ORNITOLOGIA NEOTROPICAL 23: 281–284, 2012

BREEDING SEASON CONCERNS AND RESPONSE TO FOREST MANAGEMENT: CAN FOREST MANAGEMENT PRODUCE MORE BREEDING BIRDS?

J. L. Larkin[1], P. B. Wood[2], T. J. Boves[3], J. Sheehan[2], D. A. Buehler[3], P. D. Keyser[3], A. D. Rodewald[4], T. A. Beachy[3], M. H. Bakermans[4], A. Evans[1], G. A. George[2], M. E. McDermott[2], F. L. Newell[4], K. A. Perkins[2], M. White[1], & T. B. Wigley[5]

[1] Department of Biology, Indiana University of Pennsylvania, Indiana, Pennsylvania; *E-mail:* larkin@iup.edu.
[2] US Geological Survey West Virginia Cooperative Fish and Wildlife Research Unit, West Virginia University, Morgantown, West Virginia.
[3] Department of Forestry, Wildlife, and Fisheries, University of Tennessee, Knoxville, Tennessee.
[4] School of Natural Resources, Ohio State University, Columbus, Ohio.
[5] National Council of Air and Stream Improvement, Inc., Clemson University, Clemson, South Carolina.

Key words: Cerulean Warbler, breeding habitat, timber harvest, nest success, territory density, body condition.

The Cerulean Warbler (*Setophaga cerulea*) is a neotropical migratory songbird that has gained widespread attention as a species of conservation and management concern. The species has experienced range-wide declines over the last 40 years (Sauer *et al.* 2008), especially in historically high-density areas of the Appalachian Mountains (Hamel 2000). In eastern North America, breeding habitat for Cerulean Warblers is characterized by heterogeneous canopies in mature hardwood forests, which occur naturally in the Appalachians due to topography and large-scale disturbances including fire, wind events, ice storms, and insect outbreaks. Though natural tree senescence once played an important role in creating heterogeneous canopies (Lorimer 1980), particularly in old-growth forests, the age of most second- and third-growth forests in Eastern North American is not sufficient for natural tree mortality to maintain structurally diverse canopies (Lorimer and Frelich 1994). Forest management also may be used to create forest conditions favored by Cerulean Warblers and other disturbance-adapted species (e.g. Wood *et al.* 2005, Bakermans and Rodewald 2009). However, prior to extensive use of silviculture to enhance habitat for such species, detailed habitat selection and demographic studies are needed to ensure that such actions do not have unintended negative consequences.

Here in, we present the results and their implications from a 6-year Cerulean Warbler breeding grounds study conducted by members of the Cerulean Warbler Technical Group as part of the Cerulean Warbler Conservation Initiative (Dawson *et al.* 2012). Specifically, we investigated the extent to which silvicultural techniques differing in canopy removal might serve as tools to manage habitat for Cerulean Warblers in the central Appalachian Mountains, USA. We selected 7 study areas within the core Cerulean Warbler breeding range of the central hardwoods' mixed-mesophytic forest region (Fig. 1). Study areas were located in West Virginia (n = 3), Tennessee (n = 2), Ohio (n = 1), and Kentucky (n = 1), each within a matrix of mature hardwood forest. We selected study areas based on the presence of Cerulean Warbler breeding populations and the potential to implement silvicultural prescriptions via partial timber harvest. We randomly assigned 4 silvicultural treatments to 4 20-ha plots at each study area: light, intermediate, and heavy canopy disturbance, as well as an unharvested reference plot. Each treatment included a 10-ha harvested area (except on reference plots), and two 5-ha buffers of undisturbed forest on either end of the harvest to examine edge effects. Light harvest mimicked forests disrupted by multiple tree-fall gaps; we reduced basal area (BA) and overstory canopy cover (CC) on these treatments by approximately 20% (residual BA

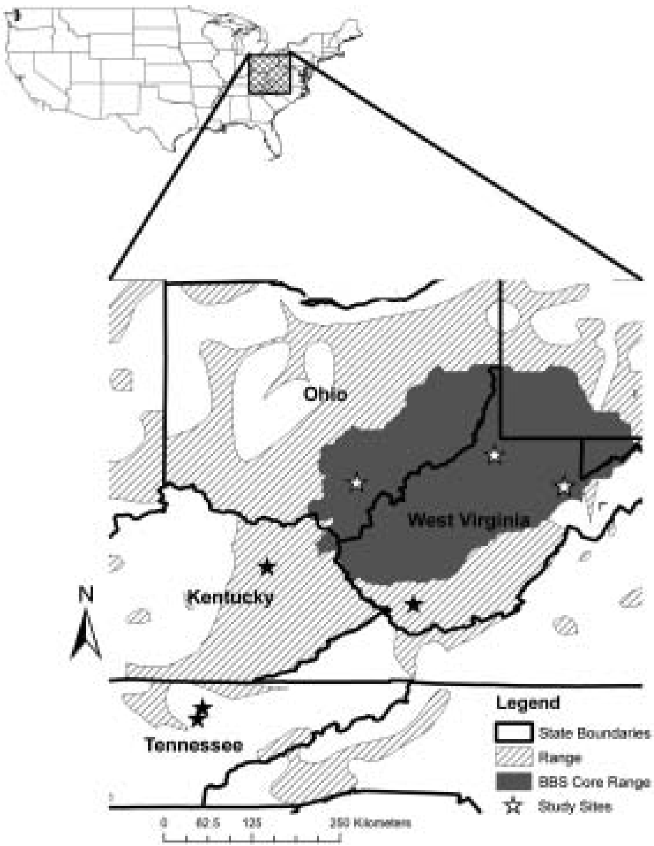

FIG. 1. Locations of seven Cerulean Warbler Forest Management study sites in the Appalachian Mountains. All sites were located within the core of the Cerulean Warbler breeding range. Map symbols indicate estimated range of the species, as "Range" the estimated breeding range of the birds based upon Dunn and Garrett (1997, Hamel 2000), and as "BBS Core Range" based on the analyses of Breeding Bird Survey data conducted by Baldy (2005).

= 21.3 ± 1.0 [SE] m^2/ha; residual CC = 60.9 ± 5.5%). Intermediate harvests mimicked more severe natural disturbances such as fire, wind events, or larger tree fall gaps; here we reduced BA and CC by approximately 40% (residual BA = 14.3 ± 1.2 m^2/ha; residual CC = 45.5 ± 6.4%). Heavy harvests emulated severe natural disturbances such as strong wind events, severe ice-storms, landslides, or more intense fire; we reduced BA and CC by approximately 75% (residual BA = 6.3 ± 1.1 m^2/ha; residual CC = 18.2 ± 4.3%). We left control plots undisturbed throughout the life of the study (BA = 26.9 ± 1.3 m^2/ha; CC = 73.2 ± 5.2%). On all treatments, disturbances were applied uniformly across the 10-ha stand. Overstory species composition was largely unchanged by the disturbances and residual stands on the intermediate and heavy treatments were comprised of dominant and co-dominant trees. We compared Cerulean Warbler territory density two years pre-harvest (2005, 2006) and four years post-harvest (2007–2010). Additionally, we compared nest survival and male age structure and condition (using body mass and wing-mass residuals) of captured males four years post-harvest.

Although mean densities of Cerulean Warblers remained stable on unharvested reference plots across all study areas (Boves 2011, Boves *et al.* in prep.), numbers on reference plots were consistently lower than on experimental harvest plots following treatment. During the first year post-harvest, Cerulean Warbler density on the intermediate harvest increased significantly and by a greater amount than on the other harvest treatments or on the reference plots. In year 2 post-harvest, density on the intermediate harvest remained higher than on other harvest treatments and reference plots, and density on the light harvest was higher than on the heavy harvest and reference plots. By year 3 post-harvest, all 3 harvest treatments had increased significantly compared to the reference plots. In year 4 post-harvest, densities on intermediate and heavy treatments remained higher than on the reference plots. Density declined on the light harvest treatment and was no longer different than that on the reference plots. Territorial male age structure did not differ among treatments, but male body condition was better in harvested treatments compared to unharvested plots (Boves 2011).

Nest survival of Cerulean Warbler was a function of site, year, and silvicultural treatment (Boves 2011, Boves *et al.* in prep.). After accounting for regional and annual differences in nest survival, Cerulean Warblers in the unharvested controls had greater nest survival and more fledglings per successful nest than those in harvested treatments. Because nest survival was greater on southern (Tennessee) than northern sites, we treated the two regions separately in analyses related to treatment effects. In southern sites, nest success was higher on the unharvested reference plots than on light (χ^2 = 15.02, $P < 0.0001$), intermediate (χ^2_1 = 4.41, $P = 0.04$), or heavy treatment plots (χ^2_1 = 15.02, $P < 0.0001$). In northern sites, nest success on the unharvested reference plots was marginally higher than on the light harvest plots (χ^2_1 = 3.50, $P = 0.06$) or in the buffers (χ^2_1 = 3.12, $P = 0.08$), but similar to the intermediate harvest plots.

Although patterns of density and body condition suggested that Cerulean Warblers are attracted to harvest-generated disturbances in mature forest ecosystems of the Appalachian Mountains, the lower nest success in harvested plots raises the possibility that recent harvests may function in some cases as ecological traps. Additional research is needed to better examine fitness consequences of timber harvests and to estimate population-level implications. In particular, does the greater number of nesting individuals, particularly in intermediate harvests, compensate for lower nesting success? For example, we detected an average of 10.5 territories/10ha on intermediate harvests (10.5 territories x 0.34 nest success × 2.6 average young fledged per successful nest = 9.3 young/10ha) compared to 4.25 territories/10ha on unharvested plots (4.25 territories × 0.42 success x 2.25 average young fledged per successful nest = 4.0 young/10ha) across all northern sites. In this example, the greater number of young produced and better adult condition (assuming adult condition contributes to higher annual survival) on intermediate harvests may substantially outweigh higher nesting success observed on the unharvested reference plots. Ultimately, we recommend management decisions be based on local conditions, particularly in forests where Cerulean Warbler populations are high.

ACKNOWLEDGMENTS

Funding for this project was provided by the National Fish and Wildlife Foundation through a grant with the National Council for Air & Stream Improvement, Inc., U.S. Fish and Wildlife Service, U.S. Forest Service, MeadWestvaco Corporation, Kentucky Department of Fish and Wildlife Resources, Ohio Division of Wildlife, School of Environment & Natural Resources at Ohio State University, Tennessee Wildlife Resources Agency, Department of Forestry, Wildlife and Fisheries at the University of Tennessee, The Nature Conservancy through a U.S. Fish and Wildlife Service HCP planning grant with the Tennessee Wildlife Resources Agency, West Virginia Division of Natural Resources Wildlife Diversity Program, USGS West Virginia Cooperative Fish and Wildlife Research Unit, Department of Biology at Indiana University of Pennsylvania. This research was conducted on U.S. Forest Service's Daniel Boone National Forest and Monongahela National Forest, on public lands owned by the Tennessee Wildlife Resources Agency and the West Virginia Division of Natural Resources, and on private lands owned by Forest Land Group/Wagner Forest Management and MeadWestvaco. We appreciate the cooperation and assistance of these agencies/groups and the efforts of their forest management personnel for assistance with study site selection, design of harvesting treatments, and especially implementation of harvests. Finally, we are most grateful for the dedicated service of over 80 field technicians. Their contribution to our improved understanding of Cerulean Warbler breeding ecology cannot be overstated.

REFERENCES

Bakermans, M. H., & A. D. Rodewald. 2009. Think globally, manage locally: The importance of steady-state forest features for a declining songbird. Forest Ecol. Manag. 258: 224–232.

Baldy, J. 2005. Climate preferences of the Cerulean Warbler on summer territory. M.Sc. thesis, Univ. of Memphis, Memphis, Tennessee, USA.

Boves, T. J. 2011. Multiple responses by Cerulean Warblers to experimental forest disturbance in the Appalachian Mountains. Ph.D. diss., Univ. of Tennessee, Knoxville, Tennessee, USA.

Dawson, D. K., T. B. Wigley, & P. D. Keyser. 2012. Cerulean Warbler Technical Group: Coordinating international research and conservation. Ornitol. Neotrop. 23(Suppl.): xxx–xxx.

Dunn, J. & K. L. Garrett. 1997. A field guide to warblers of North America. Houghton Mifflin Co., Boston, Massachusetts, USA.

Hamel, P. B. 2000. Cerulean Warbler (*Dendroica cerulea*). *In* Poole, A., & F. Gill (eds). The Birds of North America, No. 511. The birds of North America, Inc., Philadelphia, Pennsylvania, USA.

Lorimer, C. G. 1980. Age structure and disturbance history of a southern Appalachian virgin forest. Ecology 61: 1169–1184.

Lorimer, C. G., & L. E. Frelich. 1994. Natural disturbance regimes in old-growth northern hardwoods - implications for restoration efforts. J. For. 92: 33–38.

Sauer, J. R., J. E. Hines, & J. Fallon. 2008. The North American Breeding Bird Survey, results and analysis 1966–1999. Version 5.15.2008, USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA.

Wood, P. B., J. P. Duguay, & J. V. Nichols. 2005. Cerulean warbler use of regenerated clearcut and two-age harvests. Wildl. Soc. Bull. 33: 851–858.