APPLICATION OF MIDSTORY REMOVAL TO ENHANCE OAK REGENERATION POTENTIAL WITHIN UNIFORM AND IRREGULAR SHELTERWOOD SYSTEMS

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Extended abstract—Shelterwoods are recommended in the Central Hardwood Forest Region (CHFR) due to the intermediate shade tolerance and advance reproduction dependence of the region's primary oak (*Quercus*) species. Due to the widespread development of subordinate canopies dominated by shade-tolerant species, midstory removal is a typical component of oak shelterwood systems within the CHFR. This work presents the effect of midstory removal on light availability and seedling development when applied following uniform and expanding-gap shelterwoods. Leveraged studies were completed on the Berea College Forest (Madison County, KY) and occurred on intermediate quality sites (upland oak site index ranged from 22 to 24 m) associated with the western edge of the Northern Cumberland Plateau ecological section.

The first study documented the effect of midstory removal on the survival and growth of natural advance reproduction and underplanted white oak (*Quercus alba* L.), northern red oak (*Quercus rubra* L.), and black oak (*Quercus velutina* Lam.) (Craig and others 2014). The response of the predominant shade-tolerant competitor, red maple (*Acer rubrum* L.), was also evaluated. After six growing seasons, relative height and groundline diameter (GLD) growth of all oak species were significantly greater in the midstory removal treatment than in the control but did not differ between reproduction types. Survival of oak advance reproduction was high (>96 percent) and was not affected by midstory removal. However, underplanted oaks had significantly lower survival (47–70 percent) than the oak advance reproduction. While midstory removal significantly increased six-year relative height growth of red maple, the treatment did not affect red maple's relative GLD growth or percent survival. Six-year total height of red maple was similar to all but one of the oak reproduction types evaluated; only natural white oak reproduction was significantly shorter than red maple in the midstory removal treatment. In addition to quantifying seedling responses, we found that the midstory removal treatment altered canopy structure by maintaining a greater height to the forest canopy and a lower canopy closure than the control six years after treatment. Understory light data collected in the seventh growing season showed that average light transmittance in the control and midstory removal treatments were 2.9 percent and 18.5 percent of full sunlight, respectively. While the mean light transmittance value was more than five times greater following midstory removal, no significant difference was present between treatments (*P-value* = 0.055).

The second study examined an expanding-gap shelterwood with and without midstory removal as a preparatory cutting around the silvicultural gaps (Patterson 2017). The study incorporated 12 experimental units established in the spring of 2012 and consisting of a 60-m diameter gap plus a 30-m perimeter zone; forming a 120-m diameter "gap array." The experimental units were randomly assigned two treatments: gap harvest with complete midstory removal in the perimeter zone around a gap, and gap harvest with undisturbed control around the perimeter of the gap. Six transects were laid out like spokes on a wheel within each gap array for the purpose of recording light transmittance and seedling development along the spatial extent that extended from the gap edge to the outer margin of the gap array. Light transmittance was measured during summer 2013 within two hours of solar noon on cloudless days. GLD measurements of the underplanted white oak seedlings were recorded initially in spring 2013 and were remeasured after two growing seasons. Light transmittance and underplanted seedling data collected within the 30-m wide zone around the perimeter of each gap were aggregated into five, 6-m distance from gap edge categories for analysis. Effects of the two experimental factors, midstory removal treatment and distance from gap edge, on light transmittance and seedling GLD growth was tested using an ANOVA model. Second year results from this gap-based study indicated that midstory removal treatment and the distance relative to gap edge affected understory light availability and GLD growth of underplanted oak. Light transmittance was significantly higher (*P-value* = 0.005) in the midstory removal treatment (15.4 percent) than

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in the control (10.5 percent). Light transmittance directly adjacent to the gap (i.e., 0- to 6-m distance category) was nearly twice as high (25.6 percent) as transmittance in the other four distance categories (6.3 percent to 13.7 percent) occurring further away from the gap edge. Two-year GLD growth by underplanted white oak was significantly higher ($p = 0.012$) in the midstory removal treatment (1.0 mm) than in the control (0.8 mm). Mean GLD growth was significantly greater within the 0- to 6-m distance category (1.2 mm) than it was in distance categories occurring more than 12 m from the gap edge.

Together these studies support midstory removal as a silvicultural approach for oak whether the shelterwood is applied uniformly across a stand or implemented using principles of gap-based silviculture to increase structural complexity and microclimate heterogeneity. Midstory removal enhanced light availability primarily by increasing canopy heights and improved growth of natural and underplanted oaks, though the practice was also shown to increase height growth of shade-tolerant competitors. Data suggest that light availability may be greater following midstory removal in the gap-edge environment than following the treatment in a uniform shelterwood. While midstory removal enhanced light and seedling growth beyond gap margins, it did not appear to increase the spatial extent of a gap's influence on edge environment.

LITERATURE CITED

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