

## 2011 Atlantic Coast Wintering Sea Duck Survey

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Project Description: The 2011 Atlantic Coast Wintering Sea Duck Survey represented the fourth year of prerequisite work aimed at developing an operational survey to monitor sea ducks wintering along the Atlantic coast of the U.S. and Canada.

Four fixed-wing aircraft were flown along the Atlantic coast between the U.S.-Canadian border (44°46' N) and Jacksonville, FL (30°21' N, Fig 1) at 110 knots and 70 m (200 ft) altitude, while an observer and pilot-observer counted sea ducks and other aquatic birds within 400m-width strip transects. The survey was conducted between January 31<sup>st</sup> and February 17<sup>th</sup>. Crews and flight dates are listed in Table 1.

The four crews flew a total of 4,375 nm of east-west transects spaced roughly every 5 nm at latitudes ending in xx°x1' N and xx°x6' N. These transects extended east from the coastline to the longer of two distances: 8 nm (the average distance to 6 m depth) or the distance to 16 m depth (Fig 1). After each crew completed their entire set of transect lines, they flew north to their first east-west transect line and then replicated every other transect from north to south (2,150 nm of the original 4,375 re-flown).

The crews flew the same transect lines as in 2010, except transect lines south of 30°21' N were not flown. The resulting survey mileage was assigned to ten additional 8 nm east-west transect lines between the northern Georgia coast (31°33' N) and southern South Carolina coast (32°18' N), resulting in east-west transects flown at latitudes ending in xx°x1' N, xx°x3.5' N, xx°x6' N, and xx°x8.5' N within this region. In addition, all transects along the South Carolina and Georgia coasts were replicated, although the additional, even replicates were only flown to 8 nm offshore, regardless of depth. The additional survey work along this section of the coast was planned to better characterize the distribution of Black scoter *Melanitta nigra americana* in the area and to provide a comprehensive dataset in collaboration with a satellite telemetry study being conducted by the Canadian Wildlife Service.

Objectives: The primary objectives of the survey are to estimate population sizes of wintering sea ducks, assess yearly variation and trends in distribution and abundance, and determine habitat associations and areas of special significance. The survey will also provide information on the distributions of seabirds and near shore aquatic birds.

Methods: Transects were classified into 12 survey regions, representing distinct sections of the Atlantic coastline and separating major bays from the coast. From north to south, these regions are: coastline north of Cape Cod, Cape Cod & Nantucket, Nantucket Shoals, Long Island Sound, Long Island south coast, New Jersey coast, Delaware Bay, Maryland/Delaware coast, Chesapeake Bay, Pamlico Sound coast (including Virginia and North Carolina coastlines north and south of the sound), Pamlico Sound, and coastline south of Pamlico Sound (Fig. 2). We calculated the density of Scoters *Melanitta* spp., Long-tailed duck *Clangula hyemalis*, Common eider *Somateria mollissima*, and Bufflehead *Bucephala albeola* / Common goldeneye *Bucephala clangula americana* / Mergansers *Mergus* spp. in each region and overall using the standard ratio estimator; we did not include the extra replicates from the southern coast in the estimates reported here in order to make direct comparisons to the 2009-10 densities, which we calculated and report for equivalent data from the 2009-10 survey efforts.

We report a combined estimate for Bufflehead, Common goldeneye, and Merganser (primarily Red-breasted *M. serrator*). These species are at relatively low abundance (8.5% for all sea ducks counted), and are seen in similar habitats and locations along the coast (see Results); moreover, we have concerns that newer observers have difficulty distinguishing among them. In 2011, Mergansers constituted 40% of the counts for these species, Goldeneye 10%, and Bufflehead 50%. Due to similar concerns about Scoter identification, we first calculated densities for generic Scoters, a categorization that includes all birds classified to species, as well as birds classified as dark-winged Scoters and unidentified Scoters. We then estimated Scoter densities to species by multiplying the regional Scoter density by the proportion identified to species for the experienced observers in each region (experienced observers had participated previously in the survey or similar surveys).

To compare the distribution of birds between years and among species, we calculated distance from land of all flocks recorded along the east-west transects using the ArcGIS Near tool and a detailed coastline shapefile obtained from the Atlantic Coast Joint Venture. “Flocks” include birds seen alone, as we define flocks as unique records in observers’ recordings: for example, observers counted 8,981 Common eider in 662 “flocks”/records, 163 of which were singles. From these distances, we estimated average distance from land along the “coastal” east-west transects for each species (i.e., excluding flocks observed on east-west transects in Pamlico Sound, Chesapeake Bay, Delaware Bay, Long Island Sound, Cape Cod/Nantucket west of the eastern edge of the Cape, and Nantucket Shoals). The distance estimates, as well as differences between years in the total number of flocks compared to number of flocks on the coastal transects (used to estimate distance from land), illustrate distributional shifts on/offshore and into or out of bays. We also present flock size distributions by species and year to explore differences in the degree of aggregation.

We did not include 2008 in our comparisons, because the survey design differed from the subsequent three years (the northern coast was not surveyed, transect lengths differed, and replicates were only completed over Nantucket Shoals). Integration of the 2008 results, abundance estimates, and consideration of observer effects, mis-identification, and detection will be summarized in a subsequent report. As noted in previous reports, all estimates reported here are preliminary; survey design and analytical methods remain under development.

### Preliminary Results:

*Density.* Table 2 lists the densities of ducks by species and region, and the percent change in density from 2009 to 2010 and from 2010 to 2011. The transects summarized in this report covered approximately 1,168 nm<sup>2</sup> and sampled over 20,000 nm<sup>2</sup> of ocean. Crews counted 36,169 sea ducks in 2011, a decrease of 17% from 2010 and a decrease of 2% from 2009.

In 2011, the most abundant species in the survey region was Long-tailed duck (25% of all identified sea ducks), followed closely by Common eider (23%) and then Surf scoter *Melanitta perspicillata* (15%, Tables 2 and 3). Forty-two percent of the sea ducks counted were scoters, and 67% of these were reliably identified to species: 45% Surf scoters, 27% Black scoters, and 28% White-winged scoters (*M. fusca deglandi*).

White-winged scoters and Surf scoters densities increased from 2010. Surf scoters increased in all four of their consistently high density regions: Cape Cod, Delaware Bay, Chesapeake Bay, and the Maryland/Delaware coastline, whereas the increase in White-winged scoter densities was due primarily to many more birds counted along the southern coast of Long Island, as well as in Long Island Sound. In contrast, Black scoters showed a large decrease in density from 2010 to 2011 (-53%). Black scoters were at low densities in Delaware and Chesapeake Bays, and along the Maryland/Delaware coast, and were at lower than previously measured density in Pamlico Sound. Note, however, that there were a number of Black scoters with satellite transmitters (4 of 40 birds wintering along the Atlantic coast) located at the mouth of the Neuse and Tar rivers in Pamlico Sound. This area has been off-limits to survey aircraft, due to military flight restrictions, and may have contained a large number of Black scoters during the 2011 survey.

The remaining survey species also declined in abundance from 2010 to 2011: Long-tailed ducks were at their lowest density on the Nantucket Shoals in three years, but up somewhat in Chesapeake Bay and other southern parts of their winter range. Common eider densities decreased in all survey regions, but were higher than in 2009. The nearshore species also dropped in total density, particularly in the southern section of the survey.

*Distribution.* The survey data illustrating the distribution of sea ducks along the Atlantic coast of the U.S is summarized in Figures 3-4 and Tables 2-4. Consistently high density survey areas include the coast of Maine north of Portland, Cape Cod and the Nantucket Shoals, the southern tip of Long Island to Block Island, Raritan, Delaware and Chesapeake Bays, Pamlico Sound, and the southern coast between Charleston and Hilton Head, SC. Sea ducks were at high, but annually variable, abundance off the outer coast of Maryland, at lower densities off the Virginia coast, and mostly absent from the coast of North Carolina below Cape Lookout. No sea ducks were counted south of Jacksonville, FL (Figure 4a).

Black scoters are found consistently at high densities around Martha's Vineyard and in Long Island Sound, as well as in Pamlico Sound. The most southerly distributed species, they are found in significant numbers along the South Carolina and Georgia coasts, at locations that vary substantially between years. Their 2011 distribution was marked by an absence of birds in the

lower portion of the Chesapeake Bay, within Long Island Sound, and along the coast north of Cape Cod (Figure 3a, column 1).

Surf scoters are observed at reliably high densities within Chesapeake and Delaware Bays, in Long Island Sound, and around Cape Cod. They are seen less frequently and at lower densities in Pamlico Sound and along the Maryland/Delaware coast. White-winged scoters are found primarily in Long Island Sound, around Cape Cod, and over the Nantucket Shoals. They occur at low and variable abundance south of Long Island, in the Chesapeake and Delaware Bays, and along the Maine coast. A small number of White-winged scoters are sometimes seen within Black scoter flocks along the South Carolina and Georgia coasts. The distributions of both Surf and White-winged scoters in 2011 were similar to their average distributions for the three survey years (Figure 3a, columns 2-3). Black scoter densities are the most variable of the three scoter species (average 3-yr transect CV = 1.5 v. 1.4 for Surf and White-winged scoters); all the scoters had more variable densities than Long-tailed ducks (average 1.2) and Common eiders (average 1.1).

Long-tailed ducks are regularly found at high abundance around Cape Cod, on the Nantucket Shoals, and, to a lesser extent, within the Chesapeake Bay and Penobscot Bays in Maine. They are recorded at lower densities in Delaware Bay, around Long Island and off the Maine coast, and irregularly within Pamlico Sound and off the New Jersey coast (Figure 3b, column 1). They appear to occur slightly closer to shore over the Nantucket Shoals when compared to White-winged scoters (Figure 3ab).

Common eiders are found consistently at high densities from Cape Cod northward, although their densities are lower between the northern Cape and Portland, ME. They are also observed regularly within Long Island Sound, variably over the Nantucket Shoals, and incidentally south along the mid-Atlantic coast.

Bufflehead, Common goldeneye, and Mergansers are present in large numbers in Pamlico Sound and Chesapeake Bay, and at lower densities nearshore from Delaware Bay northward. Their numbers are low and variable off the southern coast of South Carolina and Georgia.

Table 4 summarizes the average distance that flocks were observed offshore, by year and species. A 2010 shift shoreward by all species was reversed in 2011: the median distance from shore was 1.9 nm in 2009, 1.2 nm in 2010, and 1.9 nm in 2011 (median distances for Black, Surf, White-winged scoters; Long-tailed duck; Common eider; and Bufflehead / Goldeneye / Merganser spp., respectively, were: in 2009 = 4.0, 3.4, 3.8, 2.4, 1.0, and 0.2; in 2010 = 2.8, 3.1, 1.9, 2.4, 0.8, and 0.1; and in 2011 = 2.9, 4.9, 4.3, 2.9, 1.3, and 0.2.). Note that distance from shore did not increase as much for Black scoter flocks as compared to Surf or White-winged scoters between 2010 and 2011, but there were relatively many more Black scoter flocks in the coastal areas than in the bays in 2011 compared to 2010 (81% in 2011 and 31% in 2010). In 2009, 95% of identified Scoters, Long-tailed ducks, and Eiders were within 6.9 nm of the coast; in 2010, 95% were within 6.3 nm; and in 2011, 95% were within 6.7 nm.

Figure 4 summarizes the distribution of observed flock sizes by species and year. We log-transformed the flock sizes prior to plotting and the resulting boxplots remain significantly right-

skewed, highlighting patchy and aggregated distribution that makes abundance estimation for wintering sea ducks a challenge. The distributions are similar among species and between years, particularly the distributions for Long-tailed duck and Common eider, although Common eiders occur in the largest concentrations. Scoters are slightly less aggregated (note the smaller variance to mean ratios) and more variable between years. The increase in White-winged scoter abundance between 2010 and 2011 was accompanied by an overall increase in flock sizes, while the Surf scoter increase was not (although Surf scoters appear to have been somewhat more aggregated in 2011).

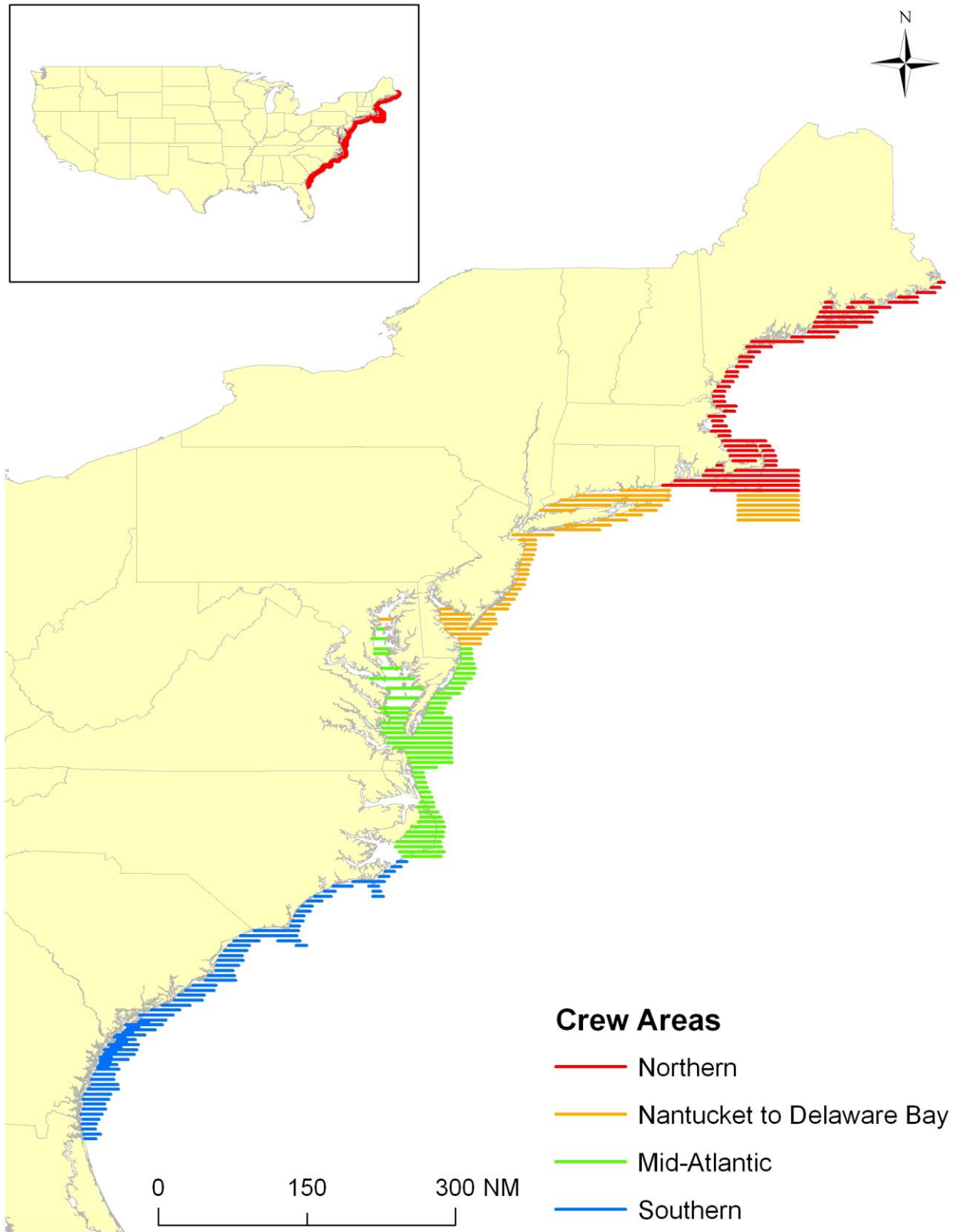
Project Status: The fourth season of prerequisite surveys was completed successfully. We are currently synthesizing, summarizing, and analyzing the data from the complete four year data set to provide recommendations for an operational survey. Our analyses are divided broadly into: (1) an exploration of survey design options and analytical methods for abundance estimation, and (2) quantification of count consistency, detection rates, observer effects, and problems of mis-identification.

As part of our exploration of abundance estimation, we are analyzing the distribution of flock sizes (and the resulting transect count distributions, which need to be characterized for appropriate abundance estimation), comparing the fit and efficiency of a variety of statistical models to estimate abundance, and simulating the effect of several stratification schemes on the precision of abundance estimation. Stratifying the coast to sample more intensely in areas of high density will likely be a critical component of an effective operational survey; we are exploring possible stratification options, including stratifying by distance from shore, as the observed annual variations in counts may well reflect distributional shifts on/offshore.

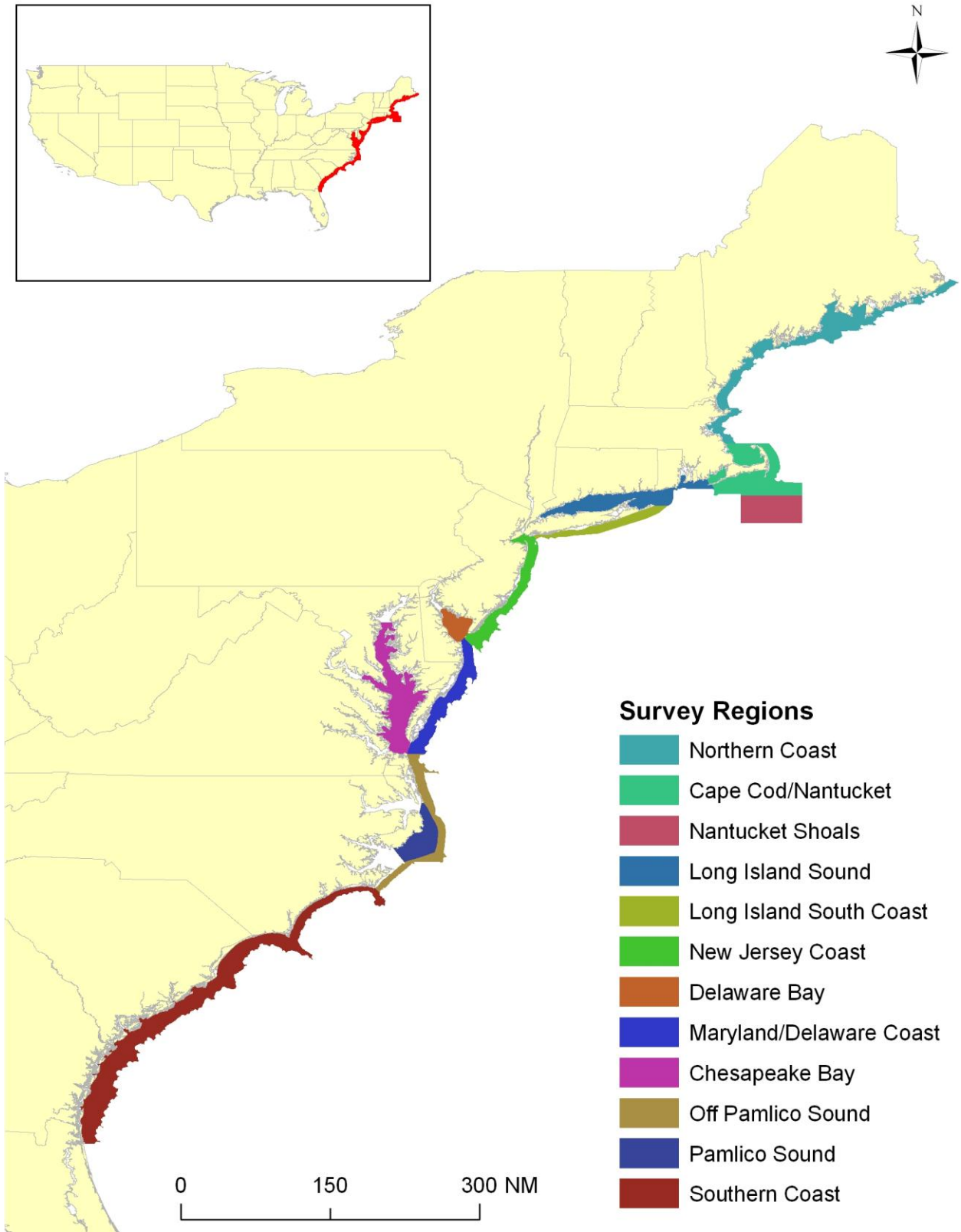
To develop a better survey methodology, we are investigating the consistency of counts on replicated transects, comparing counts between left- and right seat observers and new and experienced observers, exploring the relationship between observation condition, distance band, and detection, and exploring open population modeling to estimate detection probabilities.

Limited survey work is planned for winter 2012; this will also focus on (1) determining the distribution and movement of Black scoters off the South Carolina and Georgia coasts, and (2) collecting replicated double observer data for detection estimation from a spatially intensive survey of the lower Chesapeake Bay and Maryland coast.

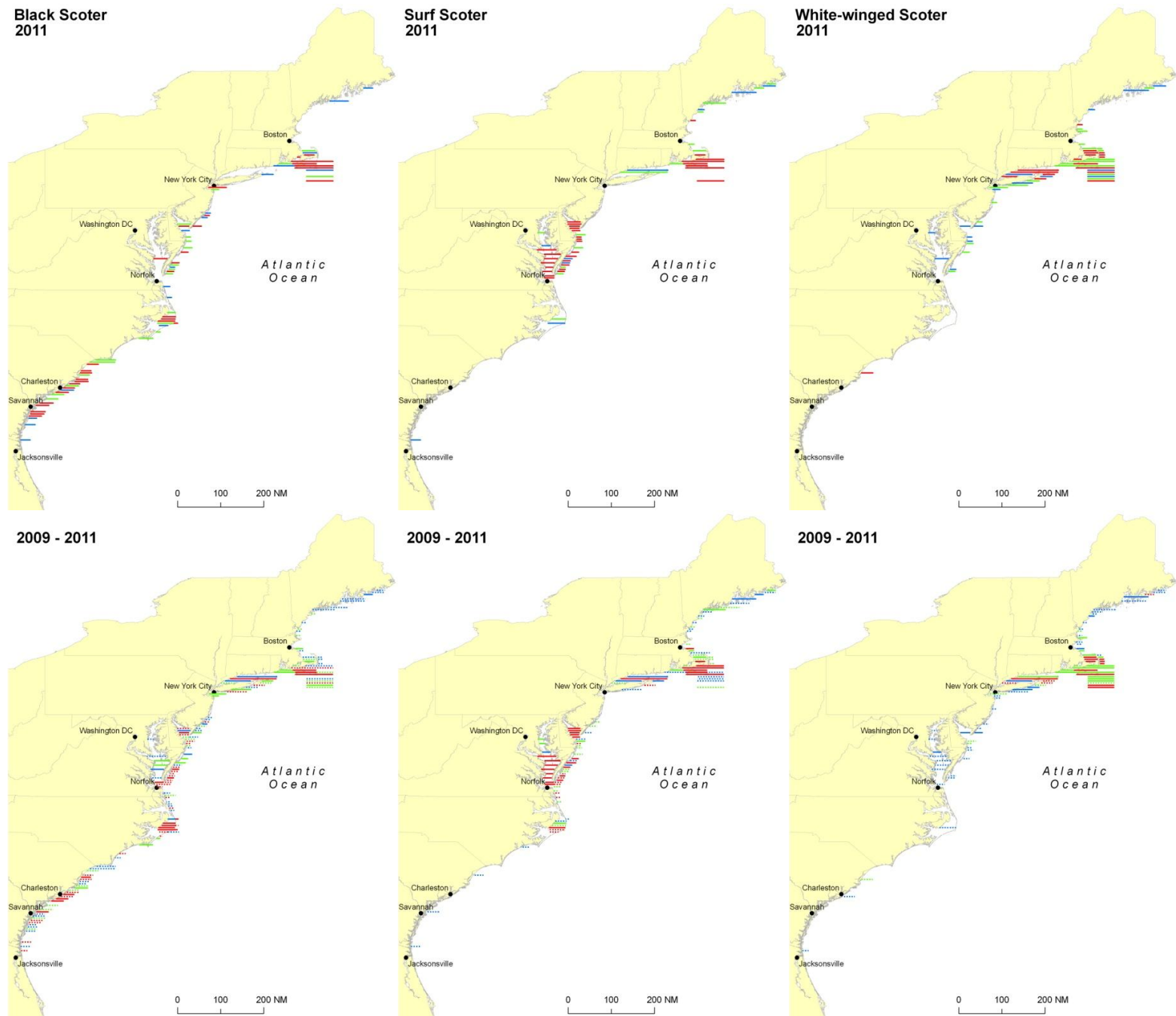
**Figure 1:** Survey transects and crew areas for the 2011 effort.



**Figure 2:** Survey regions used in density estimation.

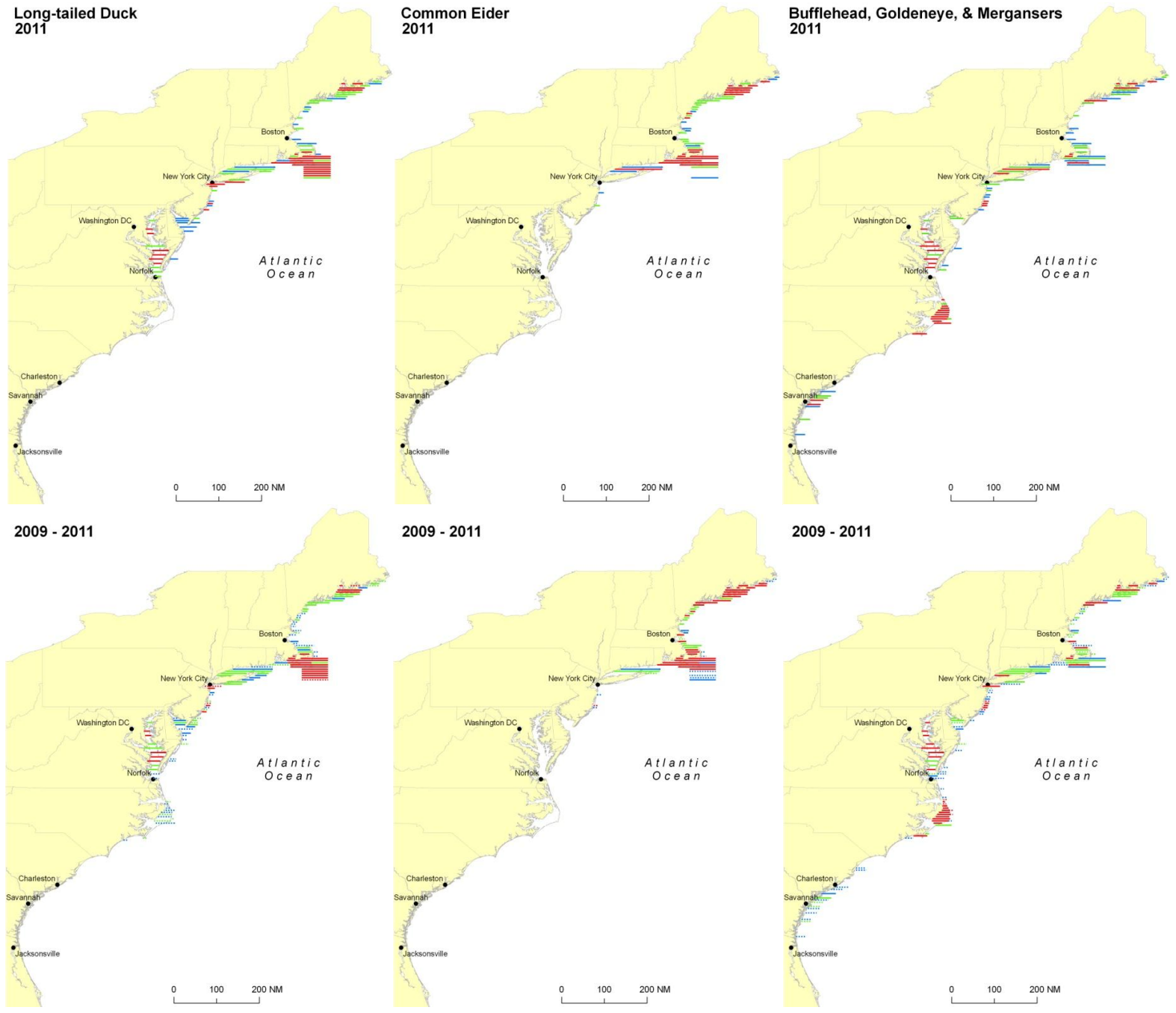


**Figure 3a:** Density (birds/nm<sup>2</sup>) in 2011 (top row) and average for 2009-11 (bottom row) by species and transect. Red > 6 birds/nm<sup>2</sup>, Green = 1-6 birds/nm<sup>2</sup>, Blue = <1 birds/nm<sup>2</sup>; dashes indicate the more variable count transects, with coefficient of variation > 1.5.

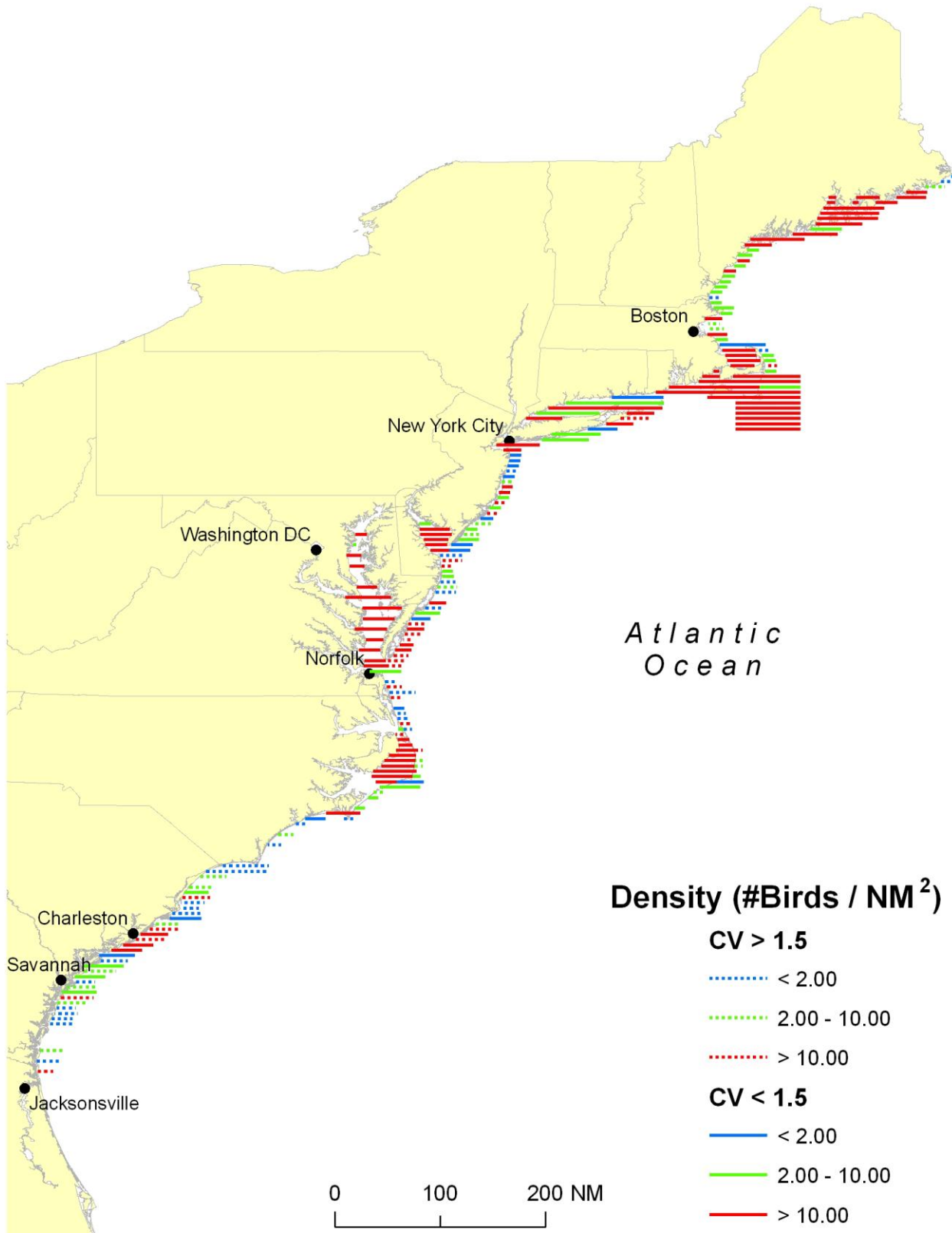




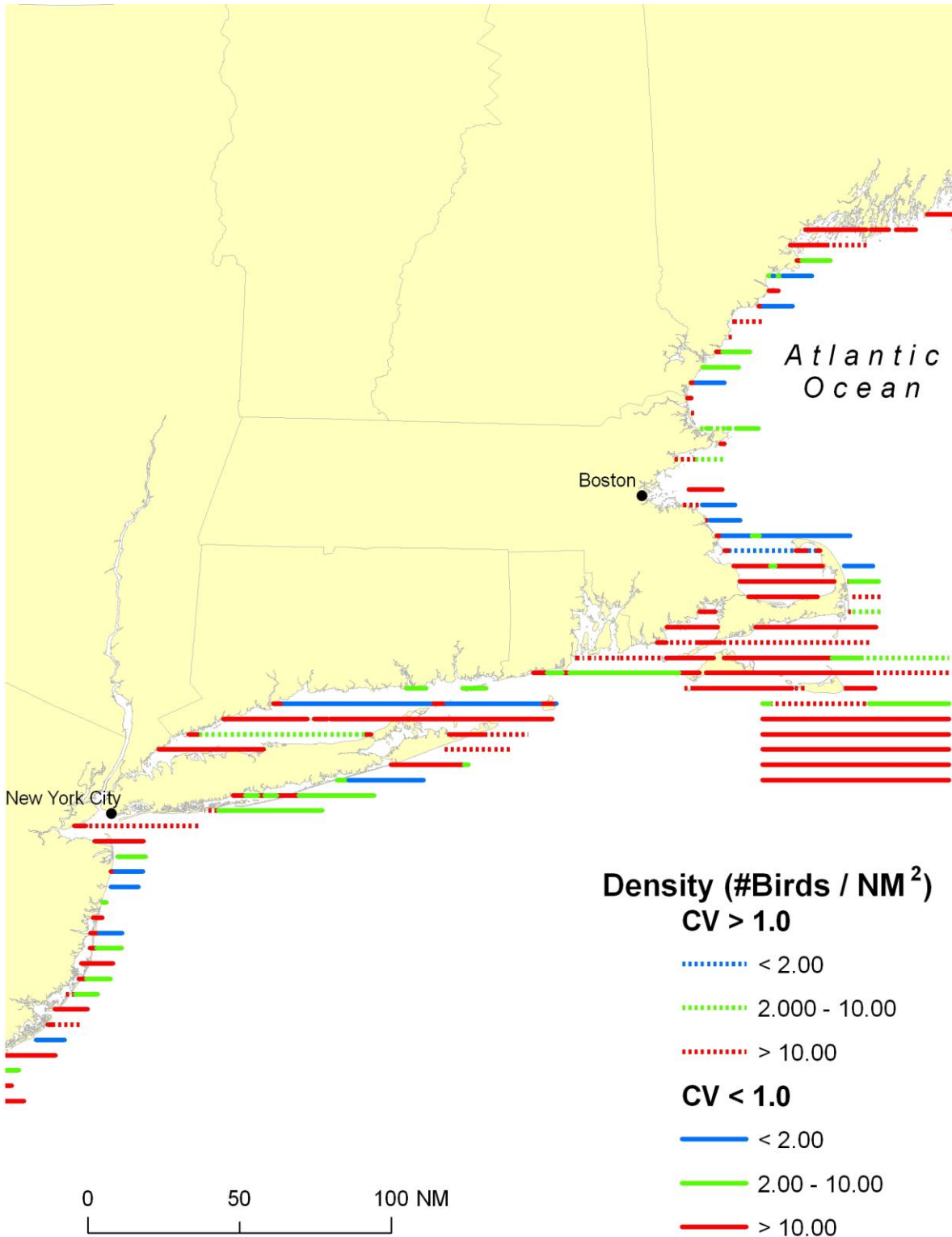
**Figure 3b:** Density (birds/nm<sup>2</sup>) in 2011 (top row) and average for 2009-11 (bottom row) by species and transect. Red > 6 birds/nm<sup>2</sup>, Green = 1-6 birds/nm<sup>2</sup>, Blue = <1 birds/nm<sup>2</sup>; dashes indicate the more variable count transects, with coefficient of variation > 1.5.



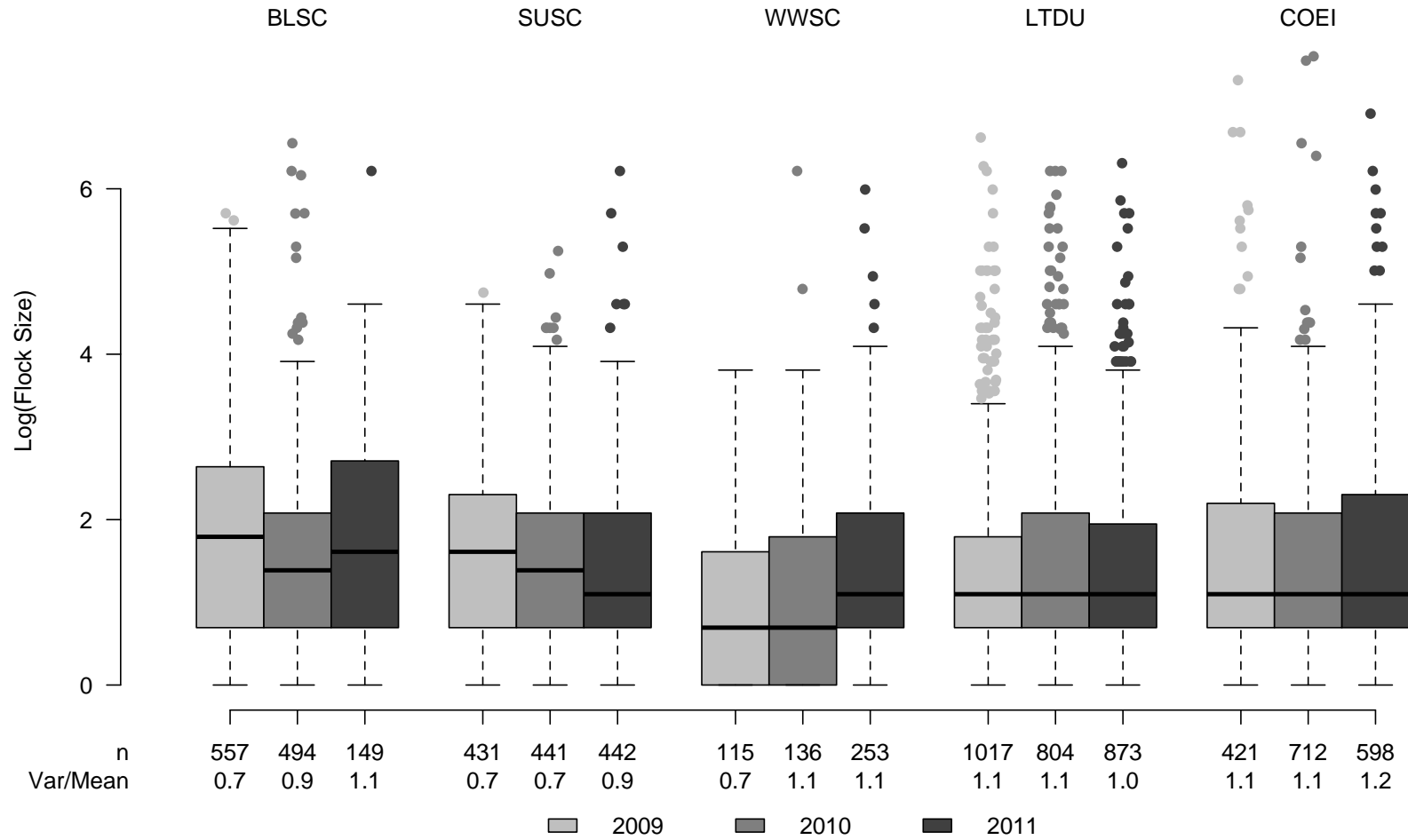
**Figure4a:** Average 2009-11 density for all sea ducks by transect.



**Figure4b:** Average 2009-11 sea duck density by distance from shore for the coast between New York and Boston. Transects were divided into three categories, based on distance from shore: within 1 nm, 1-8 nm, and >8 nm, and sea duck density was estimated separately for each distance class. This figure provides a more detailed representation of the spatial distribution of sea ducks for the section of the Atlantic coast with very long east-west transects.



**Figure 5:** Natural logarithm of flock size, number of flocks, and variance-to-mean ratio (of natural logarithm of flock size) by species and year. Flocks are defined as individual geo-located records, and include observations of singles and pairs.



**Table1:** 2011 Survey Crews. All pilots and observers were members of the Branch of Migratory Bird Surveys, Division of Migratory Bird Management, USFWS, except Tim White and Holly Obrecht (retired FWS). Transect ranges overlap when crews divided multiple transects that were located on the same latitude. Walt Rhodes flew transects 3506-3701 in the Mid-Atlantic crew area with Steve Earsom as observer.

Crew Name	Transect range (DegreeMinute of Latitude)	Dates	Pilot	Observer	Aircraft
Northern	4116-4446	Jan 31-Feb 11	Mark Koneff	Tim White	Kodiak Quest 100
Nantucket to Delaware Bay	3841-4116	Feb 6-12	Jim Bredy	Thom Lewis	Partenavia P-68C TC
Mid-Atlantic	3506-3906*	Feb 4-17	Jim Wortham	Stephen Earsom	Kodiak Quest 100
Southern	3021-3456	Feb 3-13	Walt Rhodes	Holly Obrecht	Kodiak Quest 100

**Table 2:** Observed sea duck density (birds per nm<sup>2</sup>) for the twelve survey regions. Scoter species includes all birds classified as Black, Surf, White-winged, or unidentified scoter. Percents below the densities represent change from previous year, with (XX%) indicating a decrease. Bold font highlights regions where densities exceeded 10 birds per nm<sup>2</sup>. “Total” represents an overall density (SE) for the entire survey area. 2009 Totals: 12.6 (2.7) for Scoters, 9.2 (3.2) for Long-tailed ducks, 6.8 (2.4) for Common eiders, 3.9 (0.8) for Bufflehead/Goldeneye/Merganser spp.

Region (nm <sup>2</sup> )	Species		Scoter spp.		Long-tailed duck		Common eider		Bufflehead goldeneye merganser spp.	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Northern coastline (2,400)	1.8 90%	0.8 (54%)	6.9 176%	4.2 (40%)	<b>18.5</b> 41%	6.3 (66%)	4.2 (41%)	4.8 14%		
Cape Cod/Nantucket (2,050)	<b>31.0</b> 115%	<b>48.7</b> 57%	<b>28.1</b> 163%	<b>37.0</b> 31%	<b>63.4</b> 26%	<b>54.3</b> (14%)	1.5 (22%)	3.7 147%		
Nantucket Shoals (1,300)	<b>26.4</b> 464%	8.9 (66%)	<b>68.6</b> 11%	<b>23.8</b> (65%)	3.4 306%	1.2 (66%)				
Long Island Sound (1,500)	8.0 163%	8.2 2%	2.7 83%	2.2 (18%)	6.4 (20%)	4.5 (29%)	2.5 11%	2.2 (12%)		
Long Island south coast (700)	<b>13.5</b> 170%	<b>28.1</b> 109%	2.4 (94%)	4.6 96%	1.8	0 (100%)	1.2 (84%)	1.7 43%		
New Jersey coast (1,150)	0.7 (34%)	4.8 585%	1.0 (81%)	2.1 103%	0.5	0.2 (57%)	1.5 (58%)	2.1 45%		
Delaware Bay (500)	<b>26.6</b> 31%	<b>26.1</b> (2%)	0.1 (76%)	0.4 213%			2.7 (4%)	0.5 (82%)		
Maryland/Delaware coast (1,300)	7.3 (84%)	8.4 14%	0.4 3,460%	0.1 (80%)			0.2	0.1 (39%)		
Chesapeake Bay (2,200)	<b>11.3</b> (64%)	<b>21.3</b> 89%	9.5 21%	<b>13.1</b> 38%			10.1 (21%)	8.9 (12%)		
Off Pamlico Sound (1,200)	1.8 (89%)	0.2 (88%)	0.3	0 (100%)			6.6 1,189%	0.7 (90%)		
Pamlico Sound (950)	<b>28.5</b> (50%)	5.7 (80%)	1.8	0 (100%)			<b>54.0</b> 83%	<b>35.1</b> (35%)		
Southern coastline (5,450)	<b>10.4</b> 513%	4.4 (58%)					0.3 (57%)	0.4 2%		
Total (21,700)	13.1 (2.9) 4%	12.6 (3.5) (4%)	9.9 (3.7) 8%	7.9 (2.6) (21%)	9.6 (3.5) 41%	7.3 (4.6) (23%)	4.4 (1.2) 13%	3.2 (0.7) (27%)		

**Table 2:** Scoter species densities (birds per nm<sup>2</sup>) for the twelve survey regions and for the entire survey area. Bold font highlights regions where densities exceeded 10 birds per nm<sup>2</sup>.

Scoter species Region (nm <sup>2</sup> )	Black scoter			Surf scoter			White-winged scoter		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
Northern coastline (2,400)				0	0.6	0.6	1.0	1.2	0.2
Cape Cod/Nantucket (2,050)	2.0	5.9	<b>10.3</b>	9.5	<b>22.7</b>	<b>32.3</b>	2.9	2.3	6.1
Nantucket Shoals (1,300)	0.4	<b>16.7</b>	1.2	0.5	0	1.1	3.8	9.7	6.6
Long Island Sound (1,500)	2.0	3.0	0.1	0.4	3.7	0.6	0.6	1.3	7.5
Long Island south coast (700)	2.2	3.2	0.6	1.9	0.2	0	0.9	<b>10.1</b>	<b>27.4</b>
New Jersey coast (1,150)	0.6	0.1	4.2	0.4	0.3	0	0.1	0.2	0.6
Delaware Bay (500)	3.1	<b>10.3</b>	2.6	<b>17.2</b>	<b>16.2</b>	<b>23.5</b>	0.1	0.1	0
Maryland/Delaware coast (1,300)	<b>35.5</b>	1.2	1.5	<b>10.2</b>	6.0	6.6	0.4	0.1	0.3
Chesapeake Bay (2,200)	<b>11.0</b>	1.7	0	<b>20.7</b>	9.3	<b>21.3</b>	0.1	0.3	0.1
Off Pamlico Sound (1,200)	7.3	1.6	0.2	8.7	0.1	0			0
Pamlico Sound (950)	<b>48.9</b>	<b>24.1</b>	4.3	8.2	4.3	1.4	0	0.1	0
Southern coastline (5,450)	1.7	<b>10.4</b>	4.3				0	0	0.2
Total (21,700)	7.8	7.4	3.4	4.3	4.3	5.7	0.5	1.5	3.4

**Table 3:** Mean (SD) distance of flocks to nearest land in nautical miles, by species and year. Maximum distance was calculated for observations from the three years combined. Distance calculations are based on sightings on the east-west transects, excluding transects within the major bays and shoals, i.e., without including Pamlico Sound, Delaware Bay, Chesapeake Bay, Long Island sound, Nantucket Shoals, and Cape Cod/Nantucket (but *not* excluding the lines along the eastern edge of the Cape from 41° 16' N to 42° 06' N); sample sizes are smaller for the distance calculations for this reason. The 2009 survey counted 239 unidentified scoter flocks (18% of all scoter flocks), 273 (20%) were recorded in 2010, and 310 (27%) in 2011.

Species	Mean distance			Max distance
	2009	2010	2011	
Black scoter	4.1 (2.2) n = 383	3.2 (2.3) n = 152	3.4 (2.9) n = 120	12.8
Surf scoter	3.5 (2.1) n = 213	3.1 (1.9) n = 172	4.1 (2.2) n = 204	9.9
White-winged scoter	3.4 (2.3) n = 48	2.2 (1.8) n = 48	3.8 (2.1) n = 127	9.3
Long-tailed duck	3.4 (4.4) n = 423	2.8 (2.6) n = 373	3.2 (2.8) n = 592	24.9
Common eider	2.1 (2.4) n = 364	1.5 (1.8) n = 604	2.3 (2.5) n = 455	19.3
Bufflehead Goldeneye Merganser spp.	0.5 (1.1) n = 303	0.4 (1.0) n = 203	0.4 (0.8) n = 195	14.4