Decline of Whimbrels within a mid-Atlantic Staging Area (1994-2009)

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Abstract.—Whimbrels (*Numenius phaeopus*) were monitored during spring migration across a network of ten aerial transects within the barrier island-lagoon system along the lower Delmarva Peninsula, Virginia, USA. Transects were surveyed weekly from the last week of April through the first week of June (1994-1996, 2008-2009). Whimbrel numbers increased to a peak during the first and second weeks of May then decreased sharply during the third and fourth weeks of May in all years. Between the 1990's and 2000's, peak numbers declined by 50%, corresponding to a 4.2% annual rate of decline. A similar decline was detected in accumulated, season-wide numbers. Though similar in pattern, migration phenology was significantly different between the decades. The phenology difference resulted from a greater reduction in numbers during the first half of the study period compared to the last. Habitats used by Whimbrels (N = 31,314) included mudflats (95%) and salt marshes (5%). Habitat-specific densities (birds/km^2) were 443 ± 26.6 and 9 ± 1.6 (mean ± SE) for mudflat and marsh patches, respectively, during the 1990's and 222 ± 11.1 and 8 ± 4.6 during the 2000's. These results support suggestions that Whimbrels are declining on the Hudson Bay breeding grounds and perhaps at major Atlantic Coast wintering sites. *Received 1 December 2009, accepted 30 June 2011.*

Key words.—Delmarva Peninsula, habitat use, migration ecology, *Numenius phaeopus*, population, Virginia, Whimbrel.

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Whimbrels (*Numenius phaeopus*) breeding in the Western Hemisphere have been assigned high conservation concern scores by both the United States and Canadian Shorebird Conservation Plans (Donaldson *et al.* 2000; Brown *et al.* 2001). Concerns have focused on the small population size (Morrison *et al.* 2006) and suggestions of a declining trend for the Hudson Bay population (Jehl and Lin 2001; Bart *et al.* 2007; Rockwell *et al.* 2009). Current population estimates include 26,000 and 40,000 individuals for the western and Hudson Bay populations, respectively (Morrison *et al.* 2006). However, confidence in these estimates remains low (Morrison *et al.* 2001, 2006) due to the paucity of population-level work and the difficulty of studying the species during most of the annual cycle (Wilke and Johnston-González 2009). Recent ground counts of birds during winter along the Pacific Coast have been used to increase estimates for the western breeding population by 27% (Andres *et al.* 2009). Although more than 15,000 birds were recorded along the northeastern coast of South America (presumably the primary wintering site for the Hudson Bay population) in the early 1980's (Morrison and Ross 1989), no follow-up assessment that might reveal trends has been conducted.

Surveys within major migratory staging areas may provide one of the best assessments of shorebird population sizes and trends (e.g. Senner 1979; Hicklin 1987; Clark *et al.* 1993); particularly for species that are widely dispersed during both the breeding and winter periods. Despite work on Whimbrel staging areas throughout the Palearctic (Stroud *et al.* 2004), no assessments have been made within staging areas along the Atlantic Flyway of North America. Historic accounts of large numbers of migrant Whimbrels along the south Atlantic Coast document that this region has been important as a spring staging area (Sprunt and Chamberlain 1949; Burleigh 1958). Recent satellite tracking of birds captured along the lower Delmarva Peninsula in Virginia has demonstrated that Virginia is a terminal staging area from which birds initiate long flights to both the western (Watts *et al.* 2008) and Hudson Bay breeding grounds (Center for Conservation Biology 2009).

Our objective here was to report on efforts to (1) evaluate trends in the number of Whimbrels staging on the lower Delmarva Peninsula (1994-2009) during the spring season and (2) describe patterns of habitat use and migration phenology. For long-distance migrants such as the Whimbrel, information on the relative importance of specific sites and the ecological role that they provide throughout the annual cycle is a critical to conservation planning. Similarly, information on population trends is essential for prioritizing conservation actions and assessing progress towards conservation targets.

METHODS

Study Area

The Virginia Barrier Island/Lagoon system includes the seaward margin of the lower Delmarva Peninsula from the mouth of the Chesapeake Bay to the MD-VA border (centered on 37°30'N, 74°40'W) (Fig. 1). The chain of 14 barrier islands protects an extensive lagoon system that contains over 85,000 ha of tidal marsh, mudflats, and open water. The area has been designated as a UNESCO Biosphere Reserve (UNESCO 2000), a Western Hemisphere Shorebird Reserve Site with international status (Myers *et al.* 1987) and is a National Science Foundation Long-term Ecological Research site and the focus of a multi-organizational partnership dedicated to bird conservation. A large portion of the system is in protective ownership.

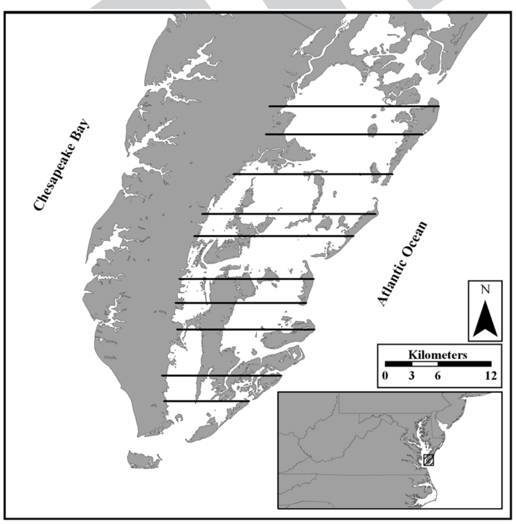

Figure 1. The study area along the seaward margin of the lower Delmarva Peninsula in Virginia. The area is bounded to the east by the uplands of the outer barrier islands and to the west by the uplands of the Delmarva mainland. Black lines indicate the approximate position of aerial transects. Gray areas within the lagoon system are patches of salt marsh.

Field Surveys

We determined Whimbrel abundance using a series of low-altitude aerial surveys from the last week of April through the first week of June (1994-1996, 2008-2009). Each survey covered a network of ten, 400-m, band transects across the barrier island-lagoon system (Fig. 1). Each transect was positioned along an east-west axis to cross the lagoon system from the landward edge of the barrier islands to the Delmarva mainland. We placed the northern-most transect near the north end of Hog Island. Remaining transects were placed at approximately successive 4 km intervals to the south. The ten transects combined covered a distance of 130 km (N = 10, 13 ± 0.9, mean ± SE) and were used to gain a representative sample of habitats within the lagoon system.

We conducted all surveys from a Cessna 172, high-wing aircraft flying 25-30 m above the ground at an air speed of approximately 140 km/hr. Low altitude flights were used to temporarily flush birds to ease identification and numerical estimation. We flew six survey flights each year beginning the last week of April and ending the first week of June. Surveys took approximately 1.5 hr to complete. Because our interest was to determine use of habitats during the peak foraging period, we conducted surveys during falling tides.

Surveys were a collaborative effort between two observers (the same two observers conducted all surveys). The first observer identified birds and estimated flock sizes while the second observer mapped flocks on aerial photographs. Substrate (marsh, mudflat) use was recorded for flocks based on the habitat where birds were flushed. Each flock was mapped and given a unique code to cross-reference with survey data. All survey data were recorded in digital audio files and later transcribed to data sheets.

Analysis

We evaluated migration phenology and trends in stopover numbers using a two-way ANOVA where season (six ranks; weekly surveys) and period (two ranks; 1990s vs 2000s) were grouping parameters and years were samples. We compiled the number of Whimbrels from the transect network for a given day to represent the dependent parameter. Tukey's honestly significant difference (HSD) test was used for pairwise, post-hoc comparisons between time periods.

We determined habitat-specific densities (birds/km^2) by dividing the number of birds detected within each habitat type (marsh, mudflat) by the availability of each habitat per transect. Although detection rates for birds on the ground are likely different between marsh and mudflat habitats, we believe that virtually all Whimbrel within the band transects were flushed by the survey plane. We quantified habitat availability by overlaying band transects on high-resolution, true-color, aerial photographs and digitizing habitat patches using ArcView 3.2 (Environmental Systems Research Institute, Inc.© 1992-2000). Aerial photographs were rectified, 0.6-m resolution, leaf-off, tiled images taken during the spring of 2002 as part of the Virginia Base Mapping Program. Transects collectively covered 130 km and included an area of 50 km^2. The surface of the entire study area was 467 km^2 such that the transect network sampled 10.7% of the available area. Transects were dominated by open water (32 km^2 (63.6%) that is unusable by Whimbrel but also included 12 km^2 (23.7%) of salt marsh (dominated by *Spartina alterniflora* and *S. patens*) and 6 km^2 (12.7%) of intertidal mudflats.

RESULTS

Whimbrel staging along the lower Delmarva Peninsula declined significantly during the study period (Table 1, Fig. 2). Mean peak numbers declined by nearly 50%, ranging from 2,880 to 3,175 and 1,430 to 1,553 during the early (1990's) and late (2000's) periods, respectively, representing a 4.2% average annual rate of decline. In addition, the total number of birds detected during the year (across 6 surveys) declined from a range of 6,696 to 8,771 and 4,295 to 4,418 for early and late decades representing a 3.3% average, annual rate of decline.

The number of Whimbrel detected along transects was significantly influenced by season (Table 1). The study window did not encompass the entire period of passage. Large (>1,350 during 1990s and >750 during 2000s) numbers were present during the first survey of each year. Typically, Whimbrels begin to arrive in the study area in late March and early April. However, numbers reached a peak during the first week of May, leading to a sudden mass exodus during the third to fourth week of May in all years. Phenology of passage varied between the two time periods resulting in a significant decade by season interaction (Table 1). The interaction results from a narrowing of the decade effect through the season (Fig. 2). Differences in the individual weeks between decades were significant for the first three weeks (Tukey's HSD statistics >4 (df 1,3), $P < 0.05$) but not for the second three weeks (Tukey's HSD statistics <2.5 (df 1,3), $P > 0.05$).

Ninety-five percent of the 31,314 Whimbrel foraged on patches of mudflat, with a few along the exposed bands of tidal creeks. The remaining 5% were flushed from saltmarsh patches. Mean peak densities (birds/km^2) on mudflats were 443 ± 26.7 and 222 ± 11.1 (mean ± SE) for the 1990s and 2000s surveys respectively. Corresponding densities for marsh patches were 9 ± 1.6 and 8 ± 4.6. Accumulated densities (birds/km^2/survey) on mudflats were 191 ± 15.9 and 108 ± 8.2 for the 1990s and 2000s surveys respectively. Corresponding densities for marsh patches were 5 ± 0.5 and 4 ± 1.5.

DISCUSSION

Whimbrel staging along the lower Delmarva Peninsula declined by 50% through the study period (1994-2009). Previous evidence from the breeding grounds (Jehl and Lin 2001) and in other migration areas (Bart *et al.* 2007) also indicates that the eastern population has been in decline since the mid-1970's. Recent aerial surveys of a portion of the most significant wintering area for this population (as delineated in the early 1980's; Morrison and Ross 1989), indicates a 3.7% average annual rate of decline (Morrison and Mizrahi, unpublished data), which is similar to the 4.2 and 3.3% average rates reported here for peak and accumulated numbers respectively. Data from other parts of the winter range are unavailable.

Although we have not attempted to quantify prey availability and habitat quality, there is no indication that the underlying cause of the decline is locally-based. The two fiddler crab species (*Uca pugnax, U. minax*)

Table 1. Results of ANOVA showing effects of decade (1994-1996 vs 2008-2009) and season on Whimbrel numbers within the study area. Numbers were significantly higher in the mid-1990s period and during early May.

Source	SS	Df	MS	F	P
Decade	2018878	1	18772643	33.7	<0.001
Season	18772643	5	3754528	62.7	<0.001
Decade*Season	2038910	5	407782	6.8	<0.001
Error	1077523	18	59862		

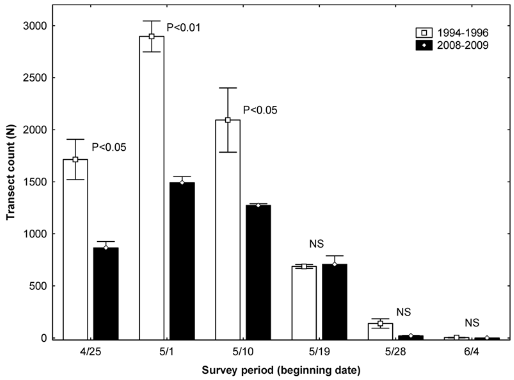

Figure 2. Mean counts (±SE) of Whimbrels within a network of aerial transects along the Delmarva Peninsula in Virginia during the 1990s (open bars) and 2000s (black bars). Whimbrel numbers reached a peak in the first half of May during both time periods. Significance values are the result of Tukey's Honestly Significant Difference, post-hoc comparisons between decades for each weekly period.

that are the main prey for staging birds remain super-abundant, and the aerial extent and the patch configuration of mudflats and salt marsh habitats have remained fairly stable (Watts, personal observation). Also, spatial distribution has remained consistent, with the bulk of birds using large mudflats near the western or mainland edge of the lagoon system.

Ecological changes throughout the arctic and sub-arctic regions have become increasingly apparent in recent decades (e.g. Chapin *et al.* 1994; Walther *et al.* 2002; Callaghan *et al.* 2004). Among others, these include changes in plant distribution and composition, reductions in the availability of open water, and a redistribution of animal populations. A recent investigation of habitat changes within a site in eastern Canada where Whimbrel have declined over a 35-year period has demonstrated a shift in habitat composition away from that believed to be important for nesting (Ballantyne 2009). Increases in woody cover avoided by breeding Whimbrel in combination with declines in other vegetation required by Whimbrel suggest a link between habitat shifts and local population declines.

Conditions on the wintering grounds may also be playing a role in population declines (Wilke and Johnston-González 2009). Although recent work has been conducted within the most important over-wintering site for Whimbrels along the Pacific Coast (Johnson *et al.* 2007; Andres *et al.* 2009), little information is available on the conditions of wintering sites for the eastern population. Hunting pressure is a concern within the highest use sites along the northeast coast of South America (Ottema and Spaans 2008; Serrano 2008). The population-level consequences of such pressures remain unclear. Mangrove forests appear to play an important role in the food chain for shorebird hotspots within tropical areas (Butler *et al.* 1997, 2001). The displacement of mangrove forests by aquaculture and shoreline development is widespread (FAO 2007) and is likely reducing the quality of foraging habitats along Atlantic Coast wintering areas (Serrano 2008).

Our results may have implications for the western breeding population. Two individuals from the study area have been tracked with satellite transmitters on transcontinental flights to the western breeding grounds (Watts *et al.* 2008). These events demonstrate that some portion of the western population is intermixing with eastern birds along the south-Atlantic Coast and likely the eastern wintering grounds. If conditions on the wintering grounds are driving trends in birds staging within our study area then such effects may be impacting a portion of the western population. If conditions in the arctic are driving observed trends then patterns for the two populations may be decoupled depending on conditions throughout the western breeding grounds. Available information indicates that the western population appears to be stable at present (Morrison *et al.* 2006; Andres *et al.* 2009). Currently, we are unable to differentiate birds from the two populations in the hand. Work is ongoing to develop morphometric and genetic techniques to separate these populations so that we may better understand the extent of mixing and clarify population-level implications.

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