
Wilson's Storm-Petrel (***Oceanites oceanicus***)
White-faced Storm Petrel (***Pelagodroma marina***) *
Northern Gannet (***Morus bassanus***)
Double-crested Cormorant (***Phalacrocorax auritis)***
Anhinga (***Anhinga anhinga***)
American White Pelican (***Pelecanus erythrorhynchos***)
Brown Pelican (***Pelecanus occidentalis***)
American Bittern (***Botaurus lentiginosis***)
Least Bittern (***Ixobrychus exilis***)
Great Blue Heron (***Ardea herodius***)
Great Egret (***Ardea alba***)
Snowy Egret (***Egretta thula***)
Little Blue Heron (***Egretta caerulea***)
Tricolored Heron (***Egretta tricolor***)
Cattle Egret (***Bubulcus ibis***)
Green Heron (***Butorides virescens***)
Black-crowned Night-Heron (***Nycticorax nycticorax***)
Yellow-crowned Night-Heron (***Nyctanassa violacea***)
White Ibis (***Eudocimus albus***)

Appendix (*continued*): Species Recorded at College Creek

Glossy Ibis (***Plegadis falcinellus***)
Black Vulture (***Coragyps atratus***)
Turkey Vulture (***Cathartes aura***)
Osprey (***Pandion haliaetus)***
Swallow-tailed Kite (***Elanoides forficatus***)
Golden Eagle (***Aquila chrysaetos***)
Mississippi Kite (***Ictinia mississippiensis***)
Northern Harrier (***Circus cyaneus***)
Sharp-shinned Hawk (***Accipiter striatus***)
Cooper's Hawk (***Accipiter cooperii***)
Northern Goshawk (***Accipiter gentilis***)
Bald Eagle (***Haliaeetus leucocephalus***)
Red-shouldered Hawk (***Buteo lineatus***)
Broad-winged Hawk (***Buteo platypterus***)
Swainson's Hawk (***Buteo swainsoni***)
Red-tailed Hawk (***Buteo jamaicensis***)
Clapper Rail (***Rallus longirostris***)
King Rail (***Rallus elegans***)
Virginia Rail (***Rallus limicola***)
Sora (***Porzana carolina***)
American Coot (***Fulica americana***)
Sandhill Crane (***Grus canadensis***)
Black-necked Stilt (***Himantopus mexicanus***)
American Oystercatcher (***Haematopus palliatus***)
Black-bellied Plover (***Pluvialis squatarola***)
Semi-palmated Plover (***Charadrius semipalmatus***)
Killdeer (***Charadrius vociferus***)
Spotted Sandpiper (***Actitis macularius***)
Solitary Sandpiper (***Tringa solitaria***)
Greater Yellowlegs (***Tringa Melanoleuca***)
Willet (eastern) (***Tringa semipalmata***)
Lesser Yellowlegs (***Tringa flavipes***)
Whimbrel (***Numenius phaeopus***)
Ruddy Turnstone (***Arenaria interpres***)
Sanderling (***Calidris alba***)
Dunlin (***Calidris alpina***)
Least Sandpiper (***Calidris minutilla***)
Semipalmated Sandpiper (***Calidris pusilla***)
Short-billed Dowitcher (***Limnodromus griseus***)
Wilson's Snipe (***Gallinago delicata***)
Red-necked Phalarope (***Phalaropus lobatus***)
Bonaparte's Gull (***Larus philadelphia***)
Black-headed Gull (***Larus ridibundus***)
Laughing Gull (***Larus atricilla***)
Ring-billed Gull (***Larus delawarensis***)
Herring Gull (***Larus argentatus***)
Lesser Black-backed Gull (***Larus fuscus***)
Glaucous Gull (***Larus hyperboreus***)
Great Black-backed Gull (***Larus marinus***)
Sooty Tern (***Onychoprion fuscatus***)
Bridled Tern (***Onychoprion anaethetus***)
Least Tern (***Sternula antillarum***)
Caspian Tern (***Hydroprogne caspia***)
Black Tern (***Chlidonias niger***)
Common Tern (***Sterna hirundo***)
Forster's Tern (***Sterna forsteri***)
Royal Tern (***Thalasseus maxima***)
Sandwich Tern (***Thalasseus sandvicensis***)
Black Skimmer (***Rynchops niger***)
Brown Noddy (***Anous stolidus***)
Rock Pigeon (***Columba livia***)
White-winged Dove (***Zenaida asiatica***)
Mourning Dove (***Zenaida macroura***)
Yellow-billed Cuckoo (***Coccyzus americanus***)
Barn Owl (***Tyto alba***)
Great Horned Owl (***Bubo virginianus)***
Barred Owl (***Strix varia***)
Common Nighthawk (***Chordeiles minor***)
Chimney Swift (***Chaetura pelagica***)
Ruby-throated Hummingbird (***Archilochus colubris***)
Belted Kingfisher (***Ceryle alcyon***)
Red-headed Woodpecker (***Melanerpes erythrocephalus***)
Red-bellied Woodpecker (***Melanerpes carolinus***)
Yellow-bellied Sapsucker (***Sphyrapicus varuis***)
Downy Woodpecker (***Picoides pubescens)***
Hairy Woodpecker (***Picoides villosus***)
Northern Flicker (***Colaptes auratus***)
Pileated Woodpecker (***Dryocopus pileatus***)
American Kestrel (***Falco sparverius***)
Merlin (***Falco columbarius***)
Peregrine Falcon (***Falco peregrinus***)
Eastern Wood-Pewee (***Contopus virens***)
Willow Flycatcher (***Empidonax trailii***)
Eastern Phoebe (***Sayornis phoebe***)
Great Crested Flycatcher (***Myiarchus crinitis***)
Eastern Kingbird (***Tyrannus tyrannus***)
White-eyed Vireo (***Vireo griseus***)
Yellow-throated Vireo (***Vireo flavifrons***)
Red-eyed Vireo (***Vireo olivaceus***)
Blue Jay (***Cyanocitta cristata***)
American Crow (***Corvus brachyrhynchos***)
Fish Crow (***Corvus ossifragus***)
Horned Lark (***Eremophila alpestris***)
Northern Rough-winged Swallow (***Stelgidopteryx serripennis***)
Purple Martin (***Progne subis***)
Tree Swallow (***Tachycineta bicolor***)
Bank Swallow (***Riparia riparia***)
Barn Swallow (***Hirundo rustica***)
Cliff Swallow (***Petrochelidon pyrrhonota***)
Cave Swallow (***Petrochelidon fulva***)

Appendix (*continued*): Species Recorded at College Creek

Carolina Chickadee (***Poecile carolinensis***)
Tufted Titmouse (***Baeolophus bicolor***)
White-breasted Nuthatch (***Sitta carolinensis***)
Brown-headed Nuthatch (***Sitta pusilla***)
House Wren (***Troglodytes aedon***)
Winter Wren (***Troglodytes troglodytes***)
Marsh Wren (***Cistothorus palustris***)
Carolina Wren (***Thryothorus ludovicianus***)
Blue-gray Gnatcatcher (***Polioptila caerulea***)
Golden-crowned Kinglet (***Regulus satrapa***)
Ruby-crowned Kinglet (***Regulus calendula***)
Eastern Bluebird (***Sialia sialis***)
Veery (***Catharus fuscescens***)
Gray-cheeked Thrush (***Catharus minimus***)
Hermit Thrush (***Catharus guttatus***)
Wood Thrush (***Hylocichla mustelina***)
American Robin (***Turdus migratorius***)
Gray Catbird (***Dumetella carolinensis***)
Brown Thrasher (***Toxostoma rufum***)
Northern Mockingbird (***Mimus polyglottos***)
European Starling (***Sturnus vulgaris***)
American Pipit (***Anthus rubescens***)
Cedar Waxwing (***Bombycilla cedrorum***)
Lapland Longspur (***Calcarius lapponicus***)
Snow Bunting (***Plectrophenax nivalis***)
Ovenbird (***Seiurus aurocapilla***)
Black-and-White Warbler (***Mniotilta varia***)
Common Yellowthroat (***Geothlypis trichas***)
American Redstart (***Setophaga ruticilla***)
Cape May Warbler (***Setophaga tigrina***)
Northern Parula (***Setophaga americana***)
Magnolia Warbler (***Setophaga magnolia***)
Yellow Warbler (***Setophaga petechia***)
Blackpoll Warbler (***Setophaga striata***)
Black-throated Blue Warbler (***Setophaga caerulescens***)
Palm Warbler (***Setophaga palmarum***)
Pine Warbler (***Setophaga pinus***)
Yellow-rumped Warbler (***Setophaga coronata***)
Yellow-throated Warbler (***Setophaga dominica***)
Prairie Warbler (***Setophaga discolor***)
Black-throated Green Warbler (***Setophaga virens***)
Yellow-breasted Chat (***Icteria virens***)
Eastern Towhee (***Pipilo erythrophthalmus***)
American Tree Sparrow (***Spizella arborea***)
Chipping Sparrow (***Spizella passerina***)
Field Sparrow (***Spizella pusilla***)
Vesper Sparrow (***Pooecetes gramineus***)
Savannah Sparrow (***Passerculus sandwichensis***)
Le Conte's Sparrow (***Ammodramus leconteii***)
Fox Sparrow (***Passerella iliaca***)
Song Sparrow (***Melospiza melodia***)
Swamp Sparrow (***Melospiza georgiana***)
White-throated Sparrow (***Zonotrichia albicollis***)
Dark-eyed Junco (***Junco hyemalis***)
Summer Tanager (***Piranga rubra***)
Northern Cardinal (***Cardinalis cardinalis***)
Rose-breasted Grosbeak (***Pheuctictus ludovicianus***)
Blue Grosbeak (***Passerina caerulea***)
Indigo Bunting (***Passerina cyanea***)
Bobolink (***Dolichonyx oryzivorus***)
Eastern Meadowlark (***Sturnella magna***)
Red-winged Blackbird (***Agelaius phoeniceus***)
Common Grackle (***Quiscalus quiscula***)
Boat-tailed Grackle (***Quiscalus major***)
Rusty Blackbird (***Euphagus carolinus***)
Brown-headed Cowbird (***Molothrus ater***)
Orchard Oriole (***Icterus spurius***)
Baltimore Oriole (***Icterus galbula***)
House Finch (***Carpodacus mexicanus***)
American Goldfinch (***Carduelis tristis***)
House Sparrow (***Passer domesticus***)

INFLUENCE OF TIME OF DAY AND STAND AGE ON DETECTION OF BROWN-HEADED NUTHATCHES (*Sitta pusilla*) IN LOBLOLLY PINE (*Pinus taeda*) STANDS, CHINCOTEAGUE NATIONAL WILDLIFE REFUGE

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ABSTRACT – Brown-headed Nuthatches (***Sitta pusilla***) act as an indicator species for assessing pine-dominated ecosystems and is an example of an avian species in decline due to fire suppression, and habitat fragmentation and loss. Thus, insight into factors affecting the detection of this species would be beneficial for future surveying personnel. Here, the influence of time of day in relation to the approximate age of loblolly pine (***Pinus taeda***) on the number of individuals detected by sight and sound was investigated. We used 5-minute point count surveys on Chincoteague National Wildlife Refuge, Virginia to detect individuals. Significantly more individuals were seen ($\chi^2 = 12.23$, d.f. = 2, $p < 0.01$) and heard ($\chi^2 = 14.90$, d.f. = 2, $p < 0.01$) in mature stands (nearest neighbor > 8 m) compared to other stand ages. These findings support earlier literature finding that Brown-headed Nuthatches prefer mature pine stands with snags and open understory. We found that time of day did not appear to affect the detection of nuthatch by sight or sound. This suggests that activity levels and detection rates would be relatively equal across the time from morning to evening. Future studies should incorporate variables such as measurements of canopy cover, community structure of pine stands, and the number of available snags. These additional inputs may provide more in-depth relationships between stand composition and nuthatch detection. It is hoped that these results will help guide the conservation of the species and future management decisions regarding pine ecosystems through improving assessment efforts.

INTRODUCTION

The Brown-headed Nuthatch (***Sitta pusilla***) is a small, primarily insectivorous bird species endemic to the south-eastern United States, and is strongly associated with pine-dominated forests (Nesbitt and Hetrick, 1976; Slater ***et al.***, 2013). Brown-headed Nuthatches use mature pine stands with open understories and snags for nesting (Nesbitt and Hetrick, 1976; Dornak ***et al.***, 2004; Slater ***et al.***, 2013). Due to this strong relationship between bird and habitat preference, it is often used as an indicator species for assessing the health of pine forests throughout the lower United States (O'Halloran and Conner, 1987; Slater ***et al.***, 2013). The call of this species is described as a "rubber ducky vocalization" (RDV) which is a two part, high pitched squeaky sound (Slater ***et al.***, 2013). This call is generally attributed to being used for long distance communication between pairs and flock members (Slater ***et al.***, 2013). These calls are thought to be most frequently made early- to mid-morning (Slater ***et al.***, 2013). The Brown-headed Nuthatch exemplifies a cooperative breeding strategy in which breeding pairs may be assisted by individuals males who act as helpers(Cox and Slater, 2007; Slater ***et al.***, 2013). Nuthatch populations in the northern parts of its range are often associated with loblolly pine (***Pinus taeda***) and shortleaf pine (***Pinus echinata***). The ranges of these trees overlap extensively with the Brown-headed Nuthatch range in the southeastern United States. Historically, this range went from Florida west to eastern Texas, and north along the east coast to southern New Jersey (United States Department of Agriculture, 1990; Wilson and Watts, 1999; Slater ***et al.***, 2013). Brown-headed nuthatches prefer mature and dead trees within the pine stands (Wilson and Watts, 1999; Slater ***et al.***, 2013). Current population trends indicate that Brown-headed Nuthatches have declined throughout most of their range due to a number of factors including degradation, fragmentation and loss of habitat, fire suppression, and logging (Cox and Slater, 2007). Therefore, it is crucial that some method of detecting nuthatch individuals be established in order to properly monitor the species. It is also important that the various environmental factors influencing the number of individuals detected be known (Nesbitt and Hetrick, 1976).

The influence of pine stand age and time of day on the number of Brown-headed Nuthatch individuals detected during summer was investigated at Chincoteague National Wildlife Refuge in Virginia. The number of individuals observed and the number of calls heard within three stand ages (mature, mid-aged, young) at three times of day (morning, afternoon, evening) were recorded. The objectives were to confirm if Brown-headed Nuthatch individuals would be detected in the greatest number in mature stands of pine as well as determine which time of day nuthatches are more easily detected. It was hypothesized that if detection increases with stand age, then individuals would be observed in the highest abundance in mature stands. Additionally, if Brown-headed Nuthatch individuals were most active during the morning and evening, fewer individuals would be observed during the afternoon.

STUDY AREA

The study area comprised 15 sampling sites located on the Wildlife Loop, Lighthouse Trail, and Black Duck Trail within Chincoteague National Wildlife Refuge in Accomack County, Virginia (37°54'31»N 75°21'24»W, Figure 1).

Figure 1. The portion of Chincoteague National Wildlife Refuge, Virginia, in which point counts (white circles with thick black outline) for Brown-headed Nuthatches were surveyed.

(***Equus ferus caballus***), Snow Goose (***Chen caerulescens,*** in winter) and Piping Plover (***Charadrius melodus***). Directly adjacent to the refuge is the small tourist community of Chincoteague with an approximate population of 3000 residents (U.S. Census Bureau).

METHODS

Observations were taken between May 12, 2014 and May 16, 2014 in fair weather with no rain or high wind to avoid auditory biases. Point counts with two observers were conducted at 15 sites, at each of which the number of individuals observed and the number of "rubber ducky vocalizations" (RDVs) within a five-minute period were recorded. During point counts, we used call frequency to estimate of the number of individuals present. Afterward, the area surrounding the point count was visually checked and the number of individuals estimated by direct sighting. Comparison of these two estimates gave us confidence that call frequency could be used in this and in future studies to estimate the minimum number of individuals present.

Sites were chosen which represented a range of loblolly pine stand densities and severity of fragmentation. All sites were a minimum of 100 m apart. Loblolly pine stands were chosen because of their importance to Brown-headed Nuthatches for feeding and nesting, and also because the stands are locally abundant. Stand density was determined using the "nearest neighbour" approach (Dixon, 2002). A focal tree was chosen and the average distance from it to the nearest five loblolly pines was used to estimate the density of the stand.

Density estimates were used to estimate stand age, on the assumption that less-dense stands with larger trees represent more mature stands (Long and Smith, 1984). Stands with mean densities < 4.5 m were categorized as "young", those with mean densities between 4.5 and 8.0 m were categorized as "mid-aged", and those with mean densities > 8.0 m were categorized as "mature".

Point counts were recorded during three time periods of the day (EST): morning (5:00-7:00), afternoon (13:00-15:00) and evening (18:00-20:00). Levene's test for homogeneity of variance was used to determine if data were normal. As data were not normally distributed, Kruskal-Wallis ranked tests were performed with post-hoc analyses in R statistical software, using the "pgirmess" package (Giraudoux, 2013).

RESULTS

Eighty-three point counts were conducted and used for data analysis (Table 1). In one observation, a pair of nuthatches was observed producing 260 RDVs in the five-

Table 1: Summary of Brown-headed Nuthatch 5-minute point count observations, Chincoteague National Wildlife Refuge, May 2014; n = number of point counts in time of day/stand age couplet, Individuals = average number of individuals sighted (± standard error), Calls = average number of calls heard (± standard error).

Time of Day	*Stand Age*	*n*	*Individuals*	*Calls*
Morning	Mature	4	1.50 (±0.65)	18.25 (±12.15)
Afternoon	Mature	9	1.89 (±0.20)	15.22 (±4.67)
Evening	Mature	6	0.83 (±0.17)	2.00 (±1.03)
Morning	Mid	10	0.90 (±0.31)	5.20 (±2.54)
Afternoon	Mid	12	1.00 (±0.25)	33.42 (±22.14)
Evening	Mid	14	1.43 (±0.34)	3.14 (±0.99)
Morning	Young	6	1.00 (±0.37)	3.50 (±1.78)
Afternoon	Young	13	0.23 (±0.12)	0.23 (±0.12)
Evening	Young	9	0.67 (±0.29)	2.00 (±1.25)

minute point count during the afternoon in a mid-aged stand. The number of RDVs in that observation was more than 42 times greater than the average of approximately 6 RDVs per point count. Removal of this observation from the analysis did not affect the significance of results. RDV data were log-transformed in order to reduce the variance between observations.

The number of individuals observed varied significantly with stand age (Kruskal-Wallis $\chi^2 = 12.23$, d.f. = 2, $p < 0.01$). The mean numbers of individuals observed were 0.54 (±0.14 SE), 1.14 (±0.18 SE), and 1.47 (±0.19 SE) in young, mid-aged and mature stands, respectively (Figure 2). Post-hoc analyses indicated significant differences between young and mature stands.

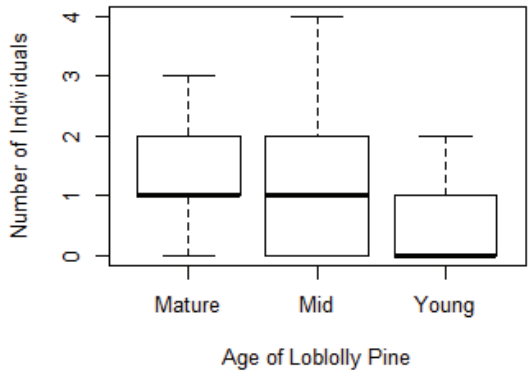

Figure 2. Number of individuals observed in a 5-minute point count by age of loblolly pine stand, Chincoteague National Wildlife Refuge, May 2014.

Stand age had a significant influence on the number of RDVs, which also increased with stand age ($\chi^2 = 14.90$, d.f. = 2, $p < 0.01$).The mean logarithm of RDVs heard was 0.14 (±0.06 SE), 0.47 (±0.10 SE) and 0.69 (±0.14 SE) in young, mid-aged and mature stands, respectively (Figure 3). Significantly more RDVs were heard in mature stands than in young stands according to the post-hoc analysis.

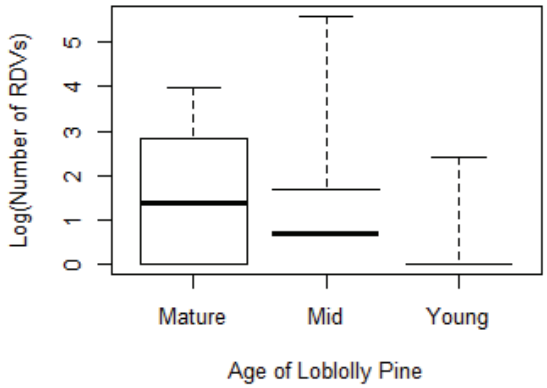

Figure 3. Logarithm of the number of RDVs in a 5-minute point count by age of loblolly pine stands, Chincoteague National Wildlife Refuge, May 2014.

Time of day did not have a significant effect on the number of individuals observed ($\chi^2 = 0.17$, d.f. = 2, $p = 0.92$) nor on the logarithm of RDVs heard ($\chi^2 = 0.35$, d.f. = 2, $p = 0.84$). The logs of RDVs recorded in the evening (0.28 ± 0.07 SE) were fewer in comparison to morning (0.48 ± 0.13 SE) and afternoon (0.48 ± 0.12 SE), but these differences, as indicated, were not significant (Figure 5).

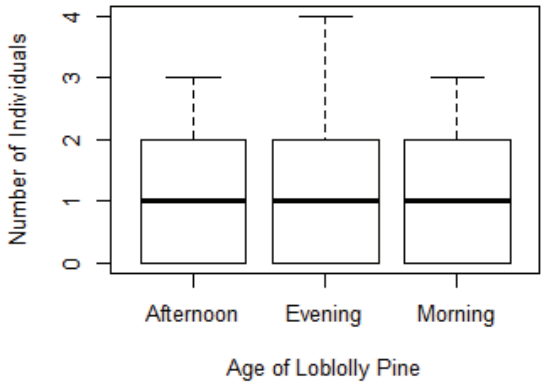

Figure 4. Number of individuals observed in a 5-minute point count by time of day, Chincoteague National Wildlife Refuge, May 2014

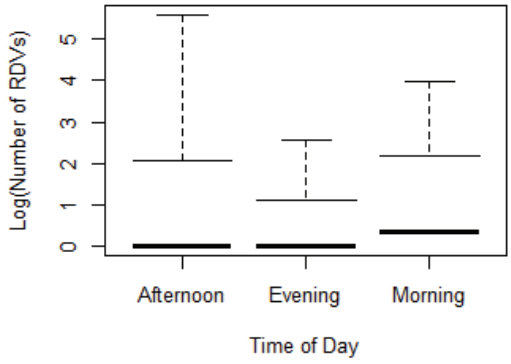

Figure 5. Logarithm of the number of RDVs in a 5-minute point count by time of day, Chincoteague National Wildlife Refuge, May 2014.

DISCUSSION

We found that the greatest numbers of individuals were observed and heard in mature stands of loblolly pine. This suggests that Brown-headed Nuthatches are most easily detected in pine stands of lower tree densities, in agreement with past findings (O'Halloran and Conner 1987). O'Halloran and Conner (1987) also reported that Brown-headed Nuthatches were in highest density in mature stands of longleaf pine (***Pinus palustris***) of greater than 45 years of age in Texas. Nests in the study were exclusive to snags, but were found in both pine and hardwood trees. Foraging was found to be related to decreased hardwood density and decreased pine overstory (O'Halloran and Conner, 1987). Similarly, Dornak ***et***

al. (2004) found that high snag availability and low mid-story density were strong indicators of nest sites and thus of nuthatches. Lloyd and Slater (2007) supported this finding, stating that increased nesting success was associated with greater numbers of large pines and snags. Additionally, Dornak *et al.* (2004) found that the basal area preferred by Brown-headed Nuthatches was 5.6 m^2/ha. Due to the strong association with snags, future studies need to take into account the number and height of snags relative to the over-story. The overall density of trees in the stand should also be included. Although our study was restricted to the visual and auditory detection of nuthatches, there was a greater increase in vocalizations as a function of stand density in comparison to the number of birds. This is indicative that larger numbers of birds probably interact more and thus use more vocalizations in communication and territorial defense (Slater *et al.*, 2013). These findings may also serve as evidence of cooperative breeding, as observed by Cox and Slater (2007).

Contrary to our hypothesis, time of day had no significant effect on the numbers of individuals observed or RDVs recorded. Therefore, the ability to detect individuals was essentially equal throughout the day. Daily patterns of vocalizations in Brown-headed Nuthatches and other species in the genus *Sitta* are not well-studied. However, Slater *et al.* (2013) stated that RDVs were most frequent in the early- to mid-morning, less frequent at dusk, and least frequent in the afternoon. While not to a significant degree, RDVs were highest in the afternoon in this study, slightly less in the morning, and least frequent in the evening. It is possible that the type of vocalization used to detect individuals affected the results of the study. RDVs are often associated with long distance communication between conspecifics and possibly during times of "excitement" (Slater *et al.*, 2013). However, the distinction between the various vocalizations is difficult (Slater *et al.*, 2013). What were categorized in this study as RDVs could have been several other types of vocalization. The RDVs were used because they were loud, clear notes that could easily be differentiated from other species. Since RDVs are not true "songs" nor "calls", it is not entirely surprising that the vocalizations do not conform to the pattern seen in songbirds that sing during the "dawn chorus" (Cassone and Menaker, 1984; Cassone, 2014). Little is written about activity patterns of Brown-headed Nuthatches concerning what time of day birds are most active and, thus, most conspicuous. Slater *et al.* (2013) reported that mean awakening and roosting during the spring and summer were 14 minutes before sunrise and 14 minutes before sunset, respectively. Activity patterns between these times are not specified. Time budget information is available for Brown-headed Nuthatches during winter months and therefore was not applicable to the period of our study, which was at the end of the breeding season (Yaukey, 1997; Slater *et al.*, 2013). In the study by Yaukey (1997), for the majority of the time in the study (43%) nuthatches were traversing up and down trees. Therefore, individuals would be conspicuous (Yaukey, 1997). This study provides evidence that activity levels and detection rates are essentially equivalent from awakening to roosting in this species.

To conclude, we found that Brown-headed Nuthatches can be detected with approximately equal likelihood for what was defined as morning, afternoon and evening. The reason for this behavior is likely due to the type of call utilized in this study (RDVs). This vocalization is used for communication between conspecifics and at times of excitement. More calls were heard and more individuals observed in mature stands of loblolly pine, than in mid-aged and young stands. These findings correspond to the known relationship between mature stands of pine, number of snags, and nesting sites of nuthatches. Additional studies would benefit from expanding on the number of sites and locations surveyed. Due to time and mobility constraints, this study primarily focused on locations within the wildlife refuge that were moderately to highly fragmented. This likely contributed to the lower than expected number of birds sighted and heard. The Woodland Trail, a less fragmented area, would be an excellent location to survey in order to supplement these results and perhaps provide more insight. Future studies on Brown-headed Nuthatch detection should also include probability analyses as well as additional parameters relating to structure of the forest, including: the number of snags, the height of snags relative to the over-story, and the overall density of all tree species in the stand.

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MINUTES OF THE VSO ANNUAL MEETING, APRIL 24-27, 2014, CHESAPEAKE, VA

JUDITH WIEGAND, VSO SECRETARY

Thursday and Friday:

The 2014 VSO Annual Meeting was held in conjunction with the Great Dismal Swamp Birding Festival. There were a number of field trips in the refuge and the surrounding area on Thursday, April 24, and Friday, April 25, 2014.

Friday Night Meeting

Joe Coleman called the meeting to order at 7:00 p.m. and introduced himself. He thanked all those who are participating in the combined VSO Annual Meeting and Great Dismal Swamp Birding Festival. He noted that participants on several field trips on Thursday and Friday had seen a great many birds, and that a list of sightings would be available at the Saturday night banquet. He then thanked Andrew Dolby, Immediate Past President, for handling the wide variety of tasks involved in preparing for the annual meeting.

Andrew Dolby also thanked everyone for coming. He thanked several individuals for their contributions to the annual meeting: Mike Lott and Shirley Devan for handling registration; Delores Freeman, the Great Dismal Swamp Birding Festival coordinator; the City of Chesapeake's Visitor & Convention Bureau; and the vendors and local businesses in the exhibit area. He encouraged everyone to patronize these local businesses.

Treasurer's Report. Joe Coleman thanked Sue Thrasher for her 22 years of service as the VSO's treasurer, and she said that it had been a pleasure to serve the VSO. Sue reported that for the calendar year 2013, the beginning balance was approximately $42,710.57 in the general fund, and $140,811.04 in the restricted fund. The ending balance was approximately $47,090.81 in the general fund, and $141,613.91 in the restricted fund. She noted that the restricted funds are in CDs, which have experienced a poor return. This year (2013) was the first time since 1996 that our investments did not generate enough income to cover the $1000 Murray award.

Wes Brown moved to accept the report, Rexanne Bruno seconded, and it was approved.

Nominating Committee Report. Andrew Dolby began by thanking those whose terms on the board were complete year: Bruce Johnson, Jerry Thornhill, and Mike Lott. He then presented the slate of officers and board members for the coming year:

President: Joe Coleman
Past President: Andrew Dolby
Vice President: Jeff Trollinger
Secretary: Judith Wiegand
Treasurer: Terri Cuthriell
Membership Secretary: Shirley Devan
Newsletter Editor: Len Alfredson
Raven Editor: Wes Brown
Board of Directors, Class of 2017:
Bruce Johnson, Loudoun County
Mike Lott, Fredericksburg
Laura Neale, Rockbridge County.

There were no nominations from the floor, so a motion for the approval of the officers and directors listed above was made, Rexanne Bruno seconded, and the motion was approved.

President's Report. Joe Coleman noted that there were several retirees among the officers. In addition to Sue Thrasher, Joe thanked Linda Fields and Alan Schreck, who are retiring as newsletter editors and editors of Virginia Birds, in which capacity they have served since 2004. Joe also thanked Jerry Thornhill for all his contributions as a board member, noting especially that Jerry traveled a great distance from southwest Virginia to attend meetings. The VSO serves the entire state; interested volunteers are needed and appreciated. Joe stated that work was expected to begin on the Breeding Bird Atlas, but budget difficulties were holding up the start of work. He concluded by informing everyone that the 2015 annual meeting would be held at Wintergreen and hosted by two bird clubs, Rockbridge and Augusta. Volunteers are needed to help. The VSO is looking for a site for the 2016 annual meeting, too. VSO hopes to rotate the meeting to other areas of the state. Joelle Buffa has offered to compile the Annual Speakers Directory, which will be on the website when it is complete. He asked if there were questions about the current state of the VSO. There were none so he turned the program over to Andrew Dolby to introduce the speaker.

Program

Deloras Freeman, Visitor Services Specialist and Birding Festival Coordinator, and Chris Lowie, Great Dismal Swamp (GDS) Refuge Manager, described the ecology and history of the GDS, as well as the current programs and conservation efforts.

Saturday:

There were a variety of field trips throughout the refuge for Saturday morning participants.

On Saturday afternoon there was a scientific papers session and a posters session. The presenters, co-authors and topics were as follows:

Papers Session:

- Vitek Jirinec. College of William and Mary. ***Bird Habitat Use within Home Ranges: Implications for***

Species Persistence in Human-Modified Landscapes. (Murray Award winner)

- Anna M. Tucker (presenter), Lesley Bulluck, Rodney Dyer, and Sarah Huber. Virginia Commonwealth University. ***The occurrence and consequences of conspecific brood parasitism in the Prothonotary Warbler (Protonotaria citrea).*** (Murray Award winner)
- Dan Albrechet-Mallinger (presenter) and Leslie P, Bulluck. Virginia Commonwealth University. ***Conspecific attraction of a declining songbird, the Golden-winged Warbler (Vermivora chrysoptera) in a fragmented landscape***. (VSO conservation grant recipient)

Posters Session:

- Emily Clark (presenter), Judith A. Guinan, Jason E. Davis. Radford University. ***Temporal variation in breeding success and corticosterone levels in eastern bluebirds, Sialia sialis.***
- Capwell Taylor, Janice Y. Park, Julia B. Kihm, John P. Swaddle, Daniel A. Cristol. College of William and Mary. ***Fluctuating asymmetry as a measure of developmental stress in mercury-dosed Zebra Finches***.

Saturday evening banquet

Post-banquet activities

Mitchel A. Byrd Award

The 2014 recipient of the VSO's Mitchell A. Byrd Award for Scientific Achievement is Dr. Dana M. Hawley, Associate Professor of Biological Sciences at Virginia Polytechnic and State University (Virginia Tech). Her area of scientific expertise is the ecology and evolution of avian infectious diseases. Much of her work has focused on the relationship between birds and ***Mycoplasma gallosepticum***, which is best known for causing conjunctivitis epidemics in House Finches. She is also well-regarded for her mentoring and teaching of students.

Banquet Speaker

Alicia King, USFWS Migratory Bird Program, gave a program about bird conservation efforts in the national wildlife refuges. She described ongoing activities and future opportunities for citizen science, bird monitoring, and research on the refuges.

Sunday:

Several field trips were offered on Sunday morning.