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Using Satellite and Radio Telemetry to Examine Stopover and Migration Ecology of the Whimbrel: 2009-2011 Report

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Project Partners:
The Nature Conservancy
U.S. Fish and Wildlife Service
Virginia Coastal Zone Management Program
Center for Conservation Biology

Front Cover: Whimbrel on exposed mudflat near Box Tree marsh. Photo by Bart Paxton.

The Center for Conservation Biology is an organization dedicated to discovering innovative solutions to environmental problems that are both scientifically sound and practical within today's social context. Our philosophy has been to use a general systems approach to locate critical information needs and to plot a deliberate course of action to reach what we believe are essential information endpoints.

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EXECUTIVE SUMMARY

The whimbrel (Numenius phaeopus) is a large, Holarctic, highly migratory shorebird. The North American race (N.p. hudsonicus) includes two disjunct breeding populations, both of which winter primarily in Central and South America. The western population breeds in Alaska and the Northwest Territories of Canada (Engelmoer and Roselaar 1998). The eastern population breeds south and west of Hudson Bay in Manitoba and Ontario (Skeel and Mallory 1996, Jehl and Smith 1970). The prevailing idea was that the western population followed a Pacific Coast migration route between breeding and wintering areas in Panama and western South America, and that the Hudson Bay population followed an Atlantic Coast migration route to wintering grounds in Northeast South America (Andres et al. 2009, Skeel and Mallory 1996, Morrison and Ross 1989). Both populations are of high conservation concern due to population declines in recent decades (Bart et al. 2007, Morrison et al. 2006, Watts and Truitt in press). Investigations into the migration routes of whimbrels staging in Virginia have shown a previously unknown link between the eastern and western populations as they stop-over in Virginia (Watts et al. 2008). The primary objective of this project is to examine the stop-over and migration strategies of whimbrels, as they relate to the conservation of the species.

A total of 12 9.5 gram PTT satellite transmitters were deployed during the 2009-2010 spring and fall migration seasons. Average weight for the whimbrels with transmitters was 568 ± 53SD grams, or approximately 150-200 grams over mean winter (lean) weight. A total of 67 digitally coded glue-on radio transmitters were attached to birds during these seasons. The cumulative data give us insight into stop-over times for whimbrels as they stage on the Eastern Shore of Virginia before migrating to both breeding and wintering grounds. Satellite and radio transmittered whimbrels departed the Eastern Shore in the spring season between 22 May and 3 June and in the fall season between 11 August and 20 September. Spring birds tend to leave during a short window (CCB/TNC spring whimbrel count unpublished data), whereas fall birds have a much bigger migration window as shown by the wide range of satellite and radio transmitter leave dates.

Several unusual migration events were observed during the spring and fall seasons. Twenty flights averaging 2,595 km were documented during the spring seasons. These flights took an average of 81 hours to complete. Twenty-four flights averaging 2,603 km were documented during the fall seasons. These flights took an average of 91hours to complete. A total of 13 shorter flights on breeding grounds were also documented, with birds moving from initial locations in along the Hudson Bay coastline to interior breeding locations. The mean distance traveled on these flights was 435 km with the mean time in flight 44 hours. A total of 17 shorter flights on wintering grounds were documented, with birds moving from initial locations in the Greater and Lesser Antilles, Suriname, and Guyana into French Guiana, Suriname, and Brazil, the primary wintering grounds for the Atlantic population of whimbrels (Morrison and Ross 1989). The mean distance traveled on these flights was 548 km with the mean time in flight 52 hours.

BACKGROUND

Context:

The whimbrel (Numenius phaeopus) is a large, Holarctic, highly migratory shorebird. The North American race (N.p. hudsonicus) includes two disjunct breeding populations, both of which winter primarily in Central and South America. The western population breeds in Alaska and the Northwest Territories of Canada (Engelmoer and Roselaar 1998). The eastern population breeds south and west of Hudson Bay in Manitoba and Ontario (Skeel and Mallory 1996, Jehl and Smith 1970). The prevailing opinion was that the western population followed a Pacific Coast migration route between breeding and wintering areas in Panama and western South America, and that the Hudson Bay population followed an Atlantic Coast migration route to wintering grounds in northeast South America (Andres et al. 2009, Skeel and Mallory 1996, Morrison and Ross 1989). Both populations are of high conservation concern due to population declines in recent decades (Bart et al. 2007, Morrison et al. 2006, Watts and Truitt in press). Investigations into the migration routes of whimbrels staging in Virginia have shown a previously unknown link between the eastern and western populations as they stop-over in Virginia (Watts et al. 2008). The primary objective of this project is to examine the stop-over and migration strategies of whimbrels, as they relate to the conservation of the species.

For more than a decade, scientists have believed that the seaside of the lower Delmarva Peninsula in Virginia played a significant role in the life history of the whimbrel. During spring migration in the mid-1990s, biologists from the Center for Conservation Biology (CCB) at the College of William and Mary and The Nature Conservancy (TNC) documented the densest concentration of whimbrels ever recorded in the western hemisphere within the barrier island lagoon system of the lower Delmarva Peninsula (Watts and Truitt, in press). It is believed that this site represents a critical coastal staging area where Whimbrels feed on vast numbers of fiddler crabs that inhabit the lagoon system to build up fat and energy reserves before making their last overland flight to the breeding grounds. It was previously assumed that birds staging along the lower Delmarva were exclusively from the Hudson Bay population. Investigations into the migration routes of whimbrels staging in Virginia have shown a previously unknown link between the eastern and western populations as they stop-over in Virginia (Watts et al. 2008, http://ccb-wm.org/programs/migration/Whimbrel/whimbrel.htm). Further investigations to determine the origins of whimbrels using the Eastern Shore of Virginia as a stop-over site are underway.

Objectives:

The objectives of this project are:

1) examine the stop-over and migration strategies of whimbrels as they relate to the conservation of the species,

2) document specific migration routes using satellite transmitters and radio transmitters,

3) investigate stop-over dynamics using conventional radio transmitters, and

4) provide satellite data to USFWS Sister Schools Shorebird Program along with other educational programs.

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) (Figure 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 (http://www.unesco.org), a Western Hemisphere Shorebird Reserve Site with international status (http://www.whsrn.org) and is the site of a National Science Foundation Long-term Ecological Research site (http://amazon.evsc.virginia.edu) and the focus of a multi-organizational partnership dedicated to bird conservation. A large portion of this system is in protective ownership.

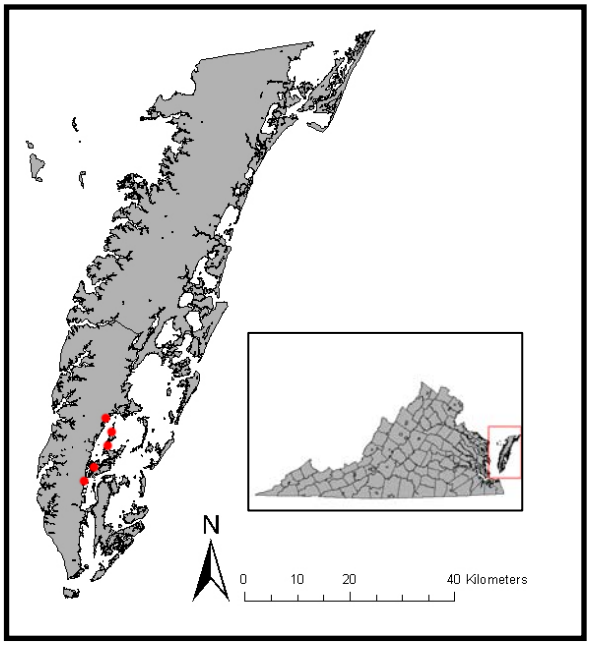

Figure 1. Location of all trapping sites (red dots) on the Eastern Shore of Virginia portion of the Delmarva Peninsula, spring and fall 2009-2010 trapping seasons.

Trapping

Trapping was conducted on all suitable days between 15 April and 6 June 2009-2010, and 8 August and 5 September 2009-2011. Whimbrels were captured using a modified rocket net capture system (Grubb 1991, King et al. 1998). Nets were placed within a waterproof box along the *Spartina alterniflora* line near the edge of tidal flats or creek banks used as high tide roosts (Figures 2 and 3). Recoilless rockets (flip-flop rockets) were attached to the net and placed on top of the box. The entire capture system was fully portable. Propellant was placed into the rocket and ignited electrically from a safe distance (>1000 feet). After ignition all birds were extracted and placed into holding cages until processing.

Figures 2 and 3. Camouflaged rocket nets set up within Box Tree Marsh in both spring (left) and fall (right).

Banding:

A serially numbered US Fish and Wildlife Service Incoloy® band was attached below the right metatarsal joint of the bird. A field readable lime green alpha-numeric band was attached above the left metatarsal joint. A yellow wrap-around darvic band was placed above the alpha-numeric band to identify the bird to banding location (Figure 4). Standard morphometric measurements, including wing, tail and culmen were recorded. Feather samples were obtained to establish sex of the individual using DNA analysis, and also to determine breeding and wintering origin using stable isotope analysis.

Figure 4. Whimbrel with field readable alpha-numeric flag and colored wrap-around darvic band on left leg, and USFWS Incoloy® band on right leg.

Transmitter attachment:

Radio transmitters were attached using digitally coded glue-on 9 gram transmitters made by Advanced Telemetry Services, Inc. Feathers were trimmed to allow contact between cyanoacrylate gel glue and feather tracts/skin. Transmitters were placed on the synsacrum anterior to the uropygial gland (Figure 5).

A 9.5 gram satellite transmitter was attached using a modified leg-loop harness (Watts et al. 2008, Sanzenbacher et al. 2000, Rappole and Tipton 1991). A Teflon® ribbon was used in place of elastic cord. The ribbon was fastened with brass rivets and cyanoacrylate glue was used to reduce fraying of the ribbon (Figure 6). Whimbrels were observed before release to confirm freedom of movement with the transmitter attached.

Figures 5 and 6. Placement of radio transmitter (left) and satellite transmitter (right).

Radio Transmitter Analysis

A number of different methods were used to locate radio transmitters. Boat surveys were used throughout the season to identify roost sites and to confirm departure dates. Stationary scans were recorded daily at Box Tree marsh to determine site fidelity. Several aerial surveys were flown to locate whimbrels within Virginia barrier island system and outside stationary scan range.

We determined the stopover duration for whimbrels that were marked with VHF radio tags and monitored for presence during migration stopover in spring of 2009-10 (N=58) and fall of 2009 (N=10). We started deploying tags on 25-30 April in the spring and on 8 August in fall. For data analysis, we summarized mark-recapture data into 5-day periods and recording when individual whimbrels were captured or their radio signal was detected (recaptured) for each period. Each season included 8 periods.

In determining stopover duration, we took into account the amount of time that whimbrels remained in the study area after marking and were present in the study area before marking by analyzing data using recruitment models (Pradel 1996) combined with program SODA (StopOver Duration Analysis)(Schaub et al. 2001).

Recruitment or reverse-time models estimate apparent survival rates, resight probabilities, and recruitment rates. Apparent survival is the product of the true survival rate and the rate of permanent emigration from the study area. Over the short duration of a migratory stopover, true survival is assumed to be equal to 1, so apparent survival is reduced to the emigration rate from the stopover location. Because births do not occur during migration, the recruitment rate is the probability of an individual arriving at the stopover location. Resight rates are the probability of an individual being captured or subsequently observed at each time step.

We used Program Mark (White and Burnham 1999) and information theoretic approaches (Burnham and Anderson 2001, Burnham and Anderson 2002) to determine the best model among a set of candidate models used to describe the stopover process. Our candidate model set allowed recruitment and emigration rates to be constant throughout the stopover period, vary by 5 day interval, or vary by 10 day interval. We assumed that resight rates differed for each 5 day interval of the study. To estimate stopover duration, we entered the best model into SODA to estimate stopover duration. This program calculated the average duration of stopover for each time period that a whimbrel was present in our study area.

RESULTS

Satellite Transmitter Results

A total of 12 9.5 gram PTT satellite transmitters were deployed during the 2009-2010 spring and fall migration seasons (see Figures 7 and 8). Average weight for the whimbrels with transmitters was 568 ± 53SD grams, or approximately 150-200 grams over mean winter (lean) weight. A total of 67 digitally coded glue-on radio transmitters were attached to birds during these seasons. The cumulative data give us insight into stop-over times for whimbrels as they stage on the Eastern Shore of Virginia before migrating to both breeding and wintering grounds. Satellite and radio transmittered whimbrels departed the Eastern Shore in the spring season between 22 May and 3 June and in the fall season between 11 August and 20 September. Spring birds tend to leave in a short window (CCB/TNC spring whimbrel count unpublished data), whereas fall birds have a much bigger migration window as shown by the wide range of satellite and radio transmitter leave dates.

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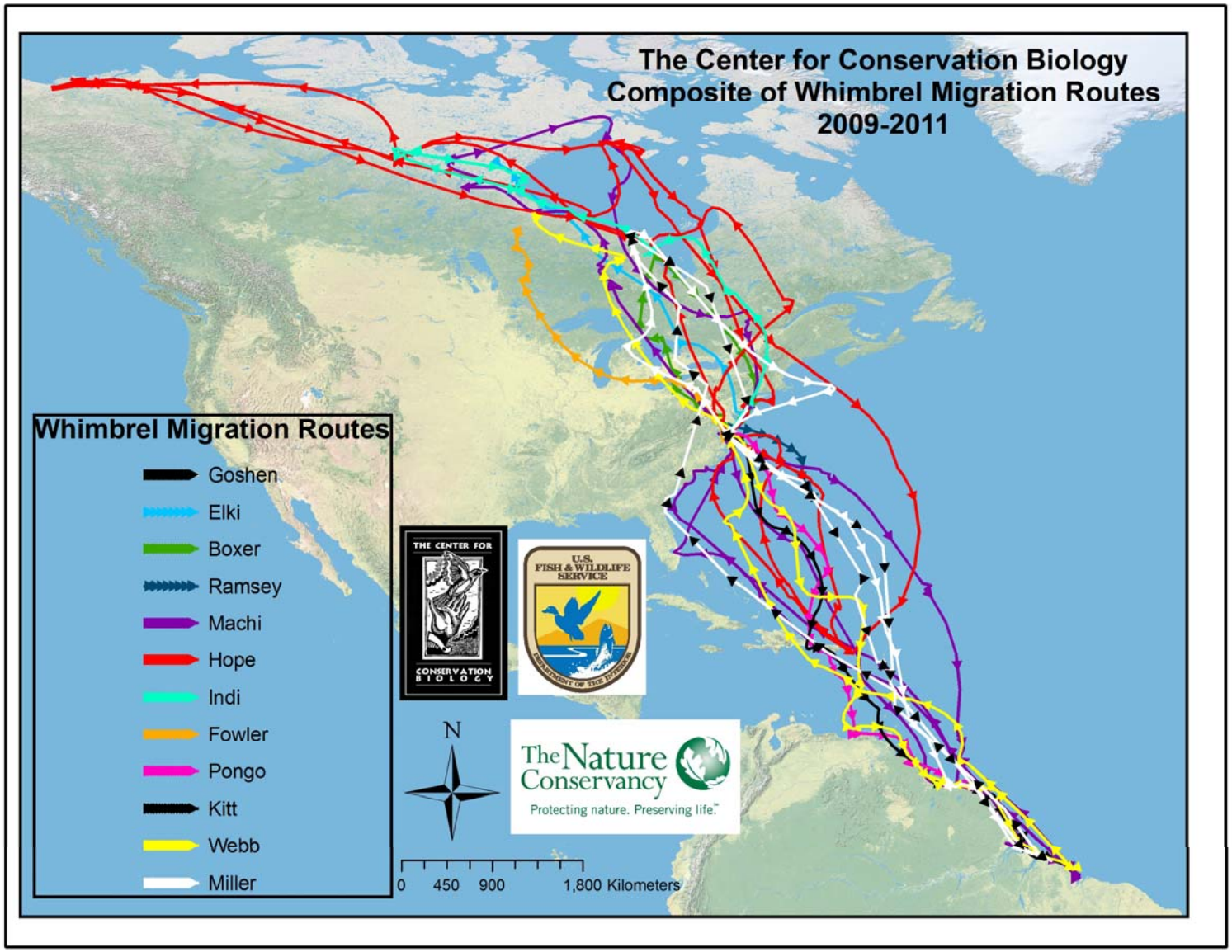

Figure 7. Composite map of all whimbrels tagged during the 2009-2010 seasons. Current through 29 October 2011.

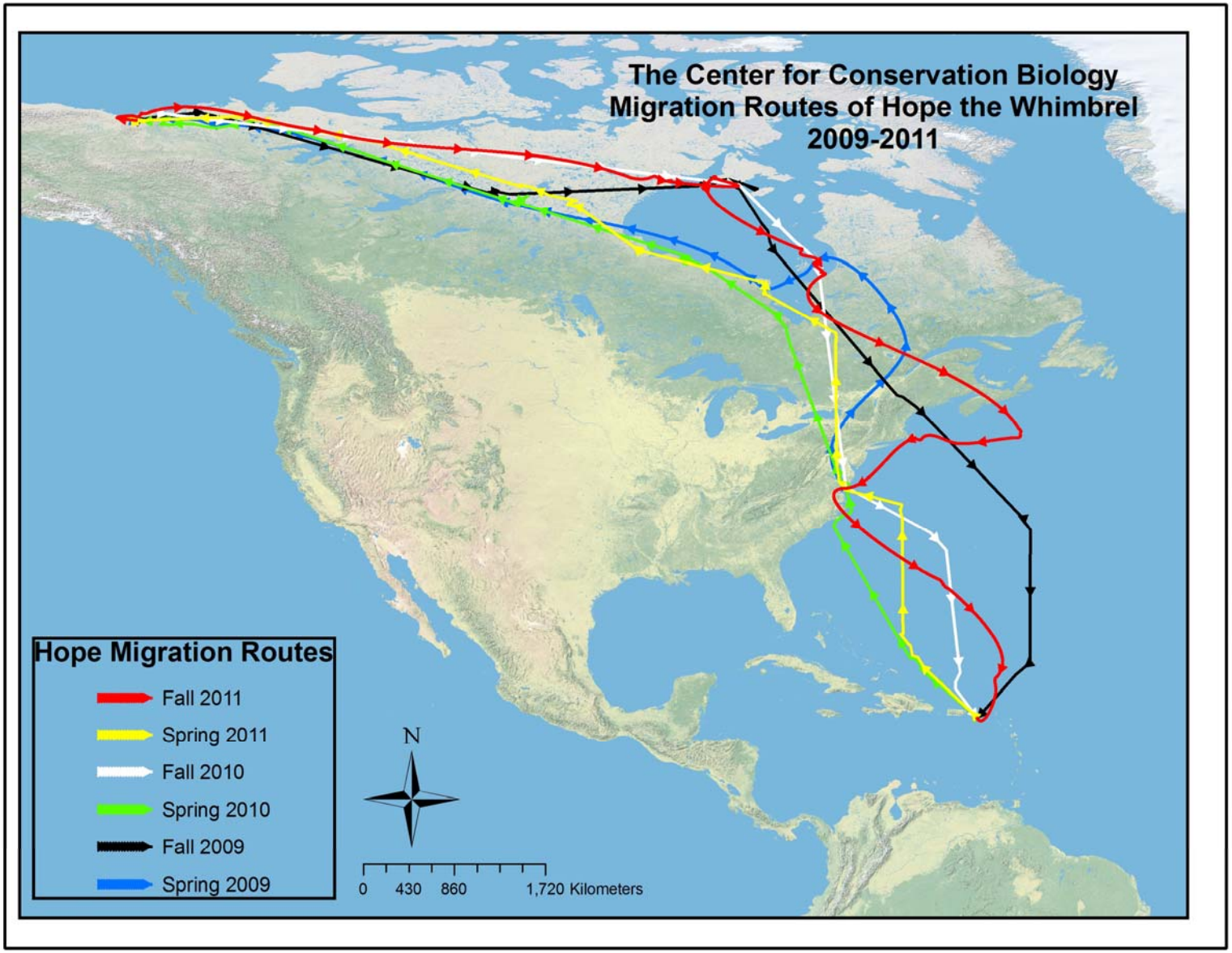

Figure 8. Composite map of all migration events for “Hope” the Whimbrel. Current through 29 October 2011.

Radio Transmitter Results

We were unable to check fit of the global model in Program MARK, likely because our sample size was relatively small for spring (N=58). Therefore, we calculated stopover duration for 2 models. The first was the AIC best model, assuming there was no overdispersion in data, which included variation in arrival over 10 day intervals and variation in departure over 5 day periods (Figure 9). The second model was the more conservative qAIC best model, assuming correction for overdisperison in data by using c-hat of 2.0. This model included constant arrival and departure rates (Figure 10).

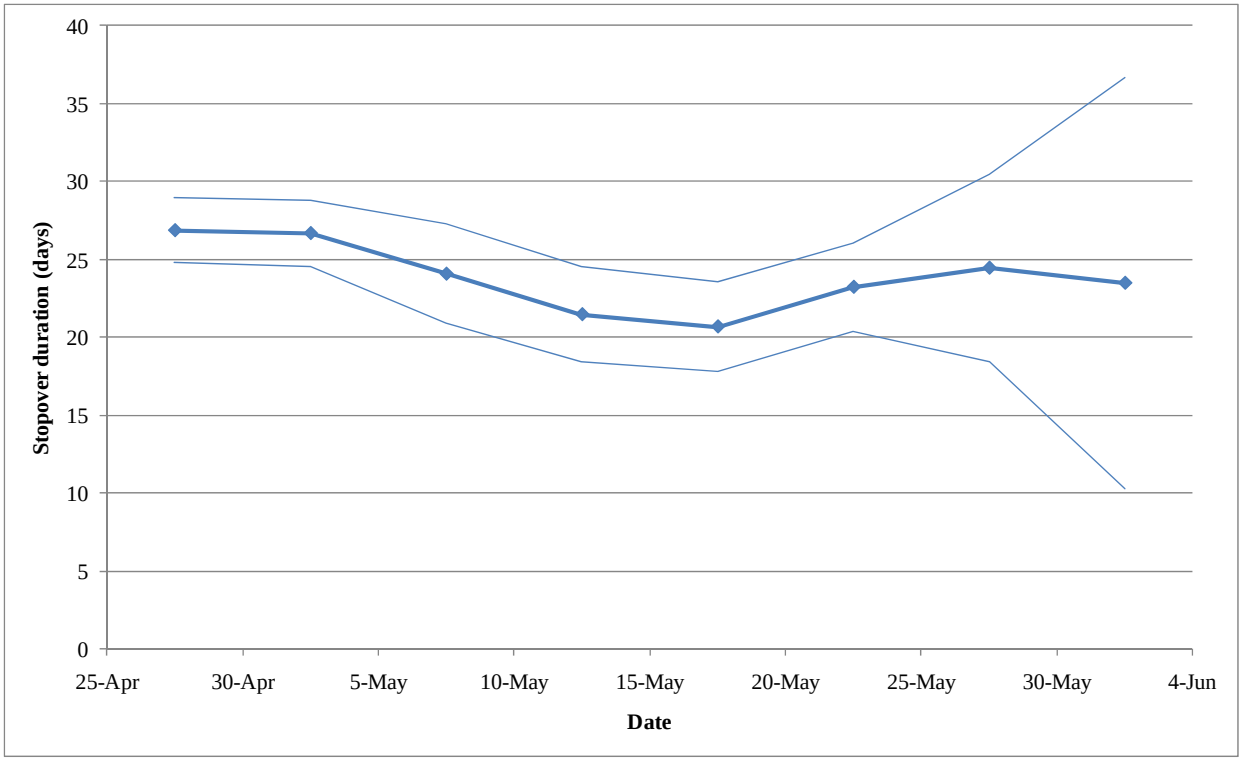

Figure 9. Duration that whimbrels stopover in Virginia during spring migration. Stopover duration is given for 5 day periods, beginning 25 April. Lighter lines denote upper and lower bounds for 95% CI.

From our first model, whimbrels stopover in Virginia for 20.7 to 26.9 days during spring migration. The duration of stopover does not vary greatly for whimbrels throughout the spring. Those that arrive early or late tend to stay slightly longer. Whimbrels that were present during the first week of spring migration stayed 27 days on average, while those present at the end of migration stayed 24 days. Thus, arrival occurred from 25 April through 11 May and departure occurred from 21 May through 4 June.

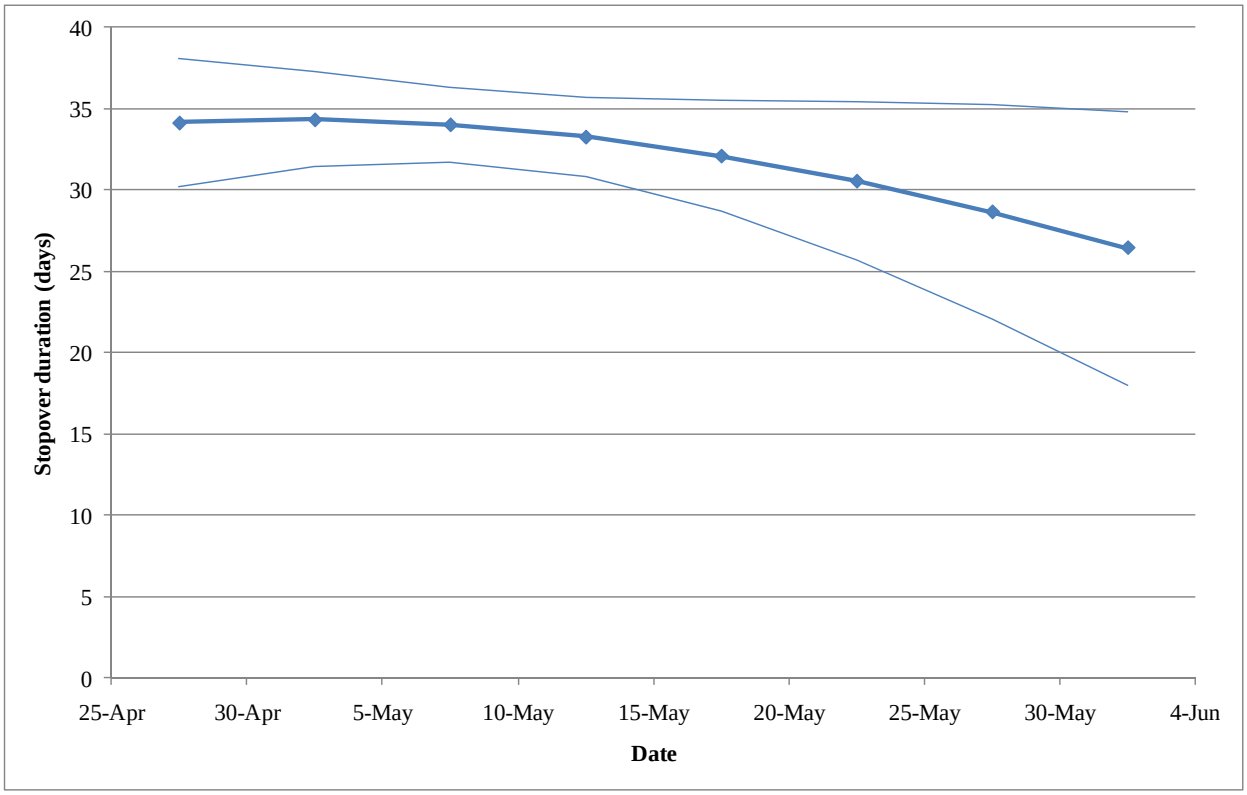

Figure 10. Based upon our more conservative second model, whimbrel stopover duration is from 26.4 to 34.4 days. Following this pattern, stopover duration declines as the season progresses. Whimbrels arrive from 25 April to 8 May and depart from 29 May to 4 June.

Fall stopover was calculated assuming constant arrival and departure rates and time-dependent resight probabilities (same as our more conservative second model used for spring). We did not use model selection to compare alternative models because sample size was only 10 whimbrels. Given this small sample size, data would be greatly overdispersed and any correction would select for the most conservative model (the model with the fewest parameters). These results should be interpreted with caution and used only as preliminary estimates of fall stopover dynamics (Figure 11).

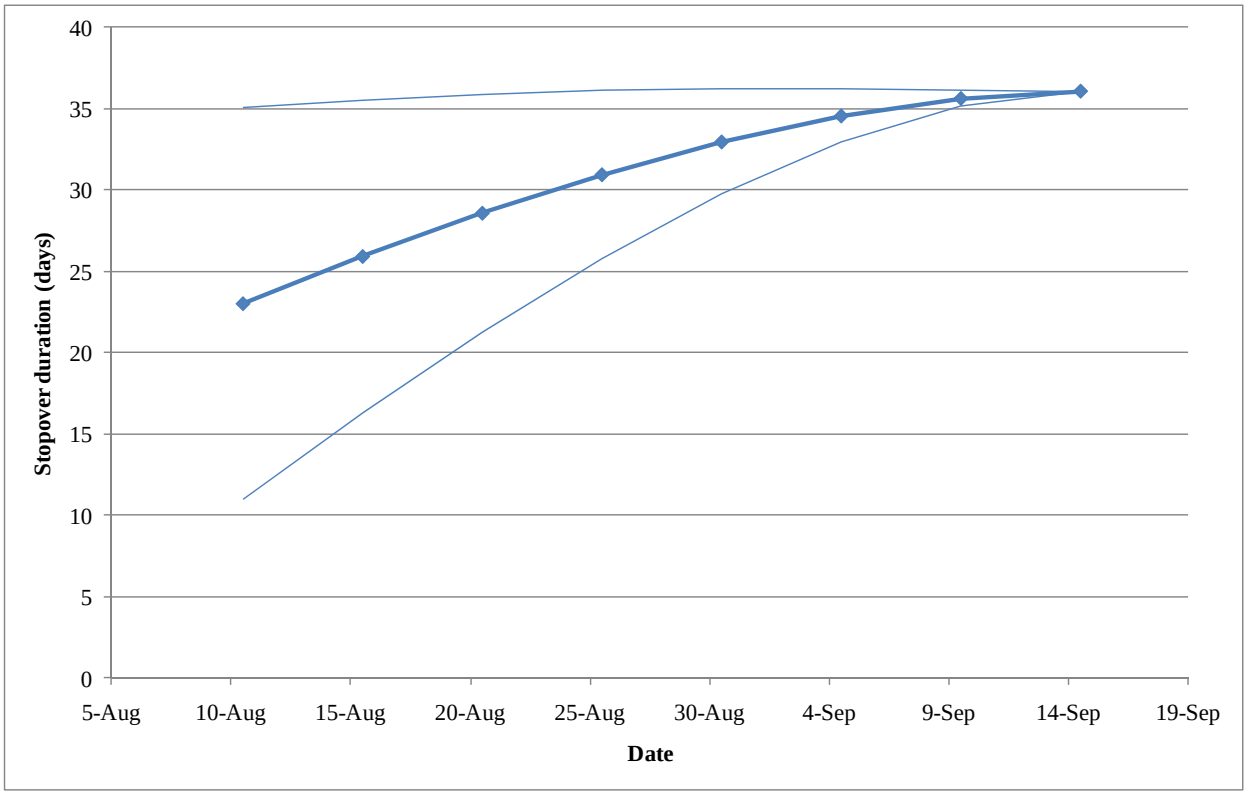

Figure 11. Fall stopover pattern suggests that whimbrels stay in Virginia from 23.0 to 36.0 days, with the duration of stay increasing throughout the fall season. Arrival in Virginia occurs over a short time frame, 8-11 August, with departure occurring from 31 August to 17 September.

DISCUSSION

The whimbrel is one of a group of shorebirds that breed in the Hudson Bay Lowlands in subarctic tundra and alpine habitat (Skeel and Mallory 1996). Most in this group of long-distance migrant shorebirds appear to be in decline (Bart et al. 2007, Morrison et al. 2006, Watts and Truitt in press), and the reasons for these declines are poorly understood. Hunting pressure, development of coastal wetlands and mangrove forests, human disturbance, and environmental contaminants remain a potential problem at migration and wintering sites (Ottema and Spaans 2008, Skeel and Mallory 1996, Vermeer and Castilla 1991, A. Levesque pers. obs.). Pressures on breeding grounds include impacts of climate change (Walther et al. 2002) and large scale changes in plant distribution that have shifted the breeding range (Ballantyne 2009).

The autumn migration season of 2011 provided new lines of investigation, including the response of migrating Whimbrels to large storm events. We had been tracking a Whimbrel known as Hope since May 2009. During her third fall migration we tracked her as she flew into the heart of a tropical storm off the coast of Nova Scotia. She averaged 14km/hr for 27 hours flying through the storm before finding tailwinds that pushed her to landfall at a rate of 147 km/hr. The next Whimbrel that encountered a storm event occurred when Chinquapin (tagged by our partners at Georgia Department

of Natural Resources) began his fall migration from Coates Island, Nunavut, Canada and made way over the Atlantic Ocean. He flew 5100km in 5 days before encountering category 3 Hurricane Irene and navigated safely through the storm to land in the Bahamas. In mid-September 2011, a third Whimbrel named Machi departed Virginia and flew straight into TS Maria. Machi was able to navigate the storm, much as Chinquapin did, and made landfall on Guadeloupe, French West Indies. Unfortunately she was shot by a hunter within minutes of arrival. The previous two fall migrations, Machi flew directly from Virginia to South America, bypassing the Lesser Antilles altogether and likely only stopped in Guadeloupe this year due to the interaction with Tropical Storm Maria. A fourth Whimbrel known as Goshen, who had flown through the outer bands of Hurricane Irene a week previous, landed in a hunting swamp on Guadeloupe the same morning as Machi. Goshen was shot within hours of arrival, suggesting very high hunting pressure on shorebirds in Guadeloupe. The data obtained from these two birds will likely help local conservation officials to begin investigating the role of hunting pressure on population declines and to protect at least some species (including Whimbrel) as they migrate through the gauntlet of storms and hunters. Hope left Virginia shortly after Machi and also encountered Tropical Storm Maria, but was able to fly through the storm and land in her annual wintering location on St. Croix, US Virgin Islands. We have now tracked her for over 64,000km in just over 2.5 years. The story of this wide ranging bird has been used to enable local conservation efforts to protect mangrove wetlands within St. Croix and is used to promote conservation through the USFWS Sister Schools Shorebird Program.

Satellite tracking data provides detailed habitat use of whimbrels during migration and on wintering grounds. This detailed information confirms the importance of critical staging areas during the life cycle of the whimbrel. Most whimbrels with satellite transmitters utilized Western Hemisphere Shorebird Reserve Network (WHSRN) Sites in for portions of their spring, fall, or winter life cycle. Satellite data, combined with detailed stopover data collected from radio tagged whimbrels, provides information on stop-over ecology and migration routes that are critical in the management of whimbrels and related long-distance migrant shorebirds. Preliminary data suggests that whimbrels stage in Virginia from 23.0 to 36.0 days, with the duration of stay increasing in later arriving birds. This is in contrast to spring migrants, where later arriving birds stay shorter periods of time than earlier arriving birds (CCB unpublished data). Arrival dates in Virginia of fall migrants are poorly modeled due to low sample size and late initial catch dates of whimbrels. A higher sample size of radio tagged migrants, distributed throughout the fall migration season, is needed to refine stop-over times of whimbrels in Virginia to better understand the importance of the location as a terminal staging area.

The whimbrel is a fiddler crab (*Uca sp.*) specialist in migration and on wintering grounds (Mallory 1981, Zwarts and Blomert 1990, Zwarts 1985). The indigestible matter of the carapace of the crabs creates a digestive bottleneck effect, where birds must pause from foraging to allow for digestion of the crabs (Zwartz and Blomert 1990, Zwartz and Dirksen 1990). The abundance of fiddler crabs on the Eastern Shore during both spring and fall migrations make this an extremely important stop-over site for whimbrels in both migration seasons. Individually marked whimbrels have been observed in both spring and fall migration seasons, suggesting site fidelity in both migration periods. One

whimbrel transmittered in spring migration flew non-stop from breeding grounds near Hudson Bay back to Box Tree Marsh, the initial place of capture (http://ccb-wm.org/programs/migration/Whimbrel/88039.pdf). Studies focusing on quantifying the density and distribution of fiddler crabs on the Eastern Shore and to quantify foraging rates of whimbrels at this staging area are planned for spring 2012 migration season.

Several transoceanic migration events were captured during the fall migration. Further investigation of migration routes with satellite transmitters will likely show patterns of staging “hot spots”, where congregations of whimbrels rest and fatten before continuing their journey to wintering grounds. These staging areas are important to survivorship of whimbrels in migration.

One of the most important aspects of whimbrel ecology documented is that an unknown proportion of birds utilizing the Eastern Shore of Virginia are of the western breeding population. Previously, all Atlantic Coast whimbrels were assumed to be of the eastern “Hudson Bay Lowlands” population (Andres et al. 2009, Skeel and Mallory 1996). Accurate population estimates of both eastern and western whimbrels are predicated on the idea that the two populations are segregated throughout their life cycle. It is critical that we be able to separate the two populations, whether by detailed study of DNA, finding origins through stable isotope analysis, or by morphometric differences. This will be a focus of research in the years ahead.

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