AMOUNTS AND SPATIAL DISTRIBUTION OF DOWNED WOODY DEBRIS, SNAGS, WINDTHROW, AND FOREST FLOOR MASS WITHIN STREAMSIDE MANAGEMENT ZONES OCCURRING IN SHORTLEAF PINE STANDS FIVE YEARS AFTER HARVESTING

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EXTENDED ABSTRACT

Shortleaf pine (*Pinus echinata* Mill.) is a dominant tree species in pine and pine-hardwood forest communities located on ridges and upper- to mid-slope positions in the Ouachita Mountains. The stream reaches located in these stands flow infrequently and are classified as ephemeral or intermittent, have low stream orders, and have relatively narrow channels and floodplains. Land management agencies, such as the Ouachita National Forest, typically establish buffers or streamside management zones (SMZs) along these streams to protect water quality and other riparian functions within as well as downstream of these reaches. Since channels and floodplains are narrow, SMZ width is also narrow along these headwater streams. Given the high edge-to-interior ratios of these riparian zones, I was interested in 1) how forest characteristics such as stand density, forest floor mass, and coarse wood debris (CWD) volumes differ between SMZs and adjacent upland locations in these stands; and 2) how forest harvesting outside SMZs affect tree density, forest floor mass, CWD volume, snag density, and windthrow density.

Eleven shortleaf pine stands in the Ouachita National Forest in Arkansas were included in this study. They were between 14 and 16 ha in size, mature with dominant tree ages >70 years, and located on south- to west–facing slopes. In 1993 three of the stands were clearcut and planted to loblolly pine, four of the stands were cut using a shelterwood reproductive harvest with the intent to retain 6.8 m^2/ha of pine and 2.3 m^2/ha of hardwoods, and the other four stands were uncut and used for controls. Streams in these stands generally extended from the upper slopes of the stand to the bottom of the slope. Prior to the 1993 harvest, SMZs were established along each stream channel in each stand. Five years after harvesting, two to four plots were established within the SMZs of each stand. The plots spanned the entire width of a SMZ. In addition a plot was established adjacent to each of the SMZ plots in the upland portion of the uncut stands. Tree density, forest floor mass, and coarse woody debris (CWD) volumes were measured in the plots. Transects were located every 30 to 50 m along all SMZs in the stands. Each transect extended across the entire width of a given SMZ. Location and characteristics of each snag and windthrow within 10 m of each transect was recorded.

Total basal area was significantly greater in the SMZs than in the upland portions of the uncut control stands (Table 1). Differences were due to the higher numbers of hardwoods in the SMZs plots than the upland plots. Although tree basal area was higher in the SMZs, forest floor mass in the uncut control stands was 23 percent greater in the upland portion of stands than in the riparian zones. These differences appear to reflect a higher rate of decomposition in the SMZs due to the greater levels of hardwood litter or soil moisture within the riparian zones. CWD volumes were very similar in the upland and riparian areas of the stands.

Reproductive cutting methods had little influence on tree basal area or CWD volumes within the SMZs (Table 2). Differences in living overstory and midstory basal area among cutting methods were generally less than 10 percent. Mean CWD volume was nearly twice as high in the clearcuts compared to the uncut or shelterwood stands. Because of the high variability in CWD volumes and the potentially low power of these tests, however, differences among volumes were not significant.

A total of 160 snags were located in the 5.6 ha of SMZs that were inventoried. Snags were equally distributed as pine and hardwoods. The average diameter at breast height (DBH) of the snags was 17.5 cm. Snag densities were significantly lower in the SMZs that were located in the clearcut and shelterwood stands than in the uncut stands (Table 2). Harvesting forests can increase the wind speed, solar radiation, air temperature, and soil temperature in riparian zones (Moore and others 2005). This alteration in microclimate is likely responsible for an accelerated deterioration of snags and thus a reduction in snag density in the clearcut and shelterwood stands. The reduction in snag density was greatest in narrower SMZs. In the uncut stands, snag densities rapidly decreased with increasing SMZ widths up to 40 to 50 m. In the clearcut and shelterwood stands, however, snag density was not significantly correlated with SMZ width. Although other studies have found increased mortality and snag recruitment along edges of harvested stands, this study indicated no increase but rather a decrease in snags during the first 5 years following harvesting.

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Table 1.—Mean (standard deviation) living tree basal area, forest floor mass, CWD volume, and P-values associated with SMZs and upland plot comparisons in four uncut shortleaf pine stands in the Ouachita Mountains.

Stand Characteristic	SMZ	Upland	P-Value
Tree basal area (m^3/ha)			
Pine	22.4 (9.4)	22.2 6.2)	0.955
Hardwood	11.8 (4.5)	7.6 (2.7)	0.006
Total	34.2 (7.2)	29.8 (5.6)	0.092
Forest floor (kg/m^3)	2.2 (0.4)	2.7 (0.5)	0.049
CWD Volume (m^3/ha)	8.9 (13.1)	9.3 (10.3)	0.922

Table 2.—Mean (stand deviation) living tree basal area, CWD volume, and snag density; median forest floor mass, median windthrow density, and P-values associated with the comparisons of SMZ 5 years following application of three reproductive shortleaf pine regeneration cutting methods in the Ouachita Mountains.

Stand Characteristic	Uncut	Shelterwood	Clearcut	P-Value
Tree basal area (m^3/ha)				
Pine	20.8 (2.2)	19.5 (6.4)	18.8 (4.2)	0.661
Hardwood	9.7 (1.6)	9.9 (2.6)	10.2 (1.6)	0.501
Total	34.2 (2.1)	29.4 (5.7)	29.0 (3.3)	0.403
Forest floor (kg/m^3)	2.2	2.4	2.7	0.422
CWD Volume (m^3/ha)	8.9 (7.9)	7.6 (2.0)	16.1 (8.1)	0.331
Snags (#/ha)	38.9 (9.7)	22.7 (11.3)	25.7 (10.2)	0.014
Windthrow (#/ha)	0.3	0.0	11.8	0.020

Twelve windthrows were located in the SMZs. All but two of the windthrows occurred in the clearcut stands and only one of the windthrown trees was a hardwood. The average DBH of the windthrows was 25.8 cm, which was much larger than the average DBH of the snags. Windthrow densities were significantly greater in the SMZs within the clearcut stands than in either of the other stand types (Table 2). Alteration of the microclimate, especially windspeed, in the SMZs with clearcutting appears to have increased the windthrow susceptibility of large pine trees. In the clearcut stands, nine of the 10 windthrows were located in SMZs that had widths less than 29 m. The high edge-to-interior ratio of these narrow SMZs also appears to have an impact on windthrow occurrence with clearcutting.

These results suggest that land managers who wish to retain snags in SMZs located in upper- to mid-slope shortleaf pine stands, should minimize tree removal outside these riparian zones. To reduce windthrow of large pine trees, land managers should also refrain from clearcutting stands. Some evidence indicates that widening SMZs may also reduce snag deterioration and windthrow susceptibility in these SMZs following harvesting operations.

LITERATURE CITED

Moore, Dan R.; Spittlehouse, D.L.; Story, A. 2005. Riparian microclimate and stream temperature response to forest harvesting: a review. Journal of the American Water Resources Association. 41(4): 813-834.