Productivity and body condition of cerulean warblers (*Setophaga cerulea*) in upland forests of Arkansas

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Abstract

The cerulean warbler (*Setophaga cerulea*) is a small forest-dwelling bird that utilizes very rich and old hardwood forests. In Arkansas, cerulean warblers occupy bottomland as well as upland hardwood forests. Because primary productivity of those forest types differs significantly, I hypothesized that cerulean warbler reproductive output and body condition might differ between the two habitats. The purpose of this research was to collect data on body condition of cerulean warblers in upland forests in Arkansas. Those data could be compared with similar data collected on cerulean warblers from bottomland hardwoods. That comparison is important because cerulean warbler populations have declined at a faster rate than any other warbler in North America and managers need guidance into which forest types are most valuable for the species so that they can focus management efforts accordingly.

Introduction

A precipitous decline in Cerulean Warbler (*Dendroica cerulea*) populations (Robbins et al., 1992; Hamel, 2000b; Link and Sauer, 2002; Sauer et al., 2008) has attracted attention to the species (e.g., Rosenberg et al., 2000; Wood et al., 2006; Buehler et al., 2008; Register and Islam, 2008). Habitat degradation and loss are probably driving the decline (Lynch, 1981; Hands et al., 1989; Hamel, 2000; Roth and Islam, 2008). For conservation purposes, managers need to know whether upland forests represent high quality habitat for cerulean warblers. Data on body condition could be used to indicate one aspect habitat quality of upland forest habitats for cerulean warblers. Initially, I intended to collaborate with Dr. Than Boves at Arkansas State University. He was to collect data on body condition of cerulean warblers in bottomland forests and I was to provide data on body condition in upland forests. We planned to compare body condition of cerulean warblers from the two forest types. Unfortunately, another commitment

drew Dr. Boves away from this project in 2013. Consequently, I focused on population status and body condition of cerulean warblers in upland forests of Arkansas.

Methods

Field work was conducted from Mid-May to the beginning of June in 2014 and 2015. In the past, I was able to capture cerulean warblers until the end of June. However, in 2014, cerulean warblers became very difficult to capture at the beginning of June. The populations also have declined substantially which also reduced my capture rate. To capture cerulean warblers two student field assistants and I used a mist net (the net has a very fine mesh that is invisible when placed in a shady location) that was raised about 6 m into the forest (Fig. 1). We also, placed a model of a cerulean warbler in a small tree near the mist net and placed a speaker by the model so that we could broadcast the song of a cerulean warbler (Fig 2). Cerulean warblers are territorial and respond aggressively to the song and the model. Sometimes they land on top of the model and peck at it. As they fly around the model they usually fly into the net. However, the placement of the net is critical in capturing cerulean warblers because they sing from the very tallest of trees and are somewhat hesitant to come to the lower forest strata in response to an intruder. If the net is placed in a very open situation cerulean warblers often do not respond to the model or song playback.

Nests of cerulean warblers are difficult to study due to their placement in the forest canopy. Between 1998 and 2006 my field assistants and I located three nests during extensive field work; those nests were placed high in the forest canopy and were inaccessible. Consequently, to assess reproductive productivity I followed Rogers (2006) example, and used an indirect measure of productivity; the ratio of the number of yearlings to older birds. That ratio is a reasonable assessment of reproduction since yearlings tend to return to their site of birth (Girvan et al., 2007). I used plumage characteristics listed by Pyle (1997) to classify birds as

either second-year (based on calendar year since hatching) or after second-year age classes (Fig. 3a,b).

I also determined body condition of all birds that were captured. Body condition was assessed based methods used by Boves et al. (2013). Those variables were visually assessed and estimated as part of the handling procedures that I used on each bird. Pectoral muscle and fat mass were classified as excellent, very good, good, fair, or poor depending on the fullness of the pectoral muscle and the depth of fat deposited in the cavity at the base of the neck (Bakermans 2008).

Results

I captured 13 birds in 2014 and 12 birds in 2015. I had expected to capture many more birds; however the populations in the Ozark National Forest have declined substantially since 2006. For example, in the cluster of sites occupied by cerulean warblers along Highway 7 north of Russellville, I found 36 birds in 2006 and only 9 birds in 2014. The site I visited in western Arkansas had a less dramatic shift and declined from approximately 28 in 2006 to 19 in 2014.

Six of the 25 birds (24%) captured were second year birds. Given that the average clutch size is 4 eggs, there were potentially 114 cerulean warbler chicks produced in 2014 among the sites we sampled; thus, the ratio could have been much higher. In fact, a ratio of 0.24 second-year birds to after-second-year birds indicates that reproduction is probably not sufficient to maintain the populations in upland forests of Arkansas. The low productivity is consistent with the population decline that has occurred since 2006.

Body condition of the birds was quite good. Only one bird in the sample had a pectoral muscle mass less than good and one third (31%) had an excellent pectoral muscle mass. None of the birds had more than a trace amount of fat which is not unusual during the breeding season. I

also evaluated the ratio of mass per wing length as a control for body size. The results were surprising. The mass/wing ratios did not vary much among individuals (mean=0.144, standard deviation =0.005) and were nearly identical for all the pectoral muscle classes (Table 1). Statistically they were indistinguishable among pectoral muscle classes ($F_{3,17}$=1.08, P=0.38). In fact all of the morphological measurements were very similar (Table 1).

Discussion

Productivity as indicated by the ratio of second-year to after-second-year birds was low. Rogers (2006) observed approximately 0.6 fledglings per pair which is over twice as many as I observed. However, his observations were made within a breeding seasons. Thus, his birds did not have to migrate to South America, survive the non-breeding season and then migrate back to the breeding sites. Had I assessed reproduction at the end of the breeding season, my ratio of adults to juveniles would have been much higher than 0.24). In any case, a ratio of 0.24 second year birds to adults indicates that reproduction and first-year survival rates are not sufficient to maintain a stable population in upland forests of Arkansas.

Condition of the birds I captured was good. I am not aware of other published studies that assess condition of cerulean warblers. Johnson et al. (1985) suggested that lipid extraction was the most robust way to assess condition for birds in general. However, they found that using mass when scaled to morphological measurements was a good alternative of assessing condition. My results indicate that visually scaling of condition by examining the pectoral muscle mass gave very different results from the scaled condition index of weight divided by wing length. Further, weight divided by wing length was very similar among individuals. Indicating that all of the birds in upland forests were similar in condition.

Overall, my results indicate that food resources are sufficient for cerulean warblers to maintain a relatively constant good body condition among individuals. However, the ratio of second-year birds to after second-year birds indicates that reproduction is not sufficient to maintain stable populations in upland forests. The cause of reproductive failure is most likely predation on eggs and nestlings (Martin 1988). Because cerulean warblers nest in the tree canopy potential predators would include birds (ex. blue-jays (*Cyanocita cristata*), American crows (*Corvus brachyrhyncos*), and several species of hawks) and snakes (ex. black rat snakes *Pantherophis obsoletus*). The future does not look good for cerulean warblers in Arkansas. In addition to poor reproductive output, models of climate change indicate that the species will very likely become extirpated in Arkansas within 30 to 50 years (National Audubon Society 2014).

Figure 1. Male cerulean warbler being removed from mist net.

Figure 2. Model of a cerulean warbler placed near a mist-net.

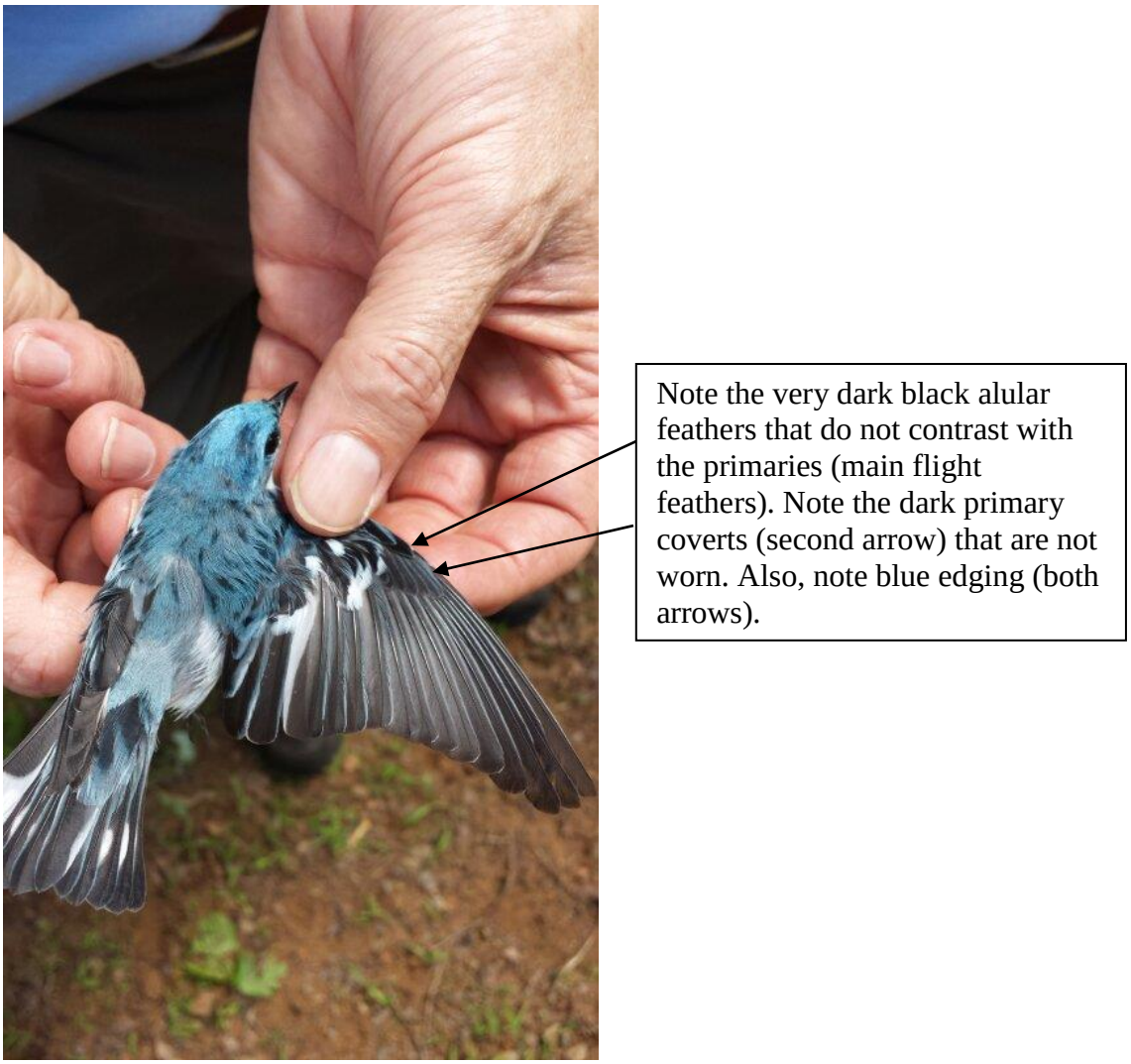

Figure 3a. Wing of an after-second year male.

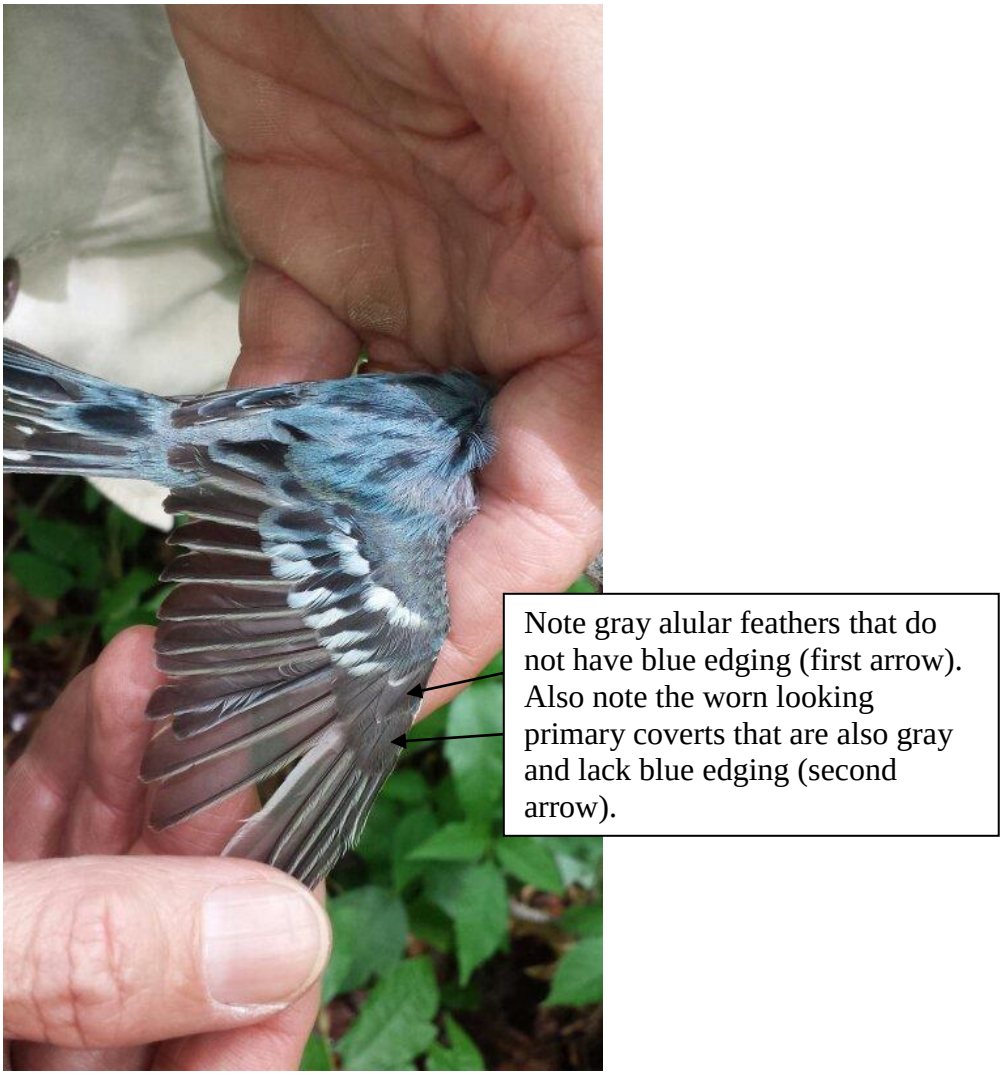

Figure 3b. Wing of a second-year male.

Table 1. Means of mass divided by wing length for each pectoral muscle class. SD=Standard Deviation of Mass/wing

Muscle class	Mass	Wing	Mass/Wing	SD
Excellent	9.33	65.2	0.143	0.004
Very Good	9.34	63.5	0.147	0.003
Good	9.39	65.5	0.143	0.001
Fair	9.20	62.5	0.147	0.000

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