EFFECT OF GEOGRAPHY ON THE MIGRATION PHENOLOGY OF THE BLACKPOLL WARBLER IN COASTAL VIRGINIA

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Abstract

For migrant birds, the timing of spring staging events and ultimate arrival on the breeding grounds has an influence on breeding performance. Advancement toward the breeding grounds is thought to reflect resource availability and is typically measured as south to north progress in North America. In coastal areas local patterns may also reflect east to west variation in resource availability since the ocean has a moderating influence on climate. During the spring of 2000, we investigated east to west variation in migration phenology in the Blackpoll Warbler (Setophaga striata). We used nine 30-ha spot-mapping grids to measure migration phenology in the Coastal Plain of Virginia including three replicates within the outer, middle and inner Coastal Plains. Migration was nearly confined to the month of May with more than 90% of birds observed between 5 and 20 May. Collectively, migration peaked in mid-May with a study-wide average of 4.6 birds/10 ha. Migration phenology exhibited a significant shift from east to west with numbers peaking in the outer Coastal Plain on 7 May, the middle Coastal Plain on 14 May and inner Coastal Plain on 17 May. Blackpoll Warblers appear to be capable of responding to the steep climate gradient across the Coastal Plain and to take advantage of early warming. Birds that stage on the outer coastal plain may be able to gain a competitive advantage. By migrating earlier these birds may arrive earlier on the breeding grounds or may achieve breeding readiness at an earlier date.

Introduction

For many bird species, the timing of arrival on the breeding grounds has a direct influence on reproductive performance (Smith and Moore 2005). Individuals that arrive early are able to claim the highest quality breeding territories, attract mates more readily, and often produce more offspring (e.g., Cooper et al. 2011). For species that migrate over long distances, "decisions" made en route presumably reflect both the potential benefits of early arrival and the risks associated with premature migration. Individuals that migrate too late may suffer a competitive disadvantage upon arrival. Individuals that migrate too early may face inhospitable conditions along the way that may have an adverse impact on their physical readiness for breeding or even survival (Lerche-Jørgensen et al. 2008). For this reason, the timing of arrival at specific staging areas may be just as essential to successful migration as the timing of ultimate arrival on the breeding grounds (Schmaljohann et al. 2022). For many insectivorous birds, the northward advance of spring migration has been presumed to shadow the moving front of spring and associated emergence of insect prey (La Sorte et al. 2014).

The Blackpoll Warbler *(Setophaga striata)* is one of the most northerly breeding warblers in North America (Cooke 1904). Within many regions, this species is also one of the latest spring migrants. The latitudinal pattern of spring arrival dates was described for Blackpoll Warblers early in the 20th century (Cooke 1915). Migrants begin to appear in the southeastern U.S. in mid to late April. The migration front advances northward at a rate of approximately 50 km per day until reaching the northern U.S when the advancement accelerates rapidly. Lincoln (1950) correlated isochronal migration lines with isotherms and suggested that Blackpoll Warblers were tracking the advancement of spring.

Although latitude has a dominant influence on broad-scale temperature patterns, numerous other factors such as elevation or land cover may contribute to local thermal profiles. In Virginia, an east-west climate gradient occurs across the Coastal Plain due to the moderating influence of the Atlantic Ocean. On average, the outer Coastal Plain receives 3.8 cm more annual rainfall and experiences an annual temperature that is 1° C higher when compared to the inner Coastal Plain (https://www.ncei.noaa.gov/cdo-web). This relatively steep climate gradient occurs over a distance of only 50 km and translates into a detectable difference in the timing of leaf out (https://www.usanpn.org/). The extent to which spring migrants respond to this gradient has not been investigated. The purpose of this study is to examine the influence of geographic position within this coastal gradient on the migration phenology for the Blackpoll Warbler

Methods

During the spring of 2000, nine 30-ha spot-mapping grids were used to investigate the distribution and arrival time of Blackpoll Warblers during spring migration on the Coastal Plain of Virginia. Three replicate grids were chosen within the outer Coastal Plain (approximately 76.1 long. 36.8 lat.), the middle Coastal Plain (approximately 76.7 long. 37.3 lat.), and the inner Coastal Plain (approximately 77.4 long. 37.5 lat.). All grid sites were large residential areas that contained hardwood-dominated forests of middle age (40-80 year age class) and an extensive road system. Forest sites were chosen for study based on stand age and canopy composition. All sites contained hardwood-dominated overstories. Common canopy species included various oaks *(Quercus spp.)*, hickories *(Carya spp.)*, red maple *(Acer rubrum)*, American beech *(Fagus grandifolia)*, and tulip poplar *(Liriodendron tulipifera)*.

Spot-mapping grids were established between 1 and 9 April, 2000. Grids were rectangular, 30-ha plots measuring 385 m by 800 m. Censuses of grids were conducted between 17 April and 3 June, 2000. Each grid was surveyed twice within a 7-day time block. Sites within a geographic location were surveyed during the same day. The order of geographic regions within time blocks and individual sites within survey days was randomly assigned to reduce the impact of temporal biases. Surveys of individual sites took between 1 and 1.5 hrs to complete. Surveys commenced 0.5 hr after sunrise and were completed by 13:00. All sites were surveyed 14 times during the study period.

Spot-mapping grids were surveyed by walking slowly along roadways and plotting all Blackpoll Warblers detected, as accurately as possible, on a detailed grid map. A large majority of birds were detected by song. These birds were located with 7X35 power binoculars and plotted. This survey technique resulted in a heavy bias toward males.

Blackpoll Warbler density and migration phenology were compared using a one-way ANOVA with geographic location as the grouping variable. Peak bird density was standardized to birds/10 ha. Differences in phenology were examined using arrival and peak dates as dependent variables. Arrival date for each site was considered to be the date on which 10% of the birds had been detected for the season. This parameter was used instead of the date of first detection to reduce the influence of outliers.

Results

In coastal Virginia, Blackpoll Warbler migration was nearly confined to the month of May. The first migrant was observed on 29 April and the last on 31 May. More than 90% of all birds included were observed in the 15-d period between 5 and 20 May. Considering all study areas together, migration peaked around mid May with a study-wide average of 4.6 birds/10 ha. Peak densities did not differ between geographic areas (one-way ANOVA, $F_{2,123} = 2.25$, $p > 0.05$).

Migration phenology varied with location across the Coastal Plain (Figure 1). Birds using the outer Coastal Plain had an earlier migration compared to those using more inland areas. On average, Blackpoll numbers peaked on the outer Coastal Plain on 7 May, on the middle Coastal Plain on 14 May, and on the inner Coastal Plain on 17 May. This 10-day difference in the migration peak across the study area was statistically significant (one-way ANOVA, $F_{2,123}=$ 35.15, $p < 0.005$).

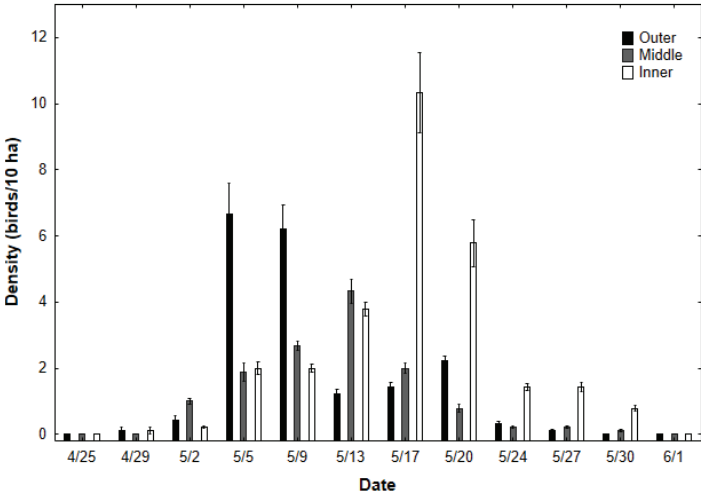

Figure 1. Patterns in migration phenology for Blackpoll Warblers on the Coastal Plain of Virginia. 'Outer', 'Middle', and 'Inner' refer to respective regions of the Coastal Plain. Dates presented indicate the beginning day of each 7-day survey block. Columns represent average (+1 SE) densities across three spatial replicates within each region.

As with the date of peak density, arrival dates varied with geography. Migrant Blackpoll Warblers were first detected on the outer Coastal Plain followed by the more inland regions. The average date on which 10% of the individuals had been detected for the season (termed "arrival date") was significantly different (one-way ANOVA, $F_{2,123} = 20.80$, $p < 0.05$) between geographic areas. However, the time difference across the Coastal Plain was much shorter for arrival times compared to peak dates. The average arrival date for the outer Coastal Plain was 5 May compared to 10 May for the inner Coastal Plain.

Discussion

Migrant Blackpoll Warblers that reach the mid-Atlantic region appear to pass through the outer Coastal Plain earlier than the inner Coastal Plain. This pattern in conjunction with the climate gradient across this region is consistent with the notion that birds are moving north in step with the emergence of insect prey. How Blackpoll Warblers are able

to track this resource on such a fine temporal and spatial scale remains unclear.

Previous discussions of Blackpoll Warbler migration through Southeastern North America have indicated a broad-front movement that is advancing northward at a rate of approximately 50 km per day (Cooke 1915). Although it is possible that birds are arriving broadly throughout the Coastal Plain and then differentially settling in specific geographic areas at different times, this seems unlikely. Birds not only arrived in geographic areas at different times they peaked and departed at different times. For the proposed northerly movement pattern to be consistent with the observed patterns in phenology, the leading edge of the migration front would have to tilt strongly north along the coast such that birds moving along the outer Coastal Plain arrive and pass through earlier.

The idea that both northwestern and northeastern breeding populations are entering the continent via a route through the extreme southeast implies that the populations are diverging in mid-continent and then advancing toward their respective breeding areas (Lincoln 1935). It is also possible that these two populations are arriving in North America using distinctly different routes. Blackpoll Warblers that make up the eastern breeding population may be making an over-water flight from the Caribbean directly to the mid-Atlantic. As has been shown in fall migration, Blackpoll Warblers are capable of long oceanic flights (Nisbet et al. 1995). In coastal Virginia, Blackpoll Warblers reached average peak densities approaching or exceeding 1 bird/ha. Bird densities fall off dramatically moving west beyond the Coastal Plain (Kain 1987). If Blackpoll Warblers are actually making landfall in coastal Virginia, the difference in phenology observed may represent an advancement front that is moving inland from the coast rather than northward from the southeast. Further work is needed to determine the specific route taken to reach this staging area. Such information would provide further insight into the role that the mid-Atlantic region plays in the lifecycle of this species.

Regardless of how Blackpoll Warblers arrive in coastal Virginia, birds appear to be able to respond to the steep climate gradient and to take advantage of the early coastal warming. Birds that stage on the outer Coastal Plain may be able to gain a competitive advantage. By migrating earlier these birds may arrive earlier on the breeding grounds or may achieve breeding readiness at an earlier date.

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