

TWO-YEAR SURVIVAL AND GROWTH OF ARTIFICIAL NORTHERN RED OAK REGENERATION AT GETTYSBURG NATIONAL MILITARY PARK

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Abstract: Overstory competition and foraging by white-tailed deer (*Odocoileus virginianus*) and small mammals are cited as reasons for regeneration failure in mixed-oak stands of Pennsylvania. At Gettysburg National Military Park, deer densities are high (>0.6 deer/ha), and the mixed-oak woodlots were lacking in seedling- and sapling-sized natural oak regeneration. To promote restoration of the woodlots to Civil War condition, we examined the effects of canopy conditions and browsing by deer and small mammals on the survival and growth of planted northern red oak (*Quercus rubra* L.) acorns, seedlings, and saplings. In 1992, three study woodlots were selected as representative of the range of conditions in the Park, including high deer densities. Within each woodlot, three 0.20 ha circular canopy treatments were assigned. Each treatment was replicated three times within each woodlot. Treatments were closed canopy and partial and complete openings in the canopy. Within each canopy treatment unit, two paired fenced and unfenced plots were established, for a total of 18 pairs per woodlot. At each pair of plots, 40 acorns, 8 bare-root seedlings (about 0.3 m in height) and 6 bare-root saplings (>1.0 m in height) were planted. Survival and height were measured at the end of the second growing season after overstory treatment. About 55% of the 2,160 planted acorns had germinated, and 86% of the 1,196 germinates were alive 2 years after planting. Of the surviving direct-seeded seedlings: 813 were not browsed by deer or clipped by small mammals, 93 were browsed, 105 were clipped, and 13 were browsed and clipped. Woodlot and canopy level were significant predictors of direct-seeded seedling survival, with lowest survival (74%) in closed canopy compared to 86 and 88% for partial and complete openings. Significant predictors of direct-seeded seedling height (mean of 20 cm) were woodlot, canopy level, and fencing. Height significantly increased with increasing amounts of direct sunlight (11, 16, and 30 cm for closed canopy, partial, and complete openings, respectively). Fenced seedlings averaged 25 cm in height, whereas unfenced seedling mean height was 15 cm. Survival for the bare-root seedlings was 93%; there were no significant predictors of survival. Of the 401 surviving stems, 224 were not browsed or clipped, 53 were browsed, 100 were clipped, and 24 were browsed and clipped. Mean height of bare-root seedlings was 35 cm. Significant predictors of seedling height were woodlot, canopy level, and fencing. Height was significantly greater in complete openings (42 cm) than in closed canopy (32 cm) or partial (32 cm) openings. Fencing significantly increased seedling height (31 and 39 cm for unfenced and fenced seedlings, respectively). Survival for the bare-root saplings was 88%. Woodlot was the only significant predictor of survival. Of the 285 surviving saplings, 198 were not browsed or clipped, 77 were browsed, 4 were clipped, and 6 were browsed and clipped. Mean sapling height was 1.44 m. Woodlot was a significant predictor of height. Survival of direct-seeded seedlings increased with increased light levels. Height growth of direct-seeded and bare-root seedlings increased with increased light levels and with fencing.

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