

DEVELOPMENT AND COMPETITIVE STATUS OF SHORTLEAF PINE SEEDLING SPROUTS AFTER PRESCRIBED BURNING IN A MID-ATLANTIC MIXEDWOOD FOREST

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EXTENDED ABSTRACT

Shortleaf pine (*Pinus echinata*) possesses multiple adaptations for persistence in fire-prone ecosystems. Arguably, the most interesting of these adaptations is the basal crook, a trait that develops during the seedling stage (Little and Somes 1956). The basal crook insulates dormant buds at the base of the stem, which helps preserve the plant's ability to form basal sprouts after being damaged or top-killed by fire (Stone and Stone 1954). Public land in the New Jersey Pine Barrens (NJPB) is periodically treated with prescribed burning, mainly for fuels reduction and wildfire mitigation, yet prescribed burning is also conducted for maintenance of fire-dependent plant communities. Prescribed burning may be important for maintaining fire-adapted shortleaf pine in pine-hardwood communities of the NJPB due to their successional nature. However, there is a lack of information on the impacts of controlled fire on shortleaf pine sprouting and competitive dynamics in Mid-Atlantic Coastal Plain pine-hardwood forests.

A prescribed burn in March 2020 provided an opportunity to assess fire effects on shortleaf pine sprouting in a Mid-Atlantic Coastal Plain pine-hardwood forest (hereafter mixedwood). The purpose of this investigation was two-fold: (1) evaluate factors related to shortleaf seedling sprouting after a single prescribed burn, and (2) assess how a single fire impacted competitive status of shortleaf pine seedlings. The study site was a 0.2-ha natural canopy opening in a mixedwood forest located on Wharton State Forest in Shamong Township, Burlington County, New Jersey. Shortleaf pine was the dominant pine species in the study area. The hardwood component was a mix of oak species (*Quercus spp.*), hickory species (*Carya spp.*), blackgum (*Nyssa sylvatica*), black cherry (*Prunus serotina*), and persimmon (*Diospyros virginiana*).

The size, fire damage, and competitive status of natural pine reproduction was assessed shortly after the burn. This effort included tagging shortleaf pine seedlings 30-150 cm tall with >25 percent of the crown scorched. Additionally, seedlings were selected based on size and damage severity across the gap area to limit potential confounding with gap position. The initial measurement was taken immediately after the burn, which was assumed to represent pre-burn seedling size. A total of 40 pine seedlings were tagged for monitoring basal crook sprouting and competitive status during the 2020 growing season. It was later determined that four of these seedlings were Virginia pine (*Pinus virginiana*). This study focused mainly on the 36 tagged shortleaf pine seedlings. The main response variables were survival, number of basal sprouts (sprout number), and height of the dominant basal

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sprout (dominant sprout height). A backward step-wise procedure was performed to construct the best model for predicting sprout number and dominant sprout height using ordinary least squares regression. This process included pre-burn seedling ground-line diameter and total height, percent crown scorch, height of stem charring, sprout number (included in the model for dominant sprout height), and dominant sprout height (included in the model for sprout number) as potential explanatory variables. Statistical analysis was performed in R 4.0.4.

All tagged shortleaf pine seedlings survived to the end of the first season after burning: 28 by basal crook sprouting (sprouters), 2 resisting top-kill (resisters), and 6 through a mixture of sprouting and resistance (mixed). Sprouters were nominally smaller prior to the burn (mean ground-line diameter and mean top height of 12.2 mm and 83.8 cm, respectively) than resisters (19.8 mm and 125.5 cm) and mixed (20.1 mm and 125.8 cm). Sprouters also had nominally greater crown scorch (mean of 87.9 percent) than resisters and mixed seedlings (62.5 and 66.7 percent, respectively). By the end of the first season, sprouting shortleaf seedlings (sprouters and mixed) supported on average 15 sprouts, with a dominant sprout height of 26.6 cm (maximum of 39 sprouts and 49.5 cm, respectively). All four Virginia pine seedlings, ranging in size from 47-131 cm tall and 5.2-21.4 mm diameter, were killed by fire. These results confirm shortleaf pine's tolerance to fire at the seedling stage. Furthermore, they also support the importance of the basal crook as a fire adaptation in pine species, since none of the Virginia pine, a species without this trait, survived the burn. Collectively, this suggests that prescribed burning can be used to favor shortleaf pine reproduction over Virginia pine, similar to what has been observed in areas with loblolly pine (*Pinus taeda*) and shortleaf pine reproduction (Bradley and others 2016, Stewart and others 2015, Williams 1998).

Step-wise regression yielded models with pre-burn seedling size variables and the sprouting variables as predictors (table 1). The model for estimating sprout number retained pre-burn ground-line diameter and dominant sprout height as predictors, while pre-burn total height and sprout number were retained as predictors in the model for dominant sprout height. Both models were statistically significant at an alpha-level of 0.05. Positive slopes (significant at $\alpha=0.05$) for pre-burn seedling size variables in both models suggests seedling sprout production is positively associated with pre-disturbance seedling size. Negative slopes were estimated when regressing the response variables with each other (significant at $\alpha=0.10$). This result suggests a possible tradeoff in the number of sprouts produced and the growth of individual sprouts.

Prior to the March 2020 burn, most of the tracked shortleaf seedlings were either overtopped (16) or intermediate between over-topped and free-to-grow (19), while only one seedling was deemed free-to-grow (fig. 1). By the end of the first season following the burn, two-thirds of the seedlings were classified as overtopped (24), which was largely due to eight pre-burn intermediate seedlings being reclassified as over-topped in October 2020. Competitors of pine were mostly sprout-origin woody broadleaf species, including heath shrubs (Ericaceae), oaks, hickories, black cherry, and persimmon. The two post-burn seedlings classed as free-to-grow were mixed seedlings (resisted top-kill and sprouted) and greater than 110 cm tall. These results indicate a single prescribed burn may have negatively affected the competitive status of shortleaf pine reproduction, particularly the smaller seedlings, in this mixedwood canopy gap. Continued monitoring will help test this hypothesis.

Table 1—Results of ordinary least squares regression models for sprout number and dominant height based on 34 shortleaf pine seedlings that sprouted after a single prescribed fire in March 2020

Response variable	Explanatory variable	Slope	Intercept	Adjusted R-squared
Sprout number	Pre-burn GLD	1.643 ^a	3.315	0.547 ^a
	Dominant sprout height	-0.344 ^b		
Dominant height	Pre-burn seedling height	0.209 ^a	15.372 ^a	0.355 ^a
	Sprout number	-0.318 ^b		

GLD = ground-line diameter.

^aStatistical significance at an alpha-level of 0.05.

^bStatistical significance at an alpha-level of 0.10.

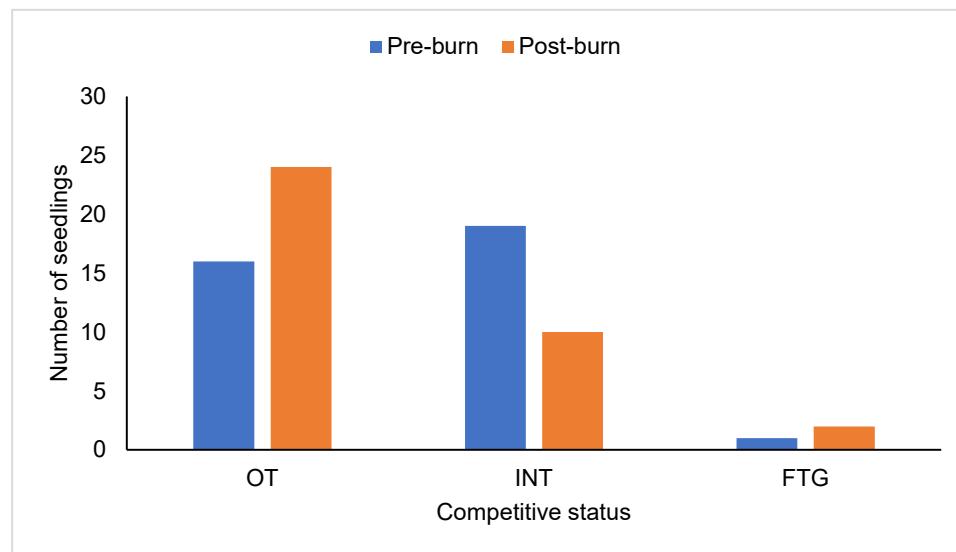


Figure 1—Competitive status of tracked shortleaf pine seedlings (n=36) before and after the first growth season following a single prescribed burn. Status categories are OT = over-topped, INT = intermediate, and FTG = free-to-grow.

LITERATURE CITED

- Bradley, J.C.; Will, R.E.; Stewart, J.F. [and others]. 2016. Post-fire resprouting of shortleaf pine is facilitated by a morphological trait but fire eliminates shortleaf x loblolly hybrid seedlings. *Forest Ecology and Management*. 379: 146–152.
- Little, S.; Somes, H.A. 1956. Buds enable pitch and shortleaf pines to recover from injury. Station Paper NE-81. Upper Darby, PA: U.S. Department of Agriculture Forest Service, Northeastern Forest Experiment Station. 14 p.
- Stewart, J.F.; Will, R.E.; Robertson, K.M. [and others]. 2015. Frequent fire protects shortleaf pine (*Pinus echinata*) from introgression by loblolly pine (*P. taeda*). *Conservation Genetics*. 16: 491–495.
- Stone, E.L., Jr.; Stone, M.H. 1954. Root collar sprouts in pine. *Journal of Forestry*. 52: 487–491.
- Williams, R.A. 1998. Effects of fire on shortleaf and loblolly pine reproduction and its potential use in shortleaf/oak/hickory ecosystem restoration. In: Waldrop, T.A., ed. *Proceedings of the ninth biennial southern silviculture research conference*. Gen. Tech. Rep. SRS-20. Washington, DC: U.S. Department of Agriculture Forest Service: 321–325.