Snag Characteristics and Evidence of Woodpecker Activity in Deciduous and Mixed Stands in Northern Michigan

BIOS 569: Practicum in Field Biology

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Abstract

Coarse woody debris (CWD)—standing dead trees, fallen trees, and decomposing large roots—is important in the functioning of healthy forest systems. One major role of CWD in temperate ecosystems is the use of snags (standing dead trees) by numerous woodpecker species for foraging, nesting, and roosting sites. I examined relationship between forest stand type and several snag characteristics: density, dbh, height, decay class, and woodpecker hole abundance. The stand types used in this study were aspen-maple, sugar maple, and mixed stands located in the Upper Peninsula of Michigan, USA. I found that there is a significant difference between the snag densities of the three stand types (P=0.009). The mixed stand type had the highest snag densities among the three. I also found a significant difference between the abundance of *Dryocopus pileatus* (pileated woodpecker) holes and stand type (P=0.172). They were most abundant in the sugar maple stand type. I found that pileated woodpecker holes were significantly more abundant on soft snags (P=0.007) and are positively correlated with snag DBH (P=0.006). These variables (decay class and DBH) were found to be highest in the sugar maple stand and are likely the reason pileated woodpeckers were more active in this stand type.

Introduction

Forest management drastically changes forest dynamics, especially the abundance of coarse woody debris (CWD) within a forest. CWD includes all dead wood, both snags (standing dead trees) and fallen logs, branches, and coarse roots (Harmon et al. 1986). CWD of all types plays numerous roles in the functioning of a healthy forest. It is an input of nutrients back into soils, a long-term carbon storage, and an essential habitat for various small mammals, amphibians, arthropods, and birds (Stevens 1997). In order for a forest ecosystem to maintain its natural animal diversity, it is critical that CWD density be close to what it would be in a pristine, unmanaged environment. This critical density differs based on the environmental characteristics of the particular site, such as climate and biome type. Since it is impossible to determine the precise value which will optimize overall habitat health of each unique site, ecologists often use bioindicators within the environment with which they can then judge if the ecosystem is healthy (high diversity and abundance of species). In many temperate forest environments woodpeckers are selected as bioindicators because of their role as cavity excavators, thus providing nesting sites for secondary cavity-nesting birds (nonexcavators). The abundance of woodpeckers is an indicator of the health of other bird species habitat. Because woodpeckers rely on snags, a standing component of CWD, for food and survival, the abundance of snags is critical for woodpecker populations. (Bate et al. 1999)

This study focuses on the abundance of snags in unmanaged, second-growth forest stands and the use of these snags by various woodpecker species. I predicted that: (1) snag densities will differ forest stands, (2) evidence of woodpecker activity (i.e. the number of woodpecker holes in snags) will be different among forest stand types, (3) abundance of woodpecker holes in snags is related to snag characteristics (i.e. dbh, height, decay class).

Materials and Methods

I conducted this study at 7500 acre University of Notre Dame Environmental Research Center (UNDERC) in Michigan's Upper Peninsula between May and July 2005. The forest at UNDERC is comprised of northern mesic hardwoods, mostly secondary-growth quaking aspen (*Populus* *tremoloides*), white birch (*Betula papynifera*), sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), white pine (*Pinus strobus*), and conifers. Extensive logging and a wildfire occurred between 1880 and 1910 (Belovsky 2005). Since then, the majority of the property has been left unmanaged. The climate is classified as humid microthermal, with cold winters (Jan: -20ºC to -10ºC) and long, cool summers (July: 16ºC to 20ºC). (Environmental Research-East)

I studied snag characteristics of three forest stand types: aspen-sugar/red maple stands, sugar maple stands, and mixed hardwood and conifer stands (Table 1). Five sites for each stand type were selected across the property (Figure 1). Within each site, I randomly set a 10m by 100m plot. The plots were ≥10m from the road or any other major edge habitat. Snags were considered standing dead trees ≥8cm in diameter and ≥100cm in height. Snags were identified by their lack of green foliage. The following information was recorded for each snag within the plots: species, dbh, height, number of *Dryocopus pileatus* (pileated woodpecker) holes, number of unknown woodpecker holes, and decay class. *Sphyrapicus varius* (yellow-bellied sapsucker) holes were not included in the survey since they are made when a tree is still living. Unknown woodpecker holes could be made by either of the two other woodpeckers on the property, the *Picoides villosus* (hairy woodpecker) or the *Picoides pubescens* (downy woodpecker) (Environmental Research-East). The amount of decay was ranked on a 1 to 6 scale (Table 2).

Results

The density of snags/ha was statistically different between the three forest types (ANOVA; DF=2, F-ratio=7.143, P=0.009; Figure 2). The average snag density for the aspen-maple, sugar maple, and mixed forest types was 70, 94, and 236 snags/ha respectively. No significant differences were found between stand type and snag dbh, height, or decay class (ANOVA; DF=2, F-ratio=0.373, P=0.697; DF=2, F-ratio=0.713, P=0.510; DF=2, F-ratio=0.194, P=0.826, respectively). The abundance of overall woodpecker holes was not significantly different between the stand types (ANOVA; DF=2, F-ratio=1.125, P=0.356). However, there was a significant difference between the abundance of pileated woodpecker holes and the stand type (ANOVA; DF=2, F-ratio=2.049, P=0.172). The sugar maple stands had significantly more pileated woodpecker holes than both the aspen-maple type and the mixed type (Tukey; P=0.264, P=0.198, respectively; Figure 3).

There is a difference in pileated woodpecker holes between decay classes (ANOVA; DF=5, F-ratio=3.544, P=0.007). Pileated woodpecker holes were most abundant in snags with a decay class of 4. There is a trend of increasing pileated woodpecker holes as decay class increase from one to four, with significant differences between classes 1 and 4, and 2 and 4 (Tukey; P=0.003, P=0.035, respectively; Figure 4). Abundance of holes drops off after class four, but this difference is not statistically significant (Tukey; 4 and 5, P=0.544; 4 and 6, P=0.810). There is a positive correlation between the average snag dbh in a site and the average number of pileated woodpecker holes within each snag in a site (Regression, R^2=0.454, P=0.006; Figure 5). There is no relationship between the number of pileated woodpecker holes and snag species (ANOVA; DF=2, F-ratio=1.013, P=0.379). In addition, no significant difference was found between snag species and its mean decay class (ANOVA; DF=2, F-ratio=0.292, P=0.750).

Discussion

Snag density versus stand type

Species composition of a stand is a major determining factor in the snag abundance of the site. The mixed stand type in this study had the greatest snag density between the three types. This was likely due to the high abundance of balsam fir and black spruce within this stand type (Table 1). Strurtevant et al. (1997) suggested that both size and age-limiting factors influence senescence within stands leading to higher densities of CWD, including snags. Balsam fir, especially, influences snag abundance due to its limited longevity within a forest system resulting from its extreme susceptibility to heartrot (Seymour 1994). In addition, the shallow rooting systems of both balsam fir and black spruce increase the probability of windthrow for these species (Newton 1992).

Pileated woodpecker versus stand type and snag characteristics

The results of this study suggested that pileated woodpeckers have stand type preferences. Between the three stand types included in this study, sugar maple stands had the most pileated woodpecker activity. Differences between the stand types are most likely responsible for this result. The results showed that the abundance of pileated woodpecker holes was significantly greater in softer snags (decay class 3-4) and in snags with greater diameters, which could explain their preference for the sugar maple sites since they had the higher average decay class (older snags) and the largest mean dbh, characteristics which woodpeckers have been shown to prefer (Scott 1978). Farris et al. (2004), in a study of pine forests in the Western US., found a similar result. They found a positive correlation between woodpecker holes and snag dbh as well as state of decay. The study suggested, however, that this may be due, at least in part, to the fact that woodpeckers contribute to tree and snag decay. Because foraging woodpeckers open holes in trees and snags, they make them vulnerable to airborne spores and other wood-decaying organisms (Otvos 1979, Ostry and Anderson 1998).

Snag density and Forest Health

Snag density values obtained from old-growth and secondary growth stands can be used as standards and points of comparison for managed forests, especially where habitat integrity (high species richness of plants and animals) is a priority. The Forest and Rangeland Renewable Resources Planning Act 1974 requires National Forests to “maintain viable levels of native wildlife populations on public lands” (Bate et al. 1999). Since numerous wildlife species rely on CWD and snags, their density within forests is being monitered (Bate et al. 1999).

Bate et al. (1999) suggested that a minimum of 2.2 snags/ha of forest should be maintained. This number is far lower than the snag density values obtained in this study in secondary-growth forest stands (between 70 and 236 snags/ha). A study by Duvall and Grigal (1999) found that timber management has an especially great impact on snags. They found that in young managed forests snag biomass is less than 1% of that of unmanaged forests. In mature forests (91-150 years old) the trend continues, managed forests having only 25% of the snag biomass of unmanaged forests of the same type. If only the minimum is achieved in most stands of managed forest there will be deterimental consequences for the survival of many different species which rely both directly and indirectly on snags and other CWD.

Improvement Suggestions

If I were to preform this study again I would observe more snag and forest characteristics than I did than I did in this study. If still constrained by time limitations I would select a smaller plot size and observe all of the trees in the plot, snags and live trees. This information would be helpful in developing a more detailed understanding of what is happening within the stand types, such as if one species constitutes a greater proportion of the snags in the plot than the live trees. Is succession involved? I would also include more data which would allow for the calculation of snag volume (i.e., degree of taper). If this study were preformed again somewhere else I would suggest choosing stand types that are more different from one another; this was not possible on UNDERC property. More replication within stand types would be useful in reducing standard error.

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Table 1. Dominant vegetation of each study site.

Sites	**Dominant Canopy Species**	**Dominant Understory Species**
Aspen-Sugar Maple		
1	*Populus grandidentata* *Populus tremuloides* *Acer saccharum*	*Abies balsamea* *Acer saccharum*
2	*Populus grandidentata* *Populus tremuloides* *Acer saccharum*	*Abies balsamea* *Acer saccharum*
3	*Populus grandidentata* *Populus tremuloides* *Acer saccharum*	*Acer saccharum*
4	*Populus grandidentata* *Populus tremuloides* *Acer saccharum*	*Abies balsamea*
5	*Populus grandidentata* *Populus tremuloides* *Acer saccharum*	*Abies balsamea*
Mature Maple		
1	*Acer saccharum*	*Acer saccharum*
2	*Acer saccharum*	*Acer saccharum*
3	*Acer saccharum*	*Acer saccharum*
4	*Acer saccharum*	*Acer saccharum*
5	*Acer saccharum*	*Acer saccharum* *Fraxinus americana*
Mixed		
1	*Acer saccharum* *Fraxinus americana* *Populus tremuloides* *Abies balsamea* *Betula papyifera*	*Abies balsamea*
2	*Acer saccharum* *Populus tremuloides* *Abies balsamea*	*Abies balsamea*
3	*Acer saccharum* *Populus tremuloides* *Abies balsamea*	*Abies balsamea* *Acer saccharum*
4	*Acer saccharum* *Populus tremuloides* *Abies balsamea* *Picea mariana*	*Acer saccharum* *Abies balsamea* *Picea mariana*
5	*Acer saccharum* *Tsuga Canadensis*	*Abies balsamea* *Acer saccharum*

Table 2. Decay class description of snags.

Class:	**Description:**
1	dead, bark intact, small twigs and branches intact, wood solid
2	dead, bark flaking, small twigs absent, large branches intact, wood solid
3	bark mostly absent, nearly all branches absent, wood still fairly solid
4	wood becoming soft in places, very top of tree has separated from bole, some flaking will result from kicking the tree
5	bole considerably decomposed, mid-portion of tree has collapsed, kicking bole may result in large chunks falling from bole, wood generally soft
6	most of the bole collapsed, wood generally soft and powdery, wood can be easily crumbled by the hand

(Whitman et al. unpublished)

Figures

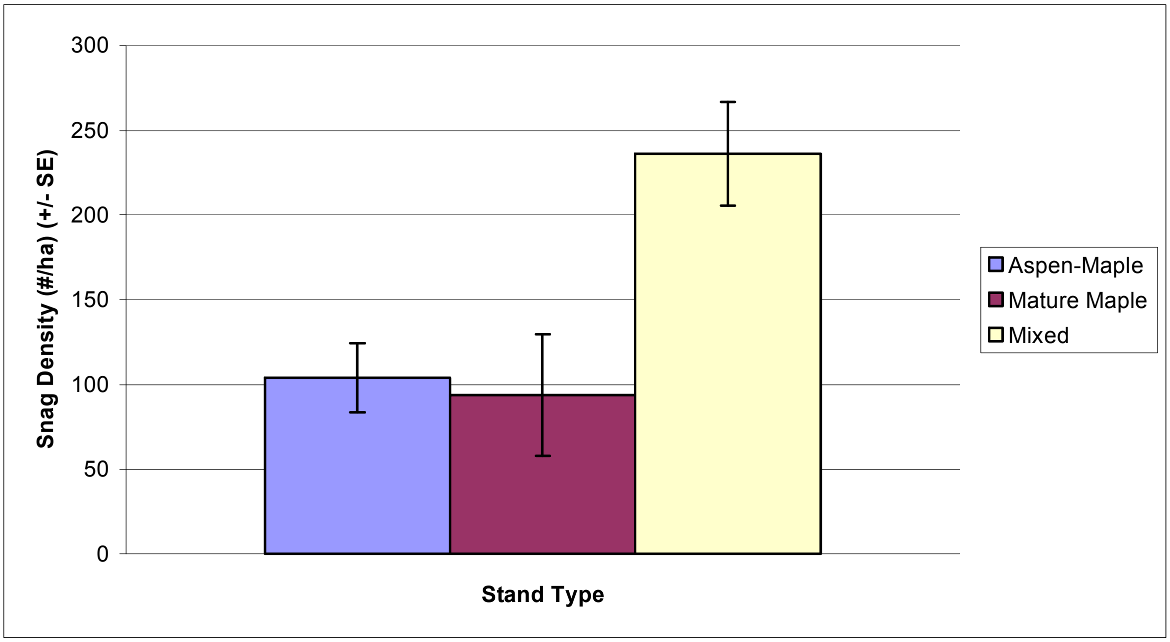

Figure 2. Mean snag density (number of snags/ha) vs. stand type. Error bars represent standard error. For each stand type, n=5.

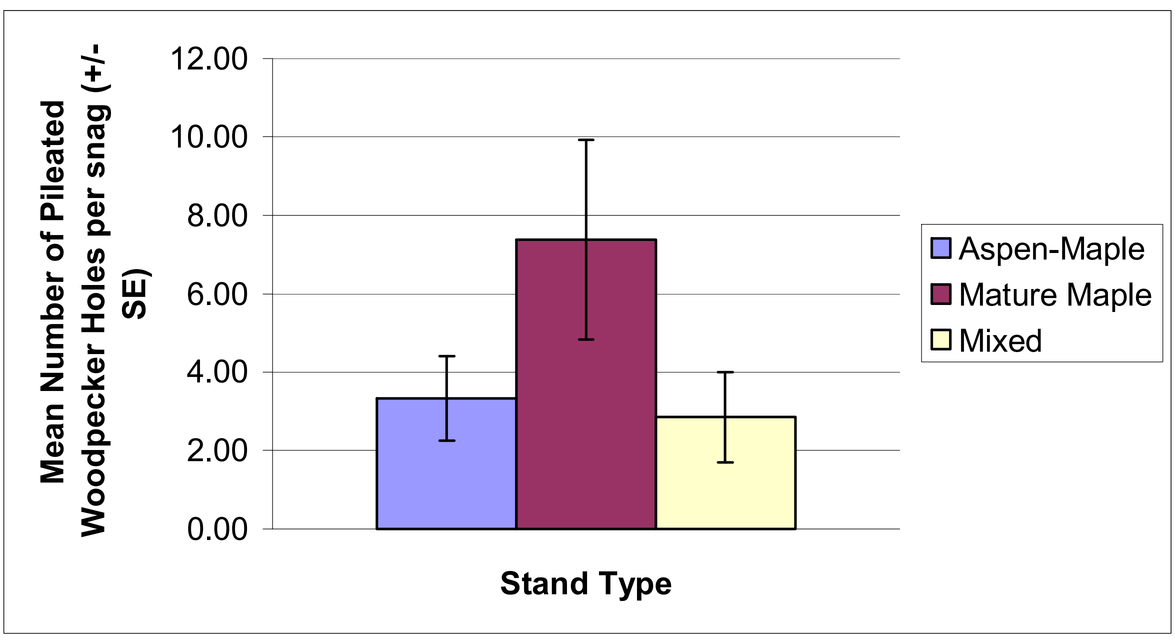

Figure 3. Mean number of pileated woodpecker holes per snag vs. stand type. Error bars represent standard error. For each stand type, n=5.

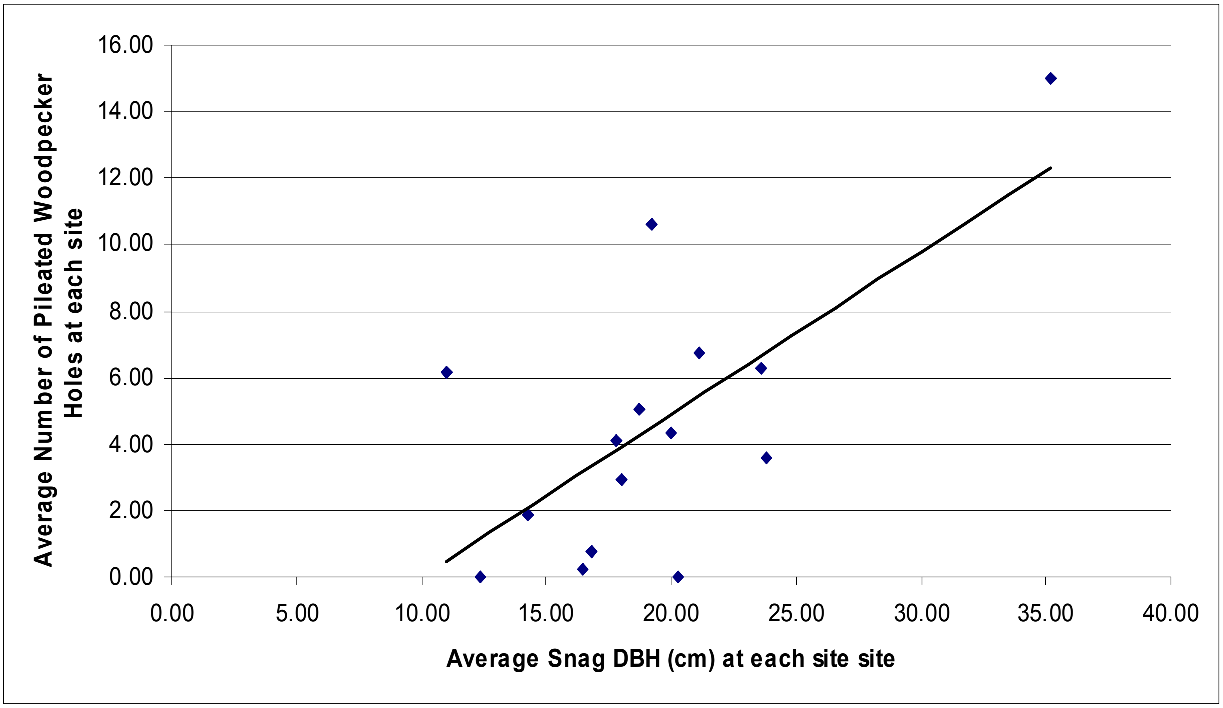

Figure 5. Mean number of pileated woodpecker holes at each site vs. mean snag DBH at each site. Error bars represent standard error. For each stand type, n=5.

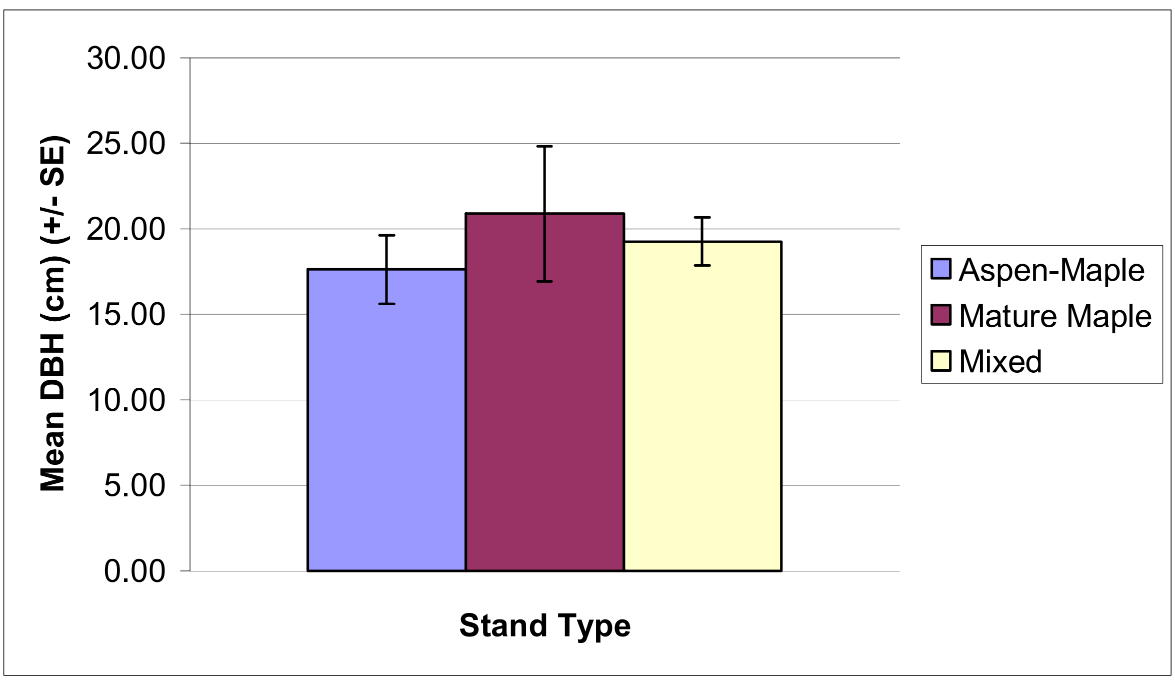

Figure 6. Mean snag DBH (cm) vs. stand type. Error bars represent standard error. For each stand type, n=5.

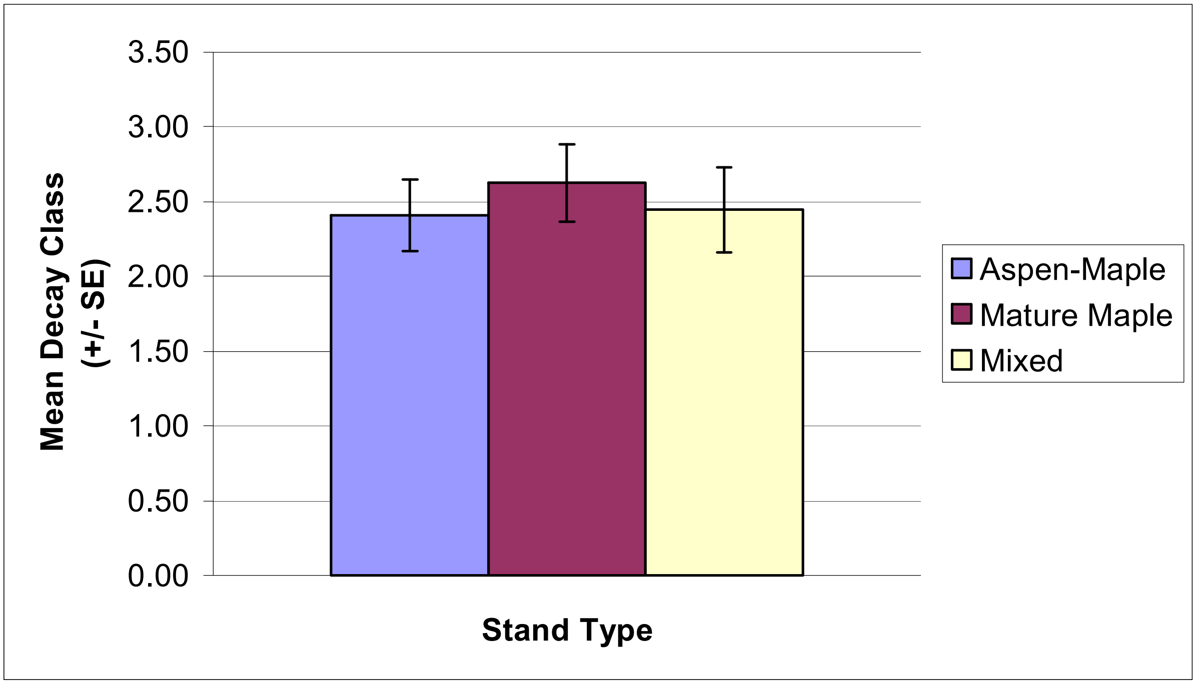

Figure 7. Mean snag decay class vs. stand type. Error bars represent standard error. For each stand type, n=5.