WILDLIFE RESPONSE TO OAK ECOSYSTEM RESTORATION

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Extended abstract—The eastern oak (*Quercus*) forest ecosystem once included extensive open-canopy and early successional communities (i.e., woodlands and savannahs) that had been maintained by frequent natural and anthropogenic fires (Burhans and others 2016). However, beginning in the early 20th century and continuing until the present, fire regimes have been dramatically altered resulting in the almost complete elimination of such communities and substantial degradation of remnants. Consequently, associated wildlife populations have also experienced pronounced declines.

Within a long-term, field experiment conducted at three sites (Catoosa Wildlife Management Area and Land Between the Lakes National Recreation Area, both in TN, and Green River Game Lands in NC), we explored responses of breeding birds and forest bats to community restoration treatments, including canopy reduction to woodland (60 square feet per acre residual BA) and savannah (30 square feet per acre residual BA) targets and prescribed fire (March and October). Treatments were assigned under a randomized block design with a total of five replicates across all three locations. We documented breeding bird responses using point counts visited three times annually, 2010–2016, and nest searching and monitoring for two focal species, red-headed woodpecker (RHWO; *Melanerpes erythrocephalus*) and prairie warbler (PRAW; *Setophaga discolor*), 2015–2016. Forest bat activity was monitored through passive acoustic arrays that detected echolocation calls of feeding bats, 2013–2014. We estimated occupancy (multiple season, robust design in Program MARK) and abundance (N-mixture model in Program Unmarked); nest success was estimated using Program MARK. We used repeated measures (sample period and year), mixed-model regressions to compare bat activity and availability of insect prey among treatments.

Occupancy of breeding birds was strongly influenced by key measures of structure (Vander Yacht and others 2016). Seven of the 10 early-successional avian species we evaluated responded positively to decreased live basal area (LBA), while three species showed no significant trend. Among ten late-successional avian species examined, two (hooded warbler [HOWA; *Setophaga citrina*] and ovenbird [OVEN; *Seiurus aurocapilla*]) showed a negative trend in response to decreased LBA, one a positive quadratic relationship, and seven no relationship. A similar pattern was observed with respect to percent herbaceous groundcover with six early successional species showing a positive relationship with herbaceous ground cover and four species having no trend; among late successional species, the same two species (HOWA and OVEN) had negative relationships, while eight species demonstrated no trend in relation to herbaceous ground cover. Associations with midstory density were weaker and less consistent, perhaps due to the ubiquitous woody cover (primarily red maple [*Acer rubrum*]) in this strata during the restoration process.

Avian abundance was also influenced by LBA and herbaceous ground cover, but unlike occupancy, midstory density was positively related to abundance for five early successional species with a less pronounced and variable influence on late successional species (Henderson 2017). For all early successional species with a relationship between abundance and LBA (n = 5), that relationship was positive. Furthermore, six late

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successional species were sensitive to reduced LBA, but in every case, abundances increased with some level of disturbance with peak abundances occurring between 45 and 75 square feet per acre. This pattern indicated some level of disturbance-dependence for these late successional species. For herbaceous ground cover, we found fewer species' abundance being influenced, but the thresholds (approximately 20-percent cover) were very similar to that observed with occupancy. As expected, the relationships for abundance were less pronounced and more gradual than occupancy in all cases.

Late successional species sensitive to disturbances associated with restoration treatments, OVEN and HOWA, are species that nest or forage in leaf litter. Early successional species were almost completely absent from controls leading to reduced species richness in these stands. Indeed, a composite index based on Partners In Flight conservation assessment scores indicated that the greatest cumulative conservation benefit for breeding birds occurred at lower LBA and greater levels of herbaceous ground cover.

Nests for both PRAW and RHWO were absent from our undisturbed control stands (Henderson 2017). Prairie warblers selected nest sites (n = 105) with greater herbaceous groundcover, although this did not influence nest survival. Our estimate of nest survival over both years was 20.7 percent but showed a strong year effect, being quite low (6.8 percent) in the breeding season immediately after burning but comparable to other studies one year post-fire (32.5 percent). Given the pattern we observed for abundance over time (a strong biennial cycle with lows linked to burning years and highs occurring one year post-burning) with this species, we believe that the reduced vegetation cover in burn years is a plausible explanation for the reduced nest success the year of the burn. Red-headed woodpeckers selected for pine snags for nest cavities (n = 47) and had very high nest survival rates, among the highest reported (84.1 percent). Furthermore, we did not find any support for any habitat covariates or for a year effect in our survival models. Collectively, our results suggest that habitat in our study area may have been near optimal for this species.

Forest bat activity for all taxa was greater in disturbed sites, especially stands reduced to savannah target basal areas, than in controls (Cox and others 2016). Activity was also greater for larger bodied species with lower call frequencies that are adapted to fly and forage in open conditions. Myotis species (4.74 percent of all classified detections) did not differ among our treatments. We found no evidence insect prey abundance or biomass influenced activity of bats, suggesting stand structure was more important than prey availability in determining habitat use by bats in woodlands and savannahs.

Woodland and savannah restoration treatments involving canopy reduction and re-introduction of prescribed fire benefited early successional wildlife in oak forest ecosystems and did not appear to negatively impact most species associated with later seral stages. Indeed, with the exception of two species (OVEN and HOWA), we did not observe consistent or substantial detriment to any wildlife taxon. On the other hand, many species of high conservation priority responded positively to the treatments we examined. Furthermore, woodlands and savannahs restore a long missing community to eastern oak ecosystems, one with substantial biodiversity and conservation value.

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