Snag Longevity in Managed Northern Hardwoods

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ABSTRACT: *Little information on standing snag and coarse woody debris longevity exists for New England forest types. Forest managers thus lack the information on changes over time of the habitat components influenced by the decay process. We examined the fate of 568 snags that occurred on a long-term hardwood growth study on the Bartlett Experimental Forest, NH. Approximately one-third of the oldest dense hardwood sawtimber snags were still standing 20 to 25 years after death and 17% were still visible on the ground. Seventeen percent of the older moderately dense hardwood sawtimber snags were standing 15 to 20 years after death, 50% were still visible on the ground, and 33% had decomposed. Pole-sized snags appear to stand for shorter times than sawtimber and large sawtimber snags. Percentage of decomposed poles increased steadily throughout the time periods. These results can be most useful in predicting future wildlife habitat conditions in managed stands, as well as providing better rates of decomposition information when modeling coarse woody debris. North. J. Appl. For. 23(3):215–217.*

Key Words: Northern hardwoods, wildlife habitat, snag condition, coarse woody debris.

Foresters and wildlife biologists recognize the importance of standing snags and coarse woody debris as interdependent habitat components within managed forests in New England (DeGraaf and Shigo 1985, Tubbs et al. 1987). Both standing snags and coarse woody debris provide structural cover and foraging components for a variety of wildlife species throughout the decay process. Snags provide numerous foraging opportunities and cavity nesting and roosting sites for various woodpeckers (e.g., primary excavators) and secondary cavity-using birds and mammals while standing (Healy et al. 1989, Welsh et al. 1992). Coarse woody debris provides cover and foraging components for species such as the redback salamander (*Plethodon cinereus*), red-backed vole (*Clethrionomys gapperi*), woodland jumping mouse (*Napaeozapus insignis*), pine marten (*Martes americana*), and black bear (*Ursus americanus*) (DeGraaf and Yamasaki 2001) when snags eventually fall.

We have no information on standing snag and coarse woody debris longevity for the variety of forest types found in New England, and therefore little information on changes over time of the habitat components influenced by the decay process (Spaulding and Hansbrough 1944). We describe a pattern of snag longevity that occurs on a long-term hardwood growth study on the Bartlett Experimental Forest, NH (Solomon 1977).

Methods and Data Analysis

Individual tree growth records in three compartments of second-growth northern hardwoods have been maintained by periodic remeasurement of the 48, 0.33-ac plots throughout the last 40 years (Solomon 1977). Plots were randomly assigned to four levels of residual stand density (40, 60, 80, and 100 sq ft of basal area per acre in trees 4.5 in. dbh and larger) and three levels of residual stand structure [30, 45, and 60% sawtimber (10.5 in. dbh and larger)]. We first constructed a record of the individually tagged trees that died, noting tree species where available, last living dbh measurement, year of last live measurement, plot location, and residual stocking and stand structure treatments throughout the first 27 years of the study. We relocated and inspected all snags, and placed them in one of three condition classes (e.g., still standing taller than 4.5 ft, down and visible on the ground, or decomposed). We were able to relocate 299 (51.5%) trees that had died on the plots. Two hundred eighty-two (48.5%) trees were decomposed to the point we were unable to locate them with certainty after thoroughly searching the plots. Of the 581 tagged trees that had died during the first 27 years, the identity of 13 were not

NOTE: Mariko Yamasaki can be reached at (603) 868-7659; Fax: (603) 868-7604; myamasaki@fs.fed.us. Dale S. Solomon had the foresight to install a long-term growth and density study in northern hardwoods at the Bartlett Experimental Forest, on which this study was conducted. We thank him posthumously for his willingness to allow us to examine the mortality component of his growth study. We also thank R. Hosmer and N. Lamson for providing the initial database search to identify individual dead stems on Solomon's study; and T. Lee, J. Gove, and K. Dudzik for their helpful suggestions.

known, so we excluded them from further analysis. We grouped species into three categories based on specific gravity (Wenger 1984), and dbh into two size categories: poles (4.5 to 10.4 in. dbh) and sawtimber (10.5+ in. dbh).

We also estimated bark condition (e.g., mostly on, half on, mostly off), cavity-dwelling bird use (e.g., presence of nesting cavities and feeding sites), remaining tree bole height to the nearest one-quarter log, and the number of years an individual tree had been dead. Since remeasurements were periodic, number of years since death was calculated as: [year the tree was reported dead − year the tree was last alive]/2 + [year of the survey (1990) − year the tree was reported dead]. We used r x c tests of independence to examine snag longevity data (Snedecor and Cochran 1967).

Results

Beech (74%), yellow birch (16%), sugar maple (9%), and white ash (1%) made up the dense hardwood category. Percentage of dense hardwood poles in the three snag condition classes (Table 1) was different across time periods ($X^2 = 142.729$, $P = 0.000$, 8 df). In the first 5 years after death, almost 92% of poles were still standing and 4% each had fallen and decomposed during the same time period. The percentage of standing snags at 15 to 20 years had decreased to 5% and were gone by 20 to 25 years; whereas the percentage of decomposed snags increased in the same periods from 86 to 95%, respectively.

Percentage of dense hardwood sawtimber in the three snag condition classes (Table 1) was also different across time periods ($X^2 = 40.336$, $P = 0.000$, 8 df). In the first 5 years after death, 100% of sawtimber snags were still standing. The percentage of standing snags from 15 to 25 years ranged from 18 to 33%; whereas the percentage of decomposed snags increased in the same periods from 32 to 50%, respectively. Percentage of down snags through the time periods was more apparent in sawtimber than pole size classes.

Red maple (65%) and paper birch (35%) made up the moderately dense hardwood category. The proportion of snag conditions for moderately dense hardwood poles (Table 2) was different across time periods as well ($X^2 = 52.783$, $P = 0.000$, 8 df). In the first 5 years after death, 68% of pole snags were still standing, and 16% each had fallen and decomposed during the same time period. The percentage of standing snags at 15 to 20 years had decreased to 4% and 7% by 20 to 25 years, and the percentage of decomposed snags increased in the same periods from 67 to 93%, respectively.

The proportion of snag conditions for moderately dense hardwood sawtimber (Table 2) was also different across time periods ($X^2 = 17.654$, $P = 0.024$, 8 df). Ninety-two percent of sawtimber snags were standing during the first 5 years after death, and 8% were on the ground. The percentage of standing snags at 15 to 20 years decreased to 17%; and was zero by 20 to 25 years. The percentage of decomposed snags increased to 33% at 15 to 20 years, and down snags had not completely decomposed at 20 to 25 years.

Thirteen hemlock and red spruce snags occurred in the sample (seven poles and six sawtimber stems), too few to conduct a chi-square analysis. Six snags, dead less than 10 years were either still standing or down. Two snags dead for 15 to 20 years were still standing.

Four tree species accounted for 92% of the sample; beech (50), red maple (20), yellow birch (11), and paper birch (11). Poles comprised 72% of the total sample; sawtimber was 28%. Ninety percent of the snags still visible (e.g., standing and down categories) showed some cavity-dwelling or foraging utilization by wildlife species. We saw excavated cavities in approximately 6% of the stems.

Table 1. Snag tree longevity for dense hardwoods[a] in second-growth northern hardwoods (Solomon 1977), Bartlett Experimental Forest, Bartlett, NH.

		Snag/CWD condition (%)				
Size class[b]	Years dead	Standing	Down	Decomposed	Total	N
Pole	<5	92	4	4	100	24
	5–10	55	9	36	100	44
	10–15	18	29	53	100	56
	15–20	5	9	86	100	135
	20–25		5	95	100	21
	N	63	34	183		280[c]
Sawtimber	<5	100			100	9
	5–10	77	23		100	35
	10–15	50	25	25	100	20
	15–20	18	50	32	100	34
	20–25	33	17	50	100	6
	N	54	31	19		104[d]
Total		117	65	202		384

[a] Dense hardwoods (percent of sample) include: sugar maple (9), yellow birch (16), beech (74), and white ash (1).

[b] Size class: hardwood poles (4.5 to 10.4 in. dbh) and sawtimber (10.5 + in. dbh).

[c] Pole snag longevity is different ($P = 0.000$) than expected; $X^2 = 142.729$, 8 df.

[d] Sawtimber snag longevity is different ($P = 0.000$) than expected; $X^2 = 40.336$, 8 df.

Table 2. Snag tree longevity for moderately dense hardwoods[a] in second-growth northern hardwoods (Solomon 1977), Bartlett Experimental Forest, Bartlett, NH.

		Snag/CWD condition (%)				
Size class[b]	Years dead	Standing	Down	Decomposed	Total	N
Pole	<5	68	16	16	100	19
	5–10	59	13	28	100	39
	10–15	9	32	59	100	22
	15–20	4	30	66	100	27
	20–25	7		93		15
	N	40	23	59		122[c]
Sawtimber	<5	92	8		100	12
	5–10	62	23	15	100	13
	10–15	75	13	12	100	16
	15–20	33	34	33	100	6
	20–25		100		100	2
	N	32	11	6		49[d]
Total		72	34	65		171

[a] Moderately dense hardwoods (percent of sample) include: red maple (65) and paper birch (35).

[b] Size class: hardwood poles (4.5 to 10.4 in. dbh) and sawtimber (10.5 + in. dbh).

[c] Pole snag longevity is different ($P = 0.000$) than expected; $X^2 = 52.783$, 8 df.

[d] Sawtimber snag longevity is different ($P = 0.024$) than expected; $X^2 = 17.654$, 8 df.

Average height of the 193 standing snags was approximately one 16-foot log. Snag height estimates ranged from one-quarter log to 3 and one-quarter logs. Seventy-five percent of the standing snags had the majority of bark still present, and the bark had mostly sloughed from 7% of the standing snags. Finally we visually inspected graphs of snag condition for each time period against residual stocking and stand structure treatments of the original study (Solomon 1977) and could not see any outstanding relationships.

Applications

Pole-sized snags appear to stand for shorter times than sawtimber and large sawtimber snags, as expected. This reinforces the "bigger is better" concept of cavity tree management guidance in DeGraaf and Shigo (1985) and Tubbs et al. (1987), but from a different perspective. Existing guidance stems from the notion of maintaining cavity trees and snags that can be used by the biggest-bodied cavity excavators (e.g., pileated woodpeckers). Our results demonstrate that sawtimber and large sawtimber-sized snags will probably remain standing longer and preserve the widest range of cavity-dwelling sites than pole-sized snags.

At 10 to 15 years after death, decomposed pole-sized snags become dominant for all hardwoods and most pole-sized snags have decomposed completely by 20 to 25 years. For down and decomposed sawtimber-sized snags, paper birch bark remains visible longer than bark or bole remnants of other hardwoods.

The decomposition rates in this study are comparable to results found by Spaulding and Hansbrough (1944) in the White Mountains, and are probably representative of the decay process in relatively closed canopy northern hardwoods in the northeastern US. This study (Solomon 1977) occurred on sites composed of washed and compact tills (Leak 1982) at the lower range of good northern hardwood sites. As such, decay rates may be accelerated somewhat on stronger northern hardwood sites [e.g., fine tills and enriched sites (Leak 1982)]. Slower decay rates in northern hardwoods may occur in drier portions of the geographic region where northern hardwoods occur.

Foresters understand the importance and value of long-term growth studies with individually marked trees and repeated measurements (Solomon 1977, Solomon and Frank 1983, Leak et al. 1987). Following the mortality component in these types of studies can give habitat biologists and foresters further insights into the snag longevity patterns in other forest types in the region. These results can be most useful in predicting future wildlife habitat conditions in managed stands, as well as providing better rates of decomposition information when modeling coarse woody debris.

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