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RELATIONSHIP BETWEEN STANDING DEAD WOOD DYNAMICS AND BIRD COMMUNITIES WITHIN NORTH CAROLINA PINE PLANTATIONS

THE CENTER FOR CONSERVATION BIOLOGY
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Snags (standing dead wood) are an important resource within all forest ecosystems. A prominent guild of birds within forests of North America depends upon snags for foraging, roosting and nesting. This guild includes both primary and secondary cavity nesters. A study of birds within Weyerhaeuser plantations in coastal North Carolina during the breeding seasons of 1997 and 1998 revealed a diverse community of both primary and secondary cavity nesters. Examination of patterns across the management cycle suggested that commercial thinning operations were important events that influence snag availability and the associated bird community. From a population perspective, snag availability reflects the balance between snag losses due to falling and recruitment associated with tree mortality. Understanding the population dynamics of snags and how they are influenced by management/harvest operations is essential to achieving an understanding of how pine plantations fit within the broader landscape in terms of value to wildlife species.

Studies were conducted during the spring and summer of 2002 and 2003 on the Weyerhaeuser Company J&W management tract located within the coastal plain of North Carolina. Snag and bird surveys were conducted within 35 study plots consisting of 5 replicates of 7 different stand age classes. Snags were surveyed to quantify the population dynamics of snags within pine plantations and to determine how or if these snag dynamics are influenced by timber operations. Birds were surveyed to determine how the bird community responds to snag availability/dynamics.

A total of 1,239 snags were identified and characterized within the 35 study blocks. Total snag numbers peaked 1-2 years after the first commercial thin and overall snag numbers declined as the plantation stands matured. Although density was lower, snags within the older age classes were larger, had undergone more decomposition and were more likely to support cavities. Results of bird surveys showed that species richness increased with stand age and that the guild of birds that utilize snags and cavities were not frequently detected until after the first commercial thin. Commercial thinning events appear to be quite beneficial to birds that utilize snags and cavities. A derivative of this management technique is the creation of snags that provide foraging, roosting and nesting sites for these bird species.

BACKGROUND

Context

Snags (standing dead wood) are an important resource within all forest ecosystems. A prominent guild of birds within forests of North America depends upon snags for foraging, roosting and nesting (Raphael and White, 1984). This guild includes both primary and secondary cavity nesters. Primary cavity nesters are those species such as woodpeckers and nuthatches that have the morphological adaptations to excavate their own cavities. Secondary cavity nesters are those species such as the Eastern Bluebird and Tufted Titmouse that do not typically excavate their own cavities but instead utilize natural cavities or those excavated and abandoned by primary cavity nesters. A widely held view within the ornithological and land management communities is that pine plantations do not support primary and secondary cavity users due to the limitation of snags. Snag numbers are generally kept to a minimum in managed pine plantation because they are not desirable for production of wood products and they may pose a safety hazard (Gunn and Hagan, 2000)

A study of birds within Weyerhaeuser plantations in coastal North Carolina during the breeding seasons of 1997 and 1998 revealed a diverse community of both primary and secondary cavity nesters. Examination of patterns across the management cycle suggested that commercial thinning operations were important events that drove snag availability and the associated bird community. An assessment of habitat use by Brown-headed Nuthatches suggested that commercial thinning events were important for both creating snags and reducing interference for their use by understory vegetation.

From a population perspective, snag availability reflects the balance between snag losses due to falling and recruitment associated with tree mortality (Morrison and Raphael, 1993). Understanding the population dynamics of snags and how they are influenced by management/harvest operations is essential to achieving an understanding of how pine plantations fit within the broader landscape in terms of value to wildlife species. State of decay, size class, understory conditions, and other factors are also important in whether or not snags are useable to specific bird species. Understanding species-specific requirements will help to explain why certain species enter the plantation bird community at different times during the management cycle.

Objectives

This study has four interrelated objectives including (1) to quantify the population dynamics of snags within pine plantations, (2) to determine how or if these snag dynamics are influenced by timber operations, (3) to determine how the bird community responds to snag availability/dynamics, and (4) to quantify the characteristics of snags that are required by the various user species.

METHODS

Study Area

This study was conducted entirely on the Weyerhaeuser Company J&W management tract. The J&W management tract is located on the extreme western end of the Albemarle-Pamlico Peninsula, in Beaufort, Martin, and Washington Counties, North Carolina (Figure 1). The area was originally dominated by tall pocosin and hardwood swamps before being ditched, drained and cleared for agricultural practices and other land uses, prior to acquisition by Weyerhaeuser. Presently, the majority of the J&W tract is managed as pine plantation and is surrounded by a matrix of agricultural, residential, and forested lands.

Pine plantation management activities generally occur during a 30-35 year crop rotation period. Loblolly pines (*Pinus taeda*) are planted at a relatively low density (<1,200 stems/ha), commercially thinned 1-3 times during maturation, and then harvested by clearing all pine and hardwood stems. Commercial thinning events are usually conducted approximately 10 and 20 years after planting. These thinning events create alternating strips of sheared and non-sheared lanes within the management stand. The staggered regime of planting, thinning and harvesting activities creates a matrix of different aged stands.

Study Design

Studies were conducted within 35 plots consisting of 5 replicates of 7 different stand age classes (Table 1). Age classes were chosen to represent stages throughout the management cycle and included; (1) pre-thin, approximately 10 year after planting and chopped, (2) 1-2 years after first commercial thin, (3) 3-4 years after fist thin, (4) 5-6 years after first thin, (5) 1-2 years after second thin, (6) 3-4 years after second thin, and (7) 5-6 years after second thin. Within each replicate a 9-ha block was established and a smaller 4ha subplot was also delineated (Figure 2). Stands were chosen based upon ease of access, lack of dense cane understory, and exclusion from the current year's thinning and harvesting schedule.

Snag Surveys

Snags were surveyed in 2002 and 2003 within each 9-ha block by methodically walking each sheared or chopped lane and identifying all snags present. Snags were defined as a dead stem > 1.5 m tall, with a diameter at breast height (DBH) >8 cm, with no live needles or leaves present and leaning < 35°. Each snag encountered in 2002 was flagged, marked with a numbered aluminum tree tag attached with bailing wire, position recorded with a Garmin eTrex Legend GPS unit. In 2002 all snags within the 9-ha plot were characterized to determine its structure. In 2003, snags were only characterized within the 4-ha subplot. Data taken to characterize each snag included; stand number, snag number, height, DBH,

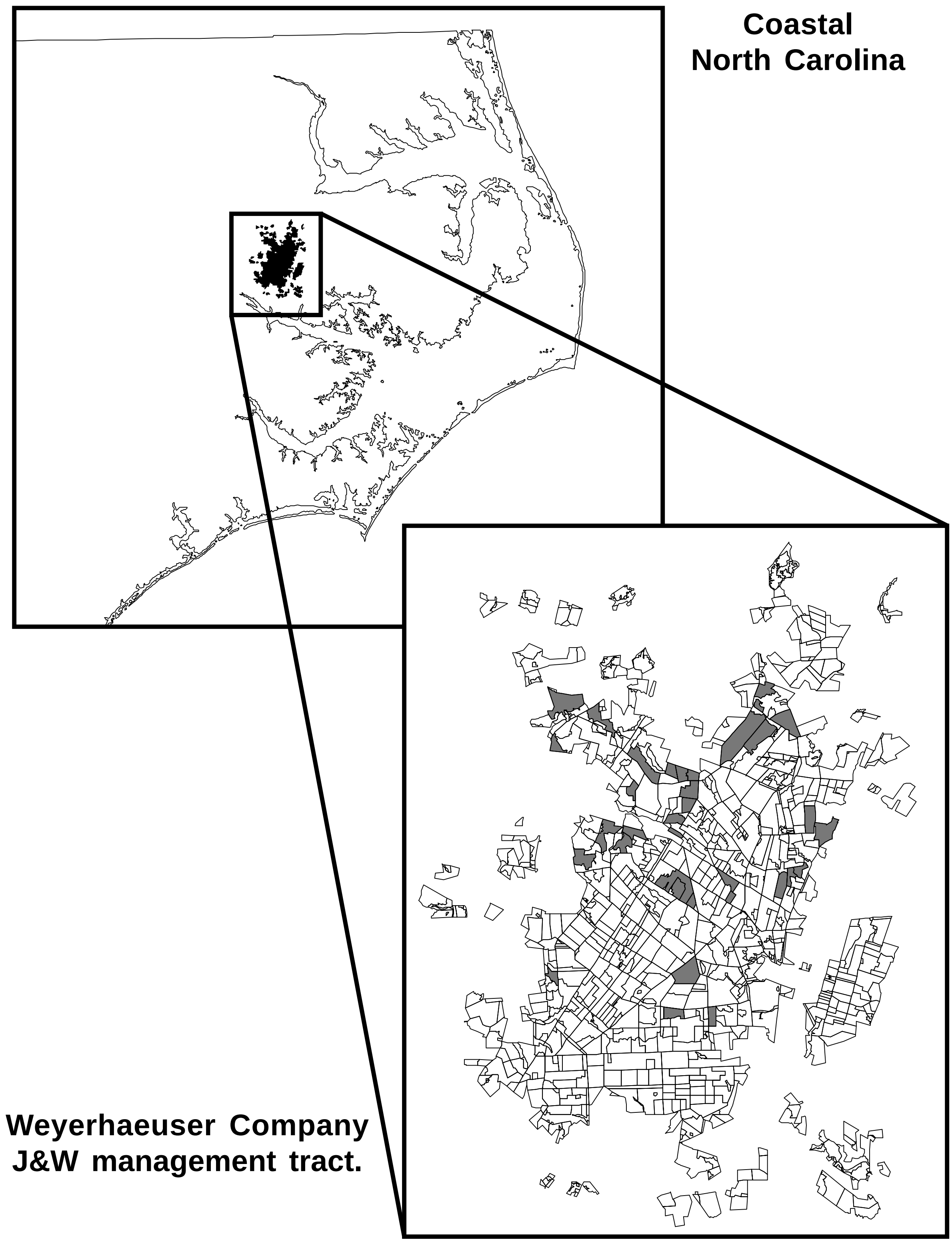

Figure 1. Map of study area within Weyerhaeuser Company J&W management tract. Management stands used are shaded gray.

Table 1. List of stands used with ages and age class codes.

Stand Number	Age	Age Class Code
42607	Pre-thin,chopped	1
45153	Pre-thin,chopped	1
42402	Pre-thin,chopped	1
42430	Pre-thin,chopped	1
42792	Pre-thin,chopped	1
45212	1-2 years after first commercial thin	2
45071	1-2 years after first commercial thin	2
44931	1-2 years after first commercial thin	2
42036	1-2 years after first commercial thin	2
44990	1-2 years after first commercial thin	2
42003	3-4 years after first commercial thin	3
44830	3-4 years after first commercial thin	3
44715	3-4 years after first commercial thin	3
44406	3-4 years after first commercial thin	3
42385	3-4 years after first commercial thin	3
44298	5-6 years after first commercial thin	4
44306	5-6 years after first commercial thin	4
42009	5-6 years after first commercial thin	4
44026	5-6 years after first commercial thin	4
44299	5-6 years after first commercial thin	4
42155	1-2 years after second commercial thin	5
44429	1-2 years after second commercial thin	5
42469	1-2 years after second commercial thin	5
42470	1-2 years after second commercial thin	5
42682	1-2 years after second commercial thin	5
42154	3-4 years after second commercial thin	6
42206	3-4 years after second commercial thin	6
42472	3-4 years after second commercial thin	6
42015	3-4 years after second commercial thin	6
42444	3-4 years after second commercial thin	6
42406	5-6 years after second commercial thin	7
42463	5-6 years after second commercial thin	7
44621	5-6 years after second commercial thin	7
42462	5-6 years after second commercial thin	7
42739	5-6 years after second commercial thin	7

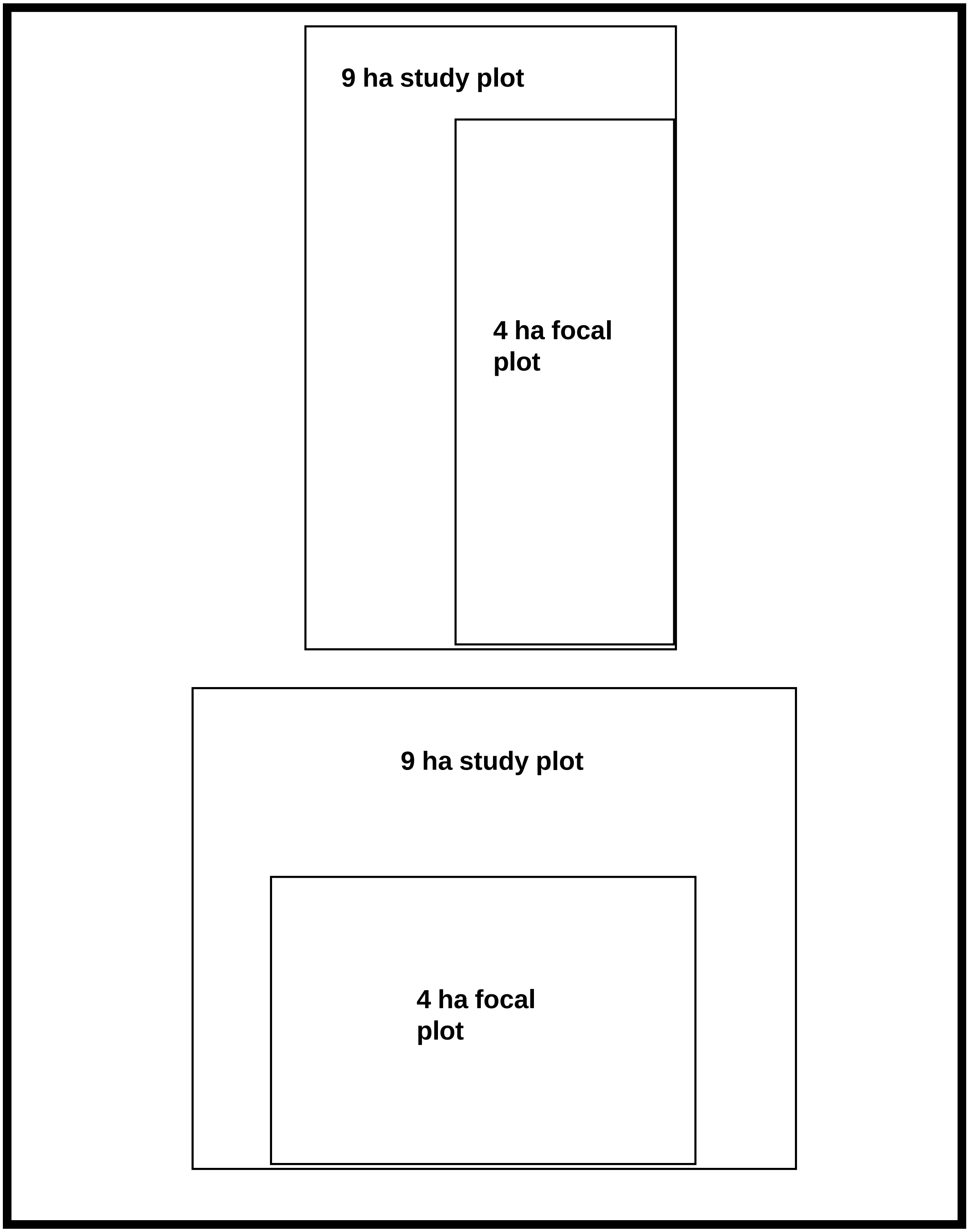

Figure 2. Two examples of study plot arrangement. Each study block consisted of a 4-ha focal block within a larger 9-ha study block.

number of limbs < 1 m projecting from the main stem, number of limbs >1 m projecting from the main stem, height to first limb, visual estimate of bark remaining on main stem, presence or absence of stem, number of limbs >1 m projecting from the main stem, height to first limb, visual estimate of bark remaining on main stem, presence or absence of needles, number of cavities, cavity heights, cavity orientations, cavity hole diameter, cavity structure, and cavity use. The height of the snag, first limb, and cavity was measured in meters using a 15-m measuring pole or clinometer depending on individual heights. DBH was measured to the nearest 0.1 cm using a diameter tape. Cavity-hole diameter was measured to the nearest cm with the aid of the height pole or visually estimated. Cavity structures recorded included; main stem, limb scar, lateral limb and natural cavity. Cavities were considered in use if birds were observed entering and/or exiting cavities, or if birds were flushed or chicks vocalized after observers tapped the main stem with a 0.5-m long 2.5-cm diameter PVC pipe. All snags within the 4-ha focal block were surveyed between 5 May 2002 and 17 May 2002, while all snags in the remaining portion of the 9-ha block were surveyed from 5 May 2002 to 15 July 2002. Snags within the 4-ha focal block were resurveyed in July 2002 to identify any obvious changes in structure. All 9-ha plots were resurveyed in 2003 from 8 May to 16 July to determine the status (standing or fallen) of individual snags identified in 2002 and the presence of new snags. Structural characteristics of marked and new snags were only collected within the 4-ha subplots.

Field technicians Danni Larson and Sandra Smith measuring the height of a snag with a height pole. photo by Bart Paxton

Field technicians Danni Larson and Sandra Smith measuring the DBH of a snag with a diameter tape. photo by Bart Paxton

Data were collected on the vegetation surrounding all snags within the 4-ha subplots in each year. Data on the surrounding vegetation was collected for all cavity bearing snags within the remaining portion of the 9-ha block in 2002 and only within the 4-ha subplot in 2003. Vegetation was surveyed within a 3-m radius circle, the center of which was the snag base. Each circle was divided 3 concentric circles 1 m apart. Circles were divided into quadrants based on the cardinal compass points, resulting in 12 survey segments (Figure 3). The total number of stems > 0.1 meter and the height of the tallest stem were recorded for each segment.

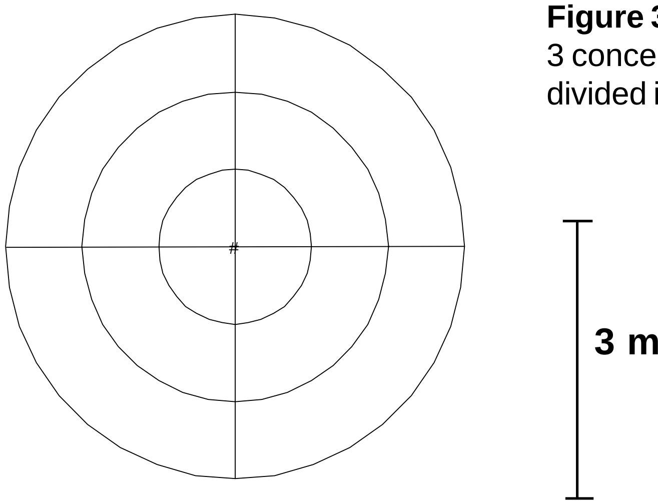

Figure 3. Vegetation survey plot consisting of 3 concentric circles spaced 1 m apart and divided into quadrants.

Cavity Monitoring

All cavity-bearing snags identified, marked, mapped, and characterized during the initial snag survey were revisited once every 18-day period to check for nesting activity. Snags were approached while watching for birds entering and/or exiting cavities. If no birds were observed the trunk was tapped with a 0.5-m long 2.5-cm diameter PVC pipe to elicit vocalizations from any chicks present or to flush out adults. Selected cavities were also inspected with a Treetop II video camera system to confirm absence of nesting activities.

Bird Surveys

Birds were surveyed along a single 300-m transect within the 9-ha study block of each of the 35 study stands. Birds were between sunrise and 4 hours after sunrise from 3 June to 19 July in 2002, and 5 June to 31 July in 2003. Surveys were conducted using a standard variable width transect technique (Emlen, 1971). The observer would walk slowly and steadily along the transect line, looking and listening for birds within 100 m (perpendicular distance) of the transect line. All birds encountered were identified to species and recorded on field data sheets. Also recorded were the initial method of detection (visual, aural, or flush), estimated detection distance and estimated perpendicular distance off of the transect line.

Data Analysis

Snags were grouped into arbitrary DBH and bark classes. The 5 DBH classes included 1) 8-11.9, 2) 12-15.9, 3)16-19.9, 4) 20-24.9, and 5) > 25 cm. Bark classes used included 1) 90-100, 2) 75-89, 3) 50-74, 4) 25-49 and 5) 0-24 % bark remaining on main stem. All snags were also classified into on of five decay classes based on the presence or absence of needles, percentage of bark remaining on the main stem, presence or absence of lateral limbs (Table 2).

Snag and habitat data were summarized to make comparisons between stand age classes, and snag condition. To make comparisons between snags with and without cavities and used and unused cavities data were summarized using all stand age classes and only the stand age classes containing the greatest proportion of cavity bearing snags. Non-parametric, univariate tests were used to compare snag and habitat data among all age classes and for snag and habitat data measured on ordinal scales. Kruskal-Wallis and Mann-Whitney U tests were used for multi-level and pairwise level comparisons respectively. For comparisons of snag characteristic and vegetation measurements between snags with and without cavities and used and unused cavities in the older stand age classes ANOVA and t-tests were used.

Snag characteristics, loss rates, and birth rates were determined by following the snag populations between years. Snag loss rates were determined for each 9-ha plot by calculating the percentage of total snags detected in 2002 that fell before 2003 surveys. These values were compared among stand age, dbh, decay, and bark classes using Kruskal-Wallis tests. Snag birth rates were too low for statistical comparisons and are only presented for descriptive purposes. Transitional changes in the structural characteristics of snags are presented for those that remained standing within the 4-ha subplots between years.

Bird survey data were summarized to produce species richness and overall bird abundance values for each stand age. Species richness was calculated for individual stands by taking the cumulative number of species detected on all transect counts. Bird density was calculated for each stand age using the cumulative average number of detections per stand over both survey years. Mean density was calculated by using the survey with the highest number of detections over a plot for each species in a given year and then averaging those values between years for each stand. Density values are given in birds / 3ha (total size of a plot).

Table 2. Criteria used to place snags into decay classes.

Decay Class	Needles Present	Bark Remaining	Limbs Present
1	Yes	> 90%	Yes
2	Yes	</= 90%	Yes
3	No	>75%	Yes/No
4	No	51-75%	No
5	No	</=50%	No

Results

Composition of Snag Populations

A total of 1,239 snags were identified within the 35 study blocks over the two years of study. There was an overall 52 % net decline in the number of snags between 2002 and 2003. This net result was due to a total of 649 snags falling between years and 75 new snags being recruited into the snag population after the first year. Snags were not evenly distributed throughout the stand age classes in either year (Figures 4 & 5). Total snag numbers were near their lowest before thinning, peaked 1-2 yrs after thinning, and then declined in older stands. This decline is marked by a precipitous drop of smaller snags immediately following the second commercial thin that produces a shift in the relative proportion of snags from lower dbh classes in young stands towards larger DBH sizes in older stands (Figures 6 & 7). Stand age class also had significant effects on all snag and vegetation variables measured (Table 3) (Figures 8 to 12 for age class comparisons). As stands mature, the relative proportion of snags of with less bark and greater decay also increased.

Of the 1,239 snags identified, 138 or 11.1 % had one or more cavities. Cavity bearing snags were not evenly distributed among the stand age, dbh, decay, and bark classes (all Chi-square-statistic > 55.0, $p < 0.001$). Among stand ages, cavity bearing snags occurred at higher than expected frequencies in age classes 5-6 years after first thin and older (Figures 13 & 14). Within DBH classes, cavity-bearing snags occurred at higher than expected frequencies in the two classes with the greatest DBHs (i.e., > 20 cm DBH) (Figure 15 & 16). Among decay and bark classes, cavity-bearing snags occurred at higher than expected frequencies in the class with the greatest amount of decay and the two classes with the least amount of bark remaining on the main stem (Figures 17 & 18 for decay class and Figures 19 & 20 for bark class).

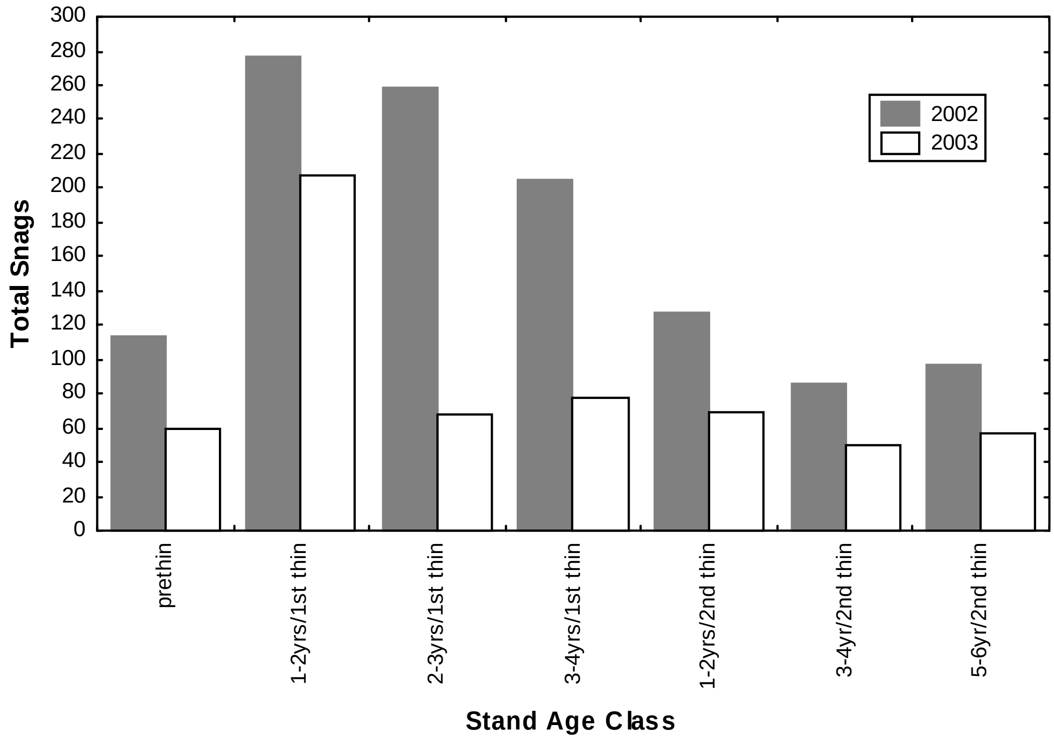

Figure 4. Total number of snags detected in each age class in 2002 and 2003.

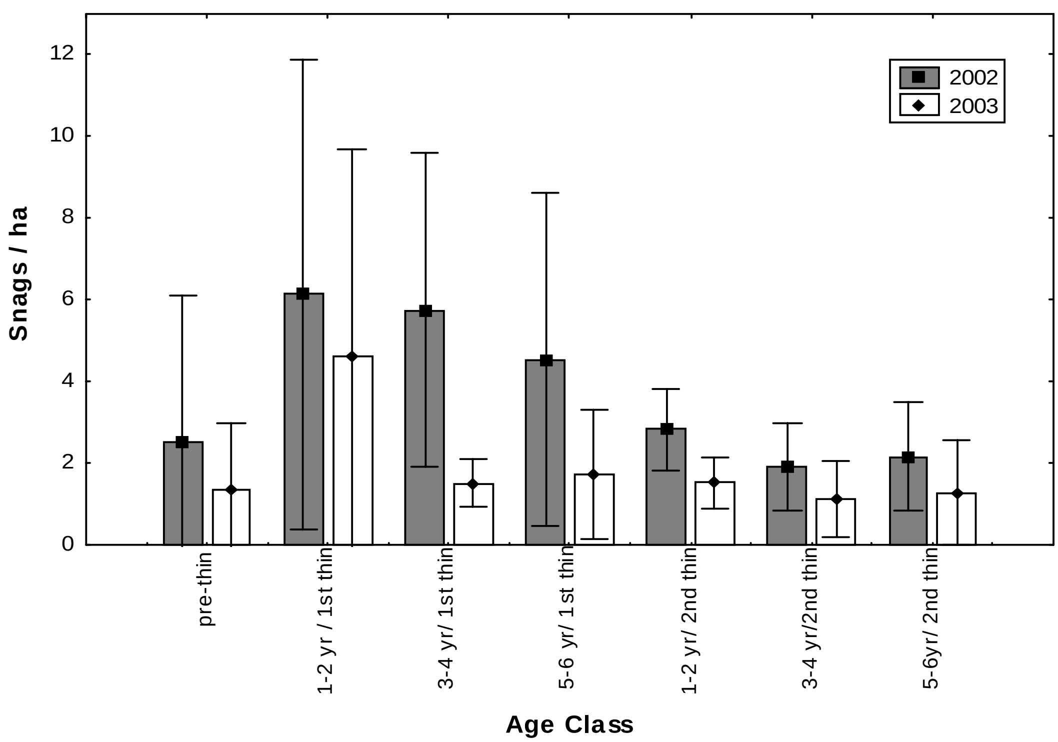

Figure 5. Mean (+ SD) snag density among stand age classes observed in 2002 and 2003.

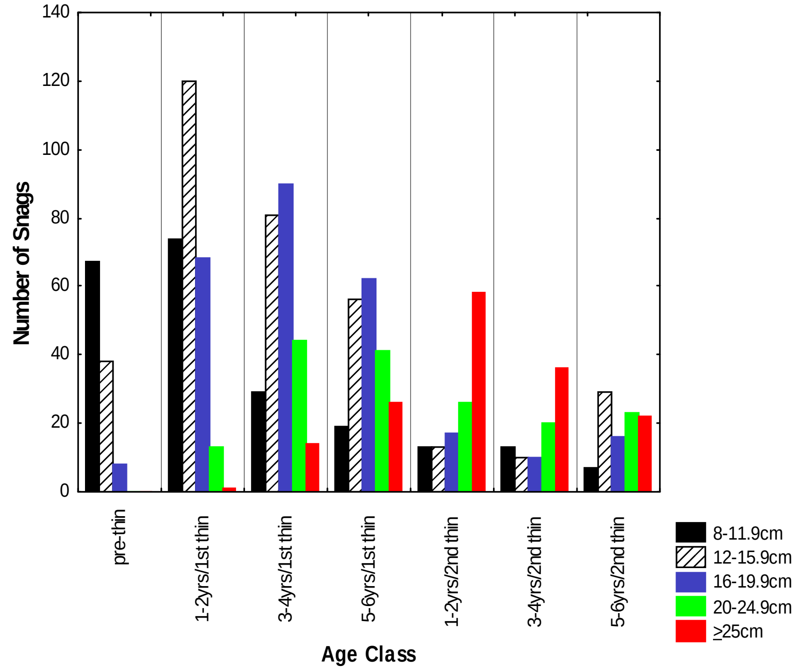

Figure 6. Total numbers of snags observed in each DBH class across age classes in 2002

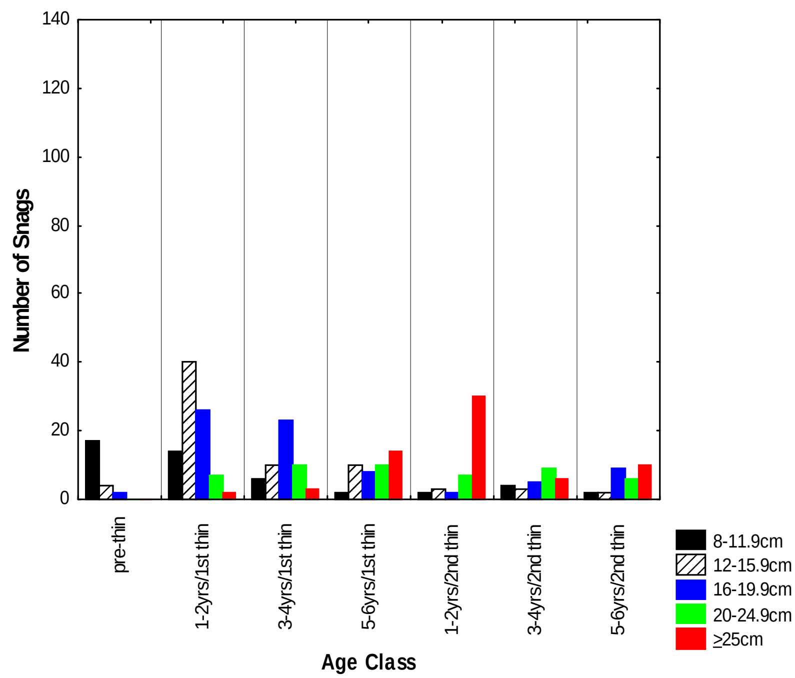

Figure 7. Total numbers of snags observed in each DBH class across age classes in 2003

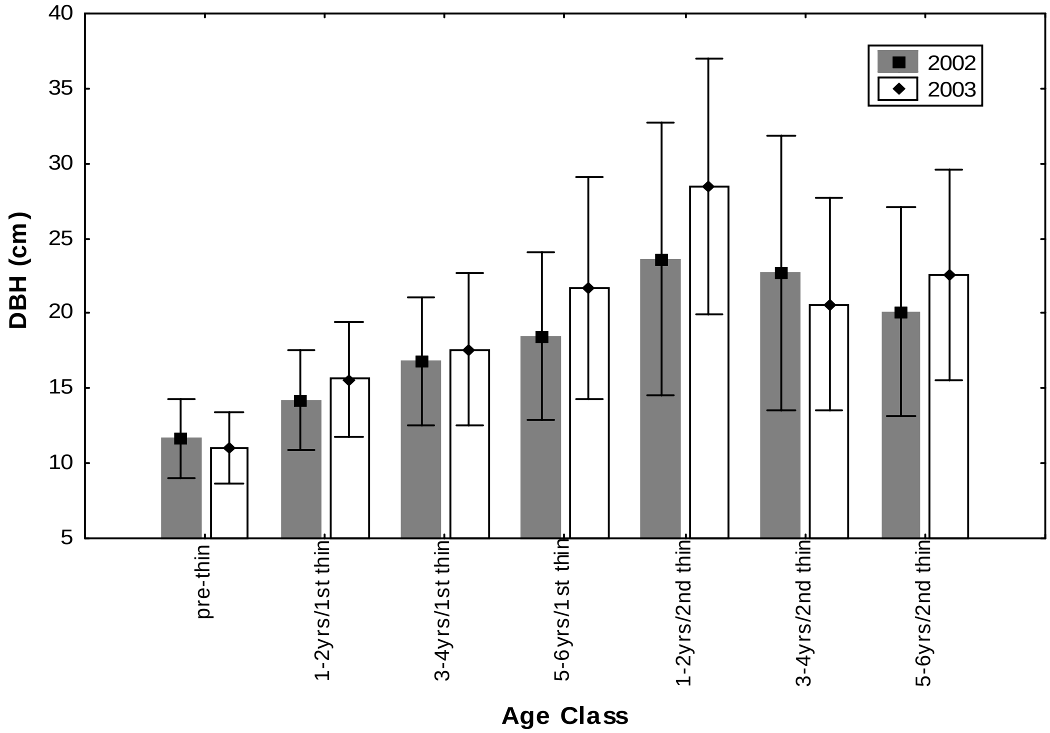

Figure 9. Mean (+ SD) snag height observed across age classes in 2002 and 2003.

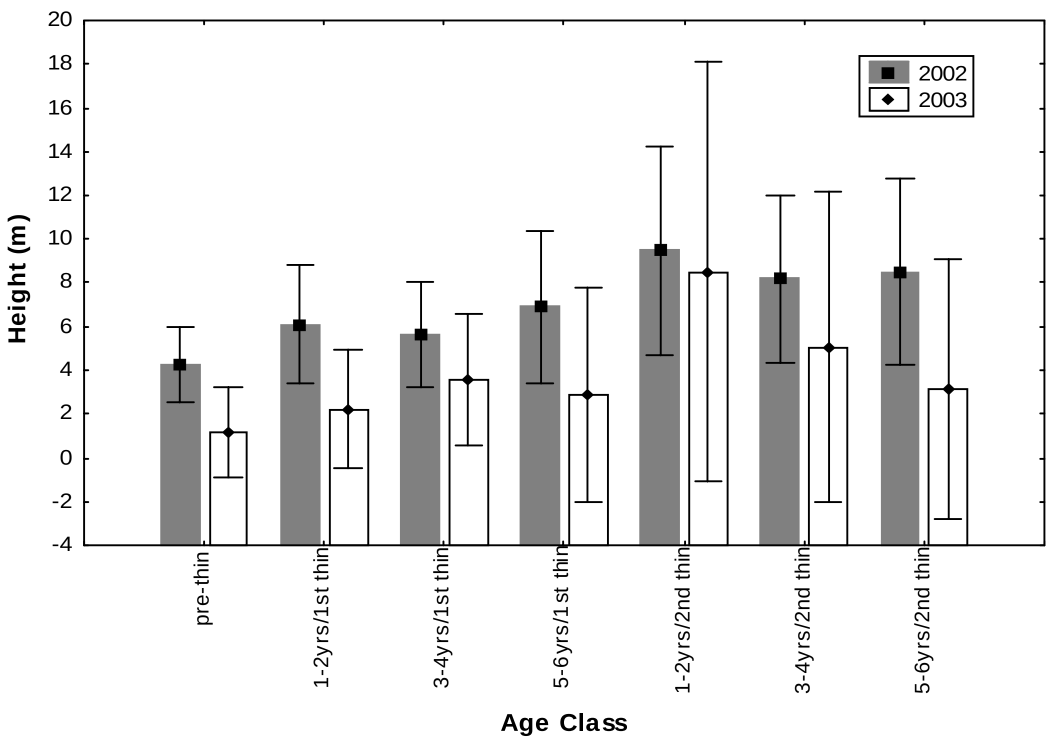

Figure 8. Mean (+ SD) snag DBH observed across age classes in 2002 and 2003.

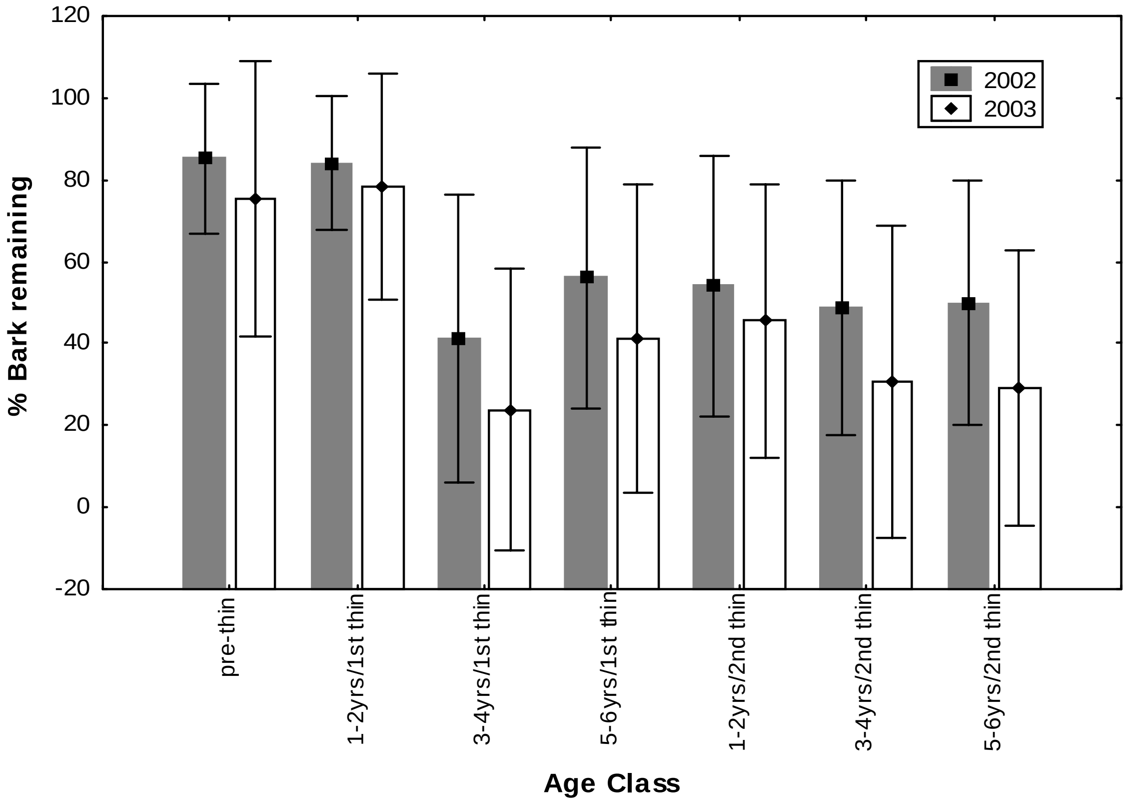

Figure 10. Mean (+ SD) percentage of bark remaining on main stem across age classes in 2002 and 2003.

Table 3. Kruskal-Wallis and Spearman rank correlation results for the effect of stand age on snag and vegetation variables.

Variable	KW H statistic	*p*	Spearman r	*p*
Height	177.1	< 0.001	0.34	< 0.05
DBH	323.4	< 0.001	0.49	< 0.05
Total Limbs	254.8	< 0.001	-0.05	> 0.05
Height to 1st Limb	112.2	< 0.005	0.13	< 0.05
% Bark Remaining	326.5	< 0.05	-0.40	< 0.05
Stems/m^2	136.4	< 0.001	-0.17	< 0.05
Vegetation Height	38.6	< 0.001	0.14	< 0.05

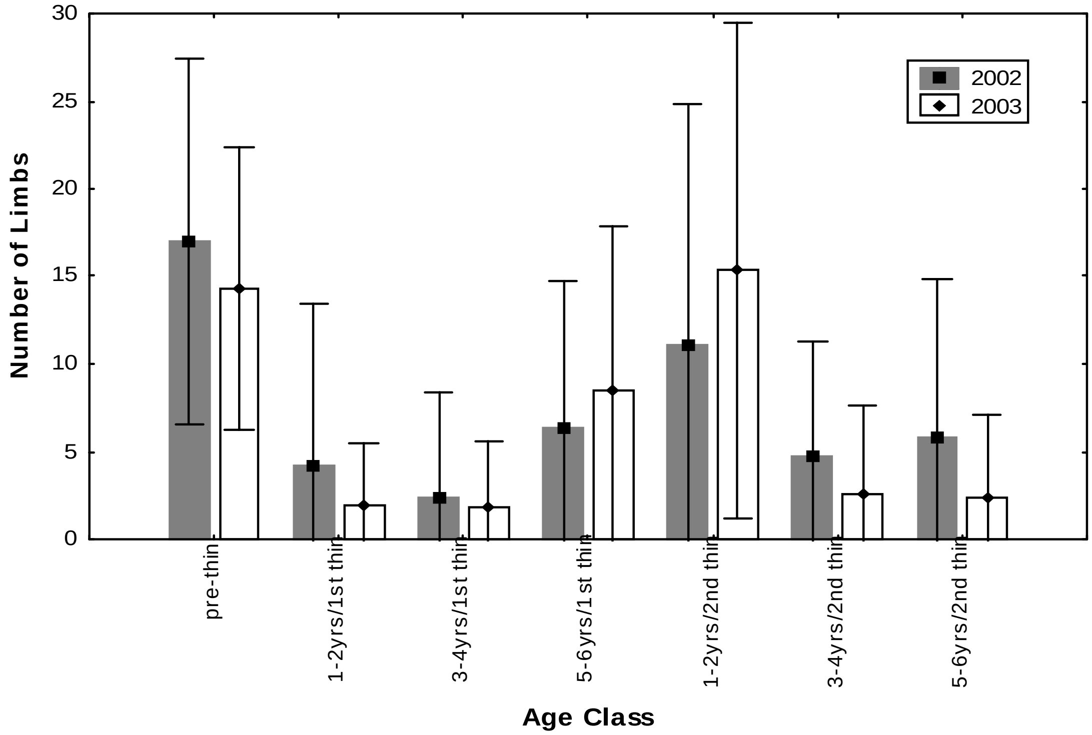

Figure 11. Mean (+ SD) number of total limbs per snag across age classes in 2002 and 2003.

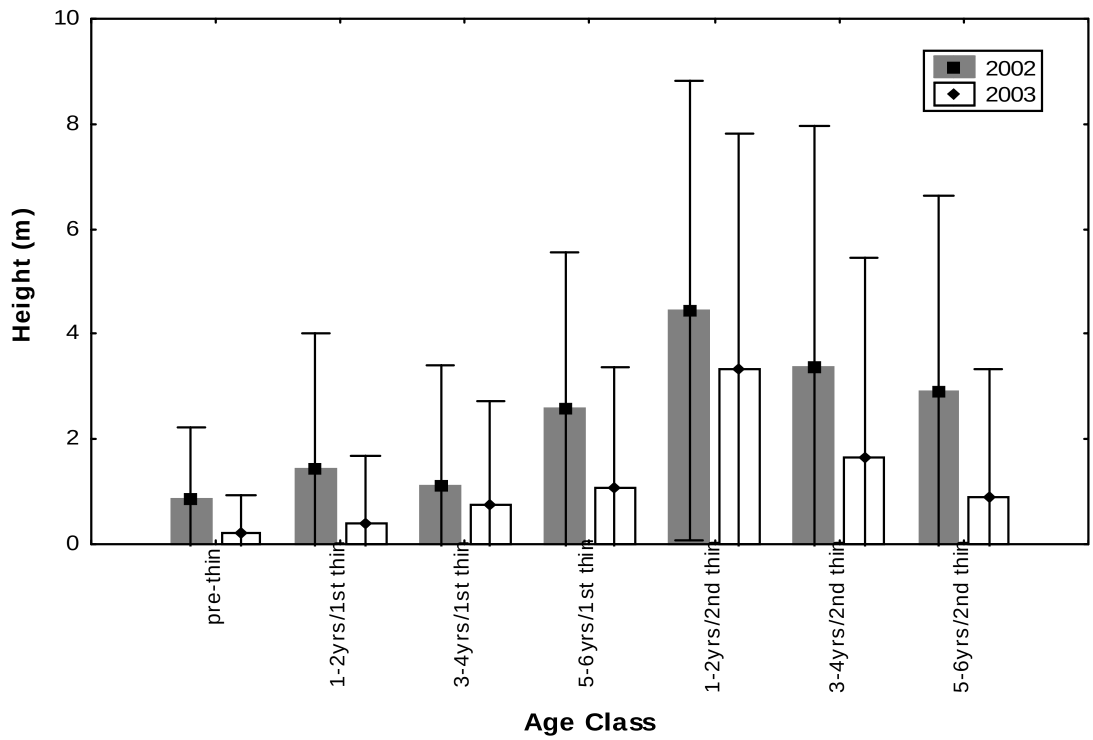

Figure 12. Mean (+ SD) height to first limb of snags across age classes in 2002 and 2003.

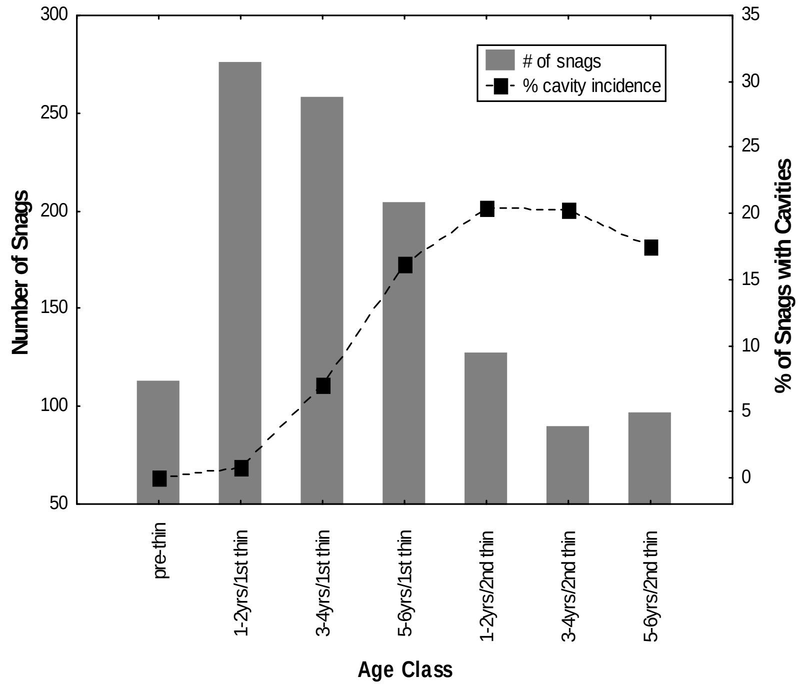

Figure 13. Number of Snags and percentage of snags with cavities across age classes as observed in 2002.

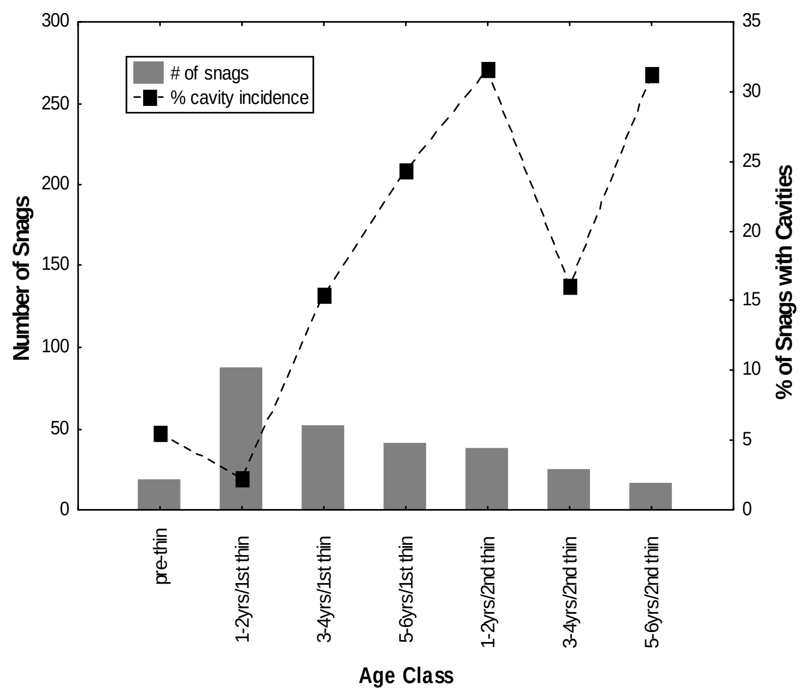

Figure 14. Number of Snags and percentage of snags with cavities across age classes as observed in 2003.

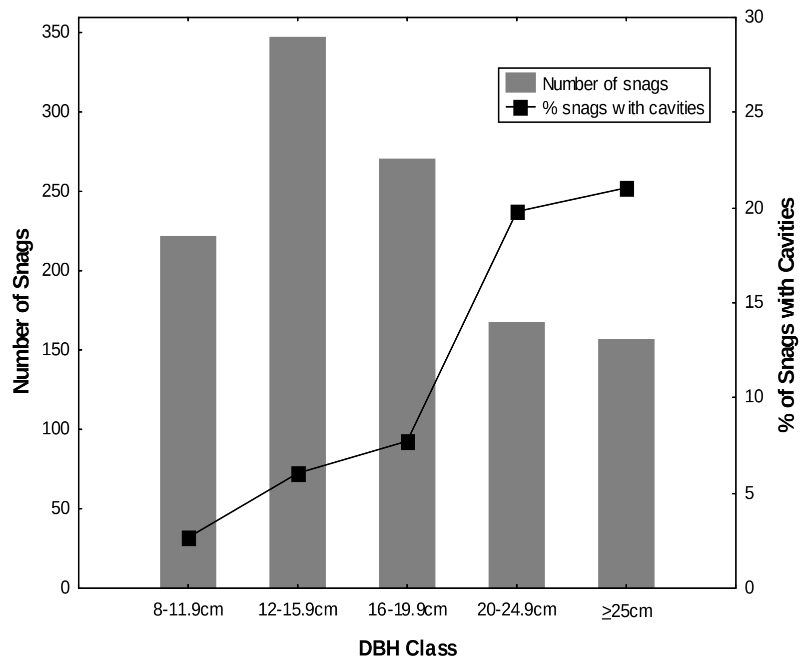

Figure 15. Number of snags and percent of snags with cavities across DBH classes as observed in 2002.

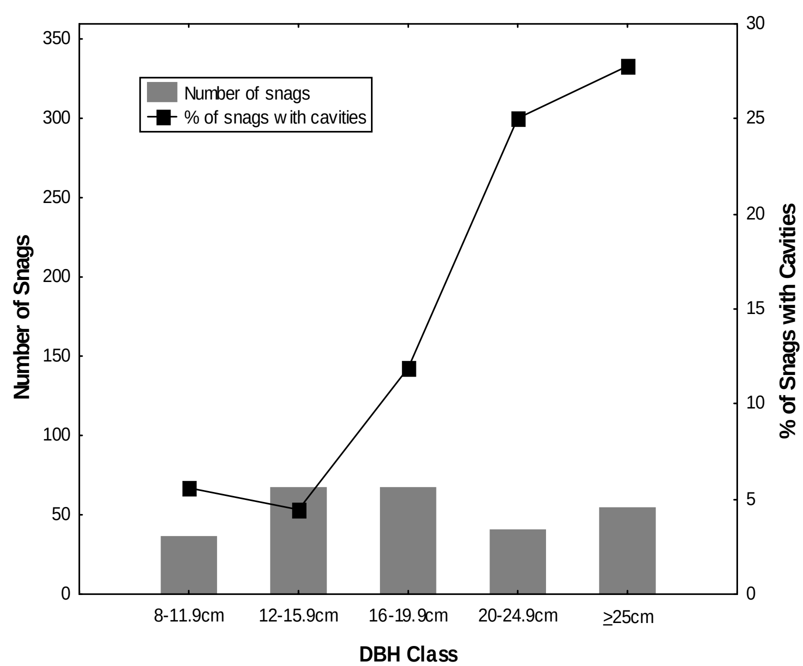

Figure 16. Number of snags and percent of snags with cavities across DBH classes as observed in 2003.

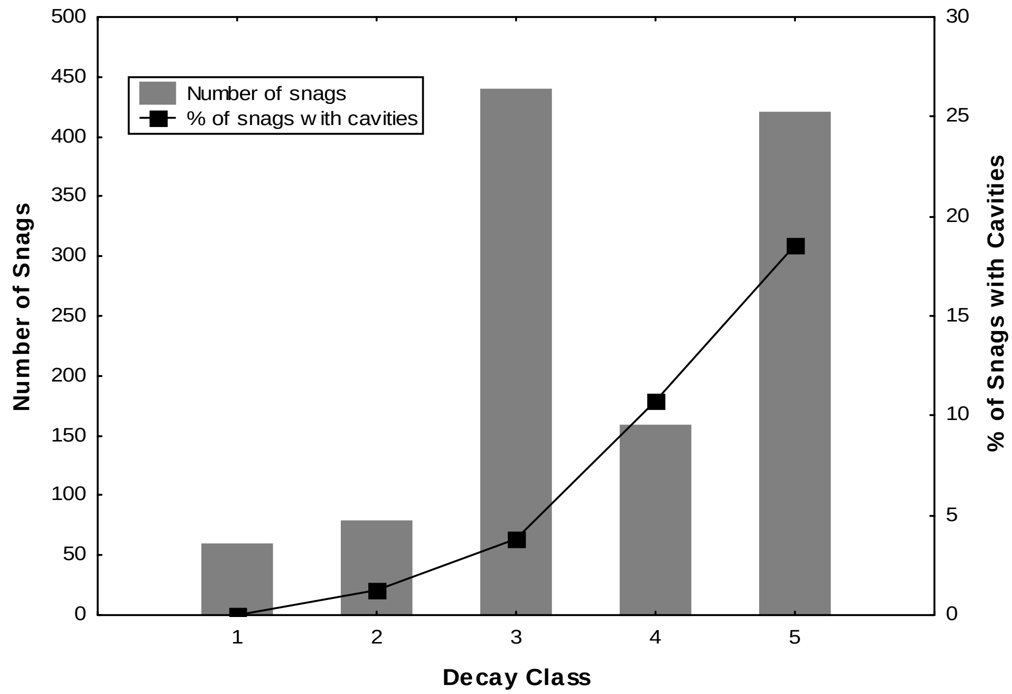

Figure 17. Number of snags and percent of snags with cavities across decay classes as observed in 2002.

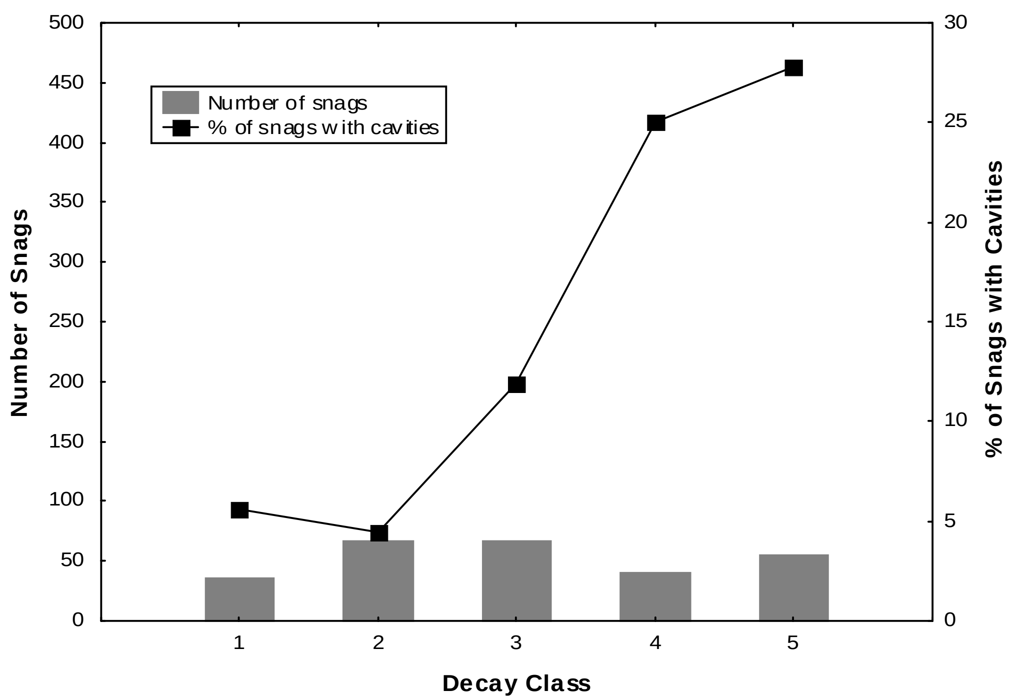

Figure 18. Number of snags and percent of snags with cavities across decay classes as observed in 2003.

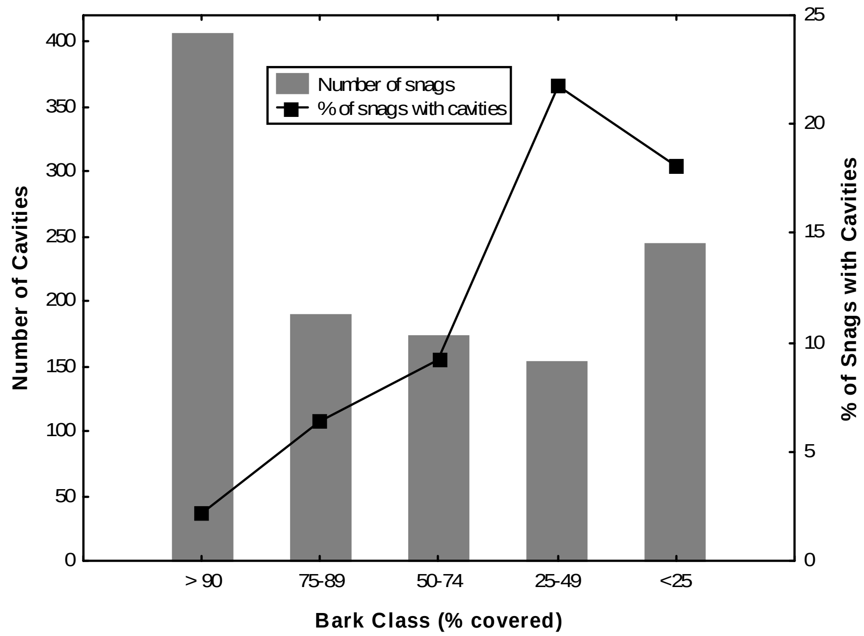

Figure 19. Number of snags and percent of snags with cavities across bark classes as observed in 2002.

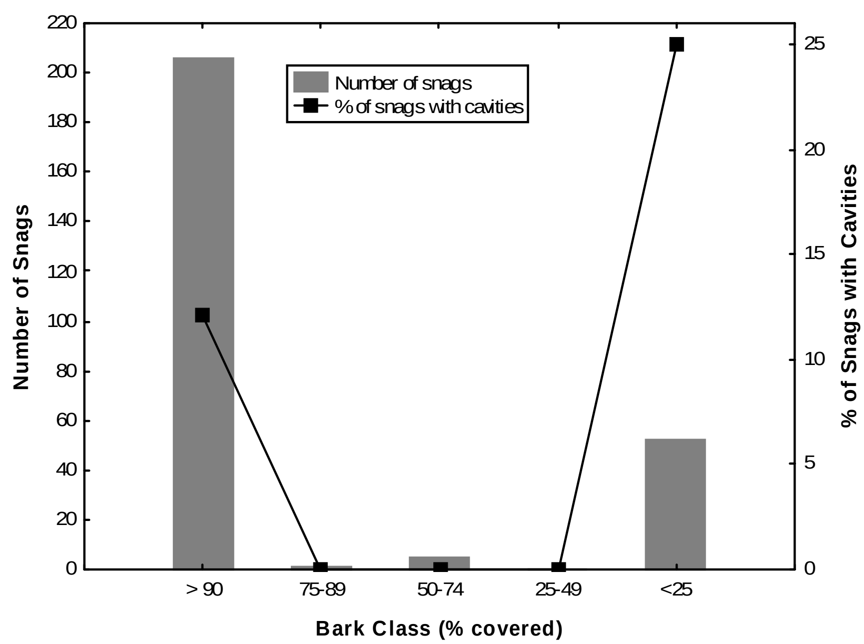

Figure 20. Number of snags and percent of snags with cavities across bark classes as observed in 2003.

Characteristics of individual snags were compared between those with and without cavities. Significant differences were found in the variables height, DBH, height to first limb, decay class, % bark remaining, and surrounding vegetation height in each year (Tables 4 & 5). Snags with cavities were found to be significantly taller, had greater DBHs and distance to first limb, had less remaining bark, and surrounded by taller understory vegetation than snags without cavities. Characteristics of snags were also examined solely within the two oldest age classes for a finer resolution. Significant differences remained to be found in the variables height, DBH, height to first limb, decay class, and % bark remaining in 2002 (Table 6). Significant differences were only found for total limbs in 2003 (Table 7). Overall, Cavity bearing snags within older stand age classes were significantly taller, had greater DBHs and distances to first limb, and had less bark remaining than snags without cavities. The number of cavities per snag ranged from 1 to 12 and showed significant positive correlations in both years to stand age (Pearson $r = 0.21$, $p < 0.05$), snag height ($r = 0.20$, $p < 0.05$), DBH ($r = 0.55$, $p < 0.05$), and a significant negative correlation with % of bark remaining ($r = -0.18$, $p < 0.05$).

Of the 116 cavity-bearing snags identified in 2002, 12 or 10.34% were confirmed as being used for nesting in 2002. In 2003, there were no cavities confirmed as being used for nesting among 44 cavity-bearing snags. Examination of selected cavities with the video camera system did not reveal any previously unidentified nests. Nesting activity was observed for 5 species in 10 stands spanning 5 age classes (Table 8). Nesting was observed in all age classes except pre-thin and 1-2 years after first thin. No significant differences were found in the frequency of cavity use when compared to bark, decay, DBH, and age classes. Comparison of individual characteristics from used and unused cavity bearing snags also resulted in no significant differences being found (Table 9).

Table 4. Mann-Whitney U test results for comparison of snag and vegetation characteristics between snags with and snags without cavities surveyed in 2002.

Variable	Mann-Whitney U	*p*	N (with cavities, without cavites)
Height	48464.0	< 0.001	115, 1040
DBH	34875.5	< 0.001	115, 1040
Total Limbs	57095.0	> 0.10	115, 1040
Height to 1st limb	47492	< 0.001	115, 1040
% of bark remaining	33229.5	< 0.001	115, 1040
Stems / m^2	18456.2	> 0.10	90, 412
Vegetation Height	16834.5	< 0.001	90, 412

Table 5. Mann-Whitney U test results for comparison of snag and vegetation characteristics between snags with and snags without cavities surveyed in 2003.

Variable	Mann-Whitney U	*p*	N (with cavities, without cavites)
Height	3684.0	< 0.05	42, 234
DBH	2469.0	< 0.001	115, 1040
Total Limbs	3379.5	< 0.05	115, 1040
Height to 1st limb	3626.5	< 0.01	115, 1040
% of bark remaining	2660.0	< 0.001	115, 1040
Stems / m^2	983.2	> 0.10	90, 412
Vegetation Height	3325.5	< 0.001	90, 412

Table 6. Student t-test results for comparison of snag and vegetation variables between snags with and without cavities from combined age, DBH, decay, and bark classes with higher than expected frequencies of cavity-bearing snags observed in 2002.

Variable	Mean value for snags with cavities	Mean value for snags without cavities	t statistic (d.f. = 184)	*p*	N (with cavities, without cavities
Height	10.14 ± 3.92	7.93 ± 3.91	2.96	< 0.001	35, 151
DBH (cm)	25.97 ± 8.86	20.25 ± 7.74	3.86	< 0.001	35, 151
Total Limbs	6.85 ± 7.23	4.92 ± 8.13	1.29	< 0.10	35, 151
Height to 1st Limb (m)	5.23 ± 5.12	2.65 ± 3.88	3.42	< 0.001	35, 151
% Bark Remaining	37.85 ± 27.91	52.00 ± 30.45	2.52	< 0.05	35, 151
Stems / m^2	1.47 ± 1.44	1.52 ± 1.62	0.13	> 0.10	23, 96
Vegetation Height	1.89 ± 0.63	1.76 ± 0.69	0.21	> 0.10	23,96

Table 7. Student t-test results for comparison of snag and vegetation variables between snags with and without cavities from combined age, DBH, decay, and bark classes with higher than expected frequencies of cavity-bearing snags observed in 2003.

Variable	Mean value for snags with cavities	Mean value for snags without cavities	t statistic (d.f. = 39)	*p*	N (with cavities, without cavities
Height	9.44 ± 10.09	7.26 ± 6.38	0.79	> 0.10	9, 32
DBH (cm)	23.52 ± 10.81	22.06 ± 6.15	0.61	> 0.10	9, 32
Total Limbs	6.12 ± 8.95	1.59 ± 2.34	2.34	< 0.05	9, 32
Height to 1st Limb (m)	3.03 ± 4.34	2.06 ± 4.03	0.62	> 0.10	9, 32
% Bark Remaining	22.50 ± 35.67	25.62 ± 33.01	0.23	> 0.10	8, 32
Stems / m^2	1.59 ± 2.13	1.35 ± 1.89	0.32	> 0.10	8, 32
Vegetation Height	1.76 ± 1.12	1.81 ± 0.98	0.43	> 0.10	8, 32

Table 8. List of active nests detected in cavities, with species, stand number stand age, and selected snag characteristics.

Common Name	Scientific Name	Stand #	Stand Age	Snag Height	Snag DBH	% of Bark Remaining	Cavity Height
Carolina Chickadee	*Parus carolinensis*	42385	3-4 years after first thin	2.41m	14.1cm	95%	2.25m
Tufted Titmouse	*Parus bicolor*	44406	3-4 years after first thin	3.31m	21.3cm	20%	3.24m
Great-crested Flycatcher	*Myiarchus crinitus*	42003	3-4 years after first thin	3.85m	19.4cm	45%	3.75m
Great-crested Flycatcher	*Myiarchus crinitus*	42385	3-4 years after first thin	8.4m	20.6cm	90%	7.2m
Great-crested Flycatcher	*Myiarchus crinitus*	44299	5-6 years after first thin	13.2m	23.9cm	55%	12.4m
Great-crested Flycatcher	*Myiarchus crinitus*	44306	5-6 years after first thin	3.80m	17.0cm	65%	2.8m
Great-crested Flycatcher	*Myiarchus crinitus*	44306	5-6 years after first thin	13.94m	29.5cm	35%	11.15m
Brown-headed Nuthatch	*Sitta pusilla*	42682	1-2 years after second thin	7.35m	19.8cm	20%	4.3m
Great-crested Flycatcher	*Myiarchus crinitus*	44429	1-2 years after second thin	11.32m	39.6cm	15%	9.1m
Yellow-shafted Flicker	*Colaptes auratus*	42682	1-2 years after second thin	9.24m	28.6cm	0%	8.31m
Carolina Chickadee	*Parus carolinensis*	42154	3-4 years after second thin	13.12m	21.2cm	10%	8.23m
Great-crested Flycatcher	*Myiarchus crinitus*	42739	5-6 years after second thin	14.12m	33.6cm	20%	8.1m

Table 9. Results of Student t-tests for comparison of snag and vegetation variables between snags with used and unused cavities.

Variable	Mean value for snags with used cavities ± SD	Mean value for snags with unused cavities ± SD	t value	p value	N (w/used cavities, w/unused cavities)
Height	8.67 ± 4.49	7.53 ± 3.62	1.01	>0.05	12, 104
DBH	24.05 ± 7.38	21.54 ± 7.55	1.09	>0.05	12, 104
Total Limbs	8.58 ± 7.79	4.71 ± 6.50	1.91	>0.05	12, 104
Height to 1st limb	4.57 ± 3.38	3.35 ± 4.05	1.00	>0.05	12, 104
% bark remaining (dec.)	.39 ± .31	.38 ± .29	0.13	>0.05	12, 104
Stems/m^2	2.28 ± 2.03	1.66 ± 1.70	1.10	>0.05	11, 84
Mean Vegetation Height	2.12 ± 0.78	1.90 ± .62	1.05	>0.05	11, 84

A total of 1,916 bird detections of 50 species were recorded over the two years of surveys. Shrub-nesting species such as the Common Yellowthroat, White-eyed Vireo, Gray Catbird and Eastern Towhee were the most commonly detected species accounting for >65 % of all observations. Cavity nesting species accounted for 10.6 % of all observations and included; Barred Owl, Downy Woodpecker, Hairy Woodpecker, Red-bellied Woodpecker, Red-headed Woodpecker, Yellow-shafted Flicker, Brown-headed Nuthatch, Carolina Wren, Eastern Bluebird, Carolina Chickadee, Tufted Titmouse, and Great-crested Flycatcher. Total species richness and total bird density was significantly influenced by stand age (One-way ANOVA, $F_6 = 3.16$, $p < 0.05$ and $F_6 = 2.91$, $p < 0.05$ respectively). Both richness and density increased significantly (post-hoc test, $p < 0.05$) after thinning and both variables were positively related with stand age ($r = 0.51$, $p < 0.05$, and $r = 0.21$, $p > 0.10$) (Table 10). Densities of composite groups of primary, secondary, and all cavity nesting species were not significantly influenced by stand age (KW H = 5.1, 7.4, and 7.1 respectively, all p values > 0.10). Even so, the density and total detections of each cavity nesting group species increased two-fold after thinning and peaked in older stands (Figures 21 & 22).

Table 10. Mean values + SD and total values for species richness and overall bird density detected among stand age classes.

Age Class	Mean Species Richness (± SD)	Total Species Detected	Total Bird Density / 3 ha
Prethin	14.40 ± 2.70	30	19.0 ± 4.71
1-2yr after 1st thin	17.80 ± 2.16	36	26.80 ± 8.13
3-4yr after 1st thin	16.20 ± 2.49	29	23.00 ± 5.63
5-6yr after 1st thin	19.20 ± 2.39	35	22.20 ± 7.43
1-2 yr after 2nd thin	19.00 ± 1.73	41	27.00 ± 5.77
3-4yr after 2nd thin	19.80 ± 2.04	38	30.60 ± 15.42
5-6yr after 2nd thin	19.0 ± 3.31	33	23.00 ± 4.71

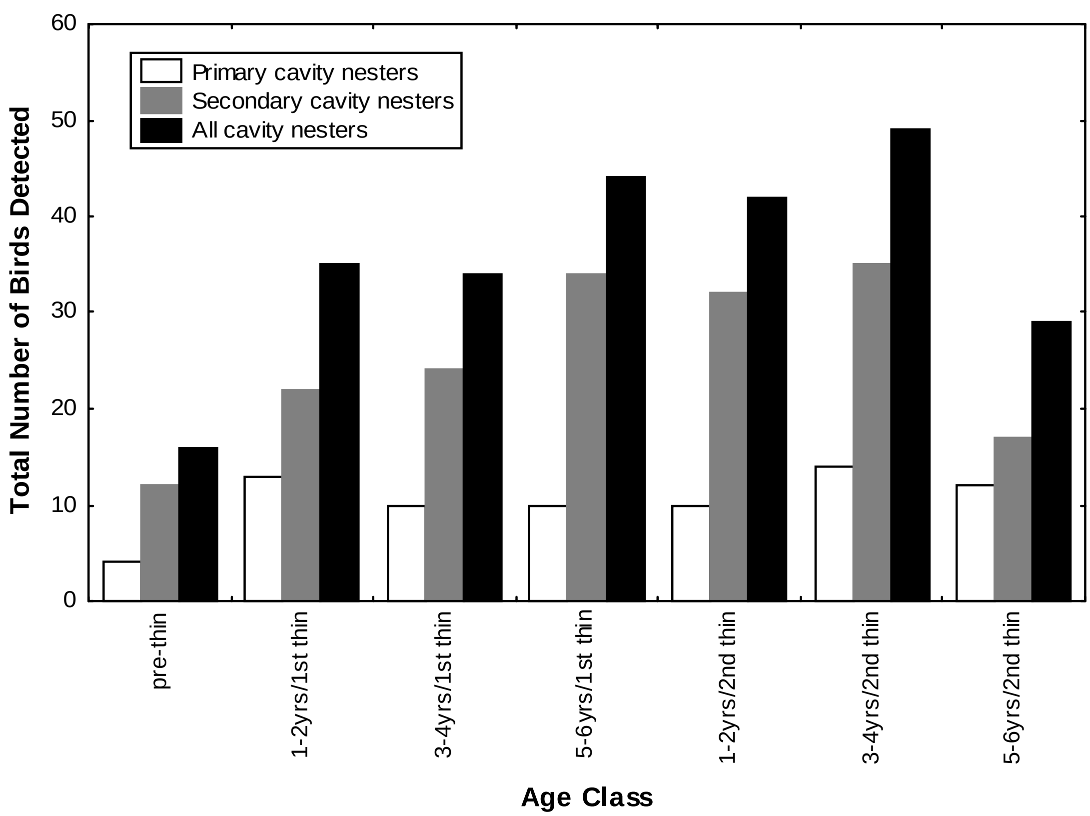

Figure 21. Total detections of primary, secondary, and all cavity nesting birds during 2002 and 2003 surveys across age classes.

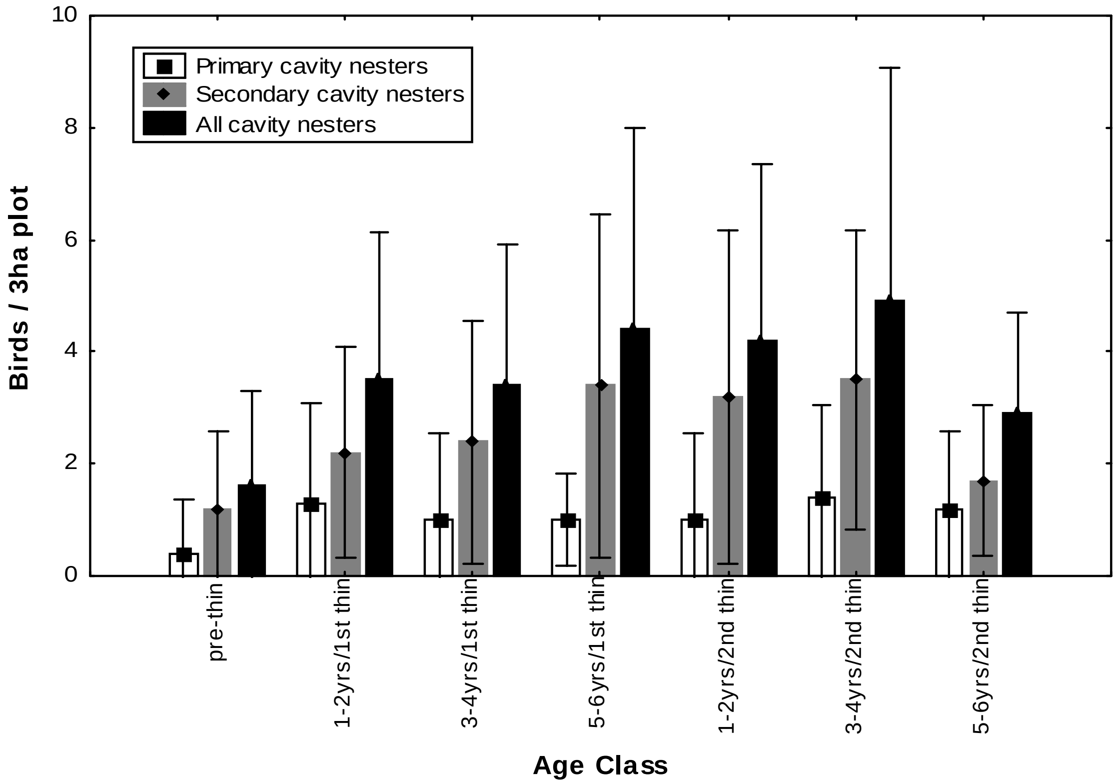

Figure 22. Mean (+ SD) density of primary, secondary, and all cavity-nesting birds detected within 3-ha survey plots across age classes.

Snag Loss and Recruitment Between Years

There was an overall 52 % net decline in the number of snags between 2002 and 2003. This net result was due to a total of 649 snags falling between years and 75 new snags being recruited into the snag population in 2003. Snag loss rates were statistically indistinguishable between stand age classes (KW ANOVA, $H = 7.8$, $p > 0.25$). Average loss rates were lowest (35.7 %) for cohorts that were within 1-2 years after first thinning and varied between 53 and 64 % for cohorts within the remaining age classes (Figure 23). Snag loss rates were also statistically indistinguishable among categorical variables of DBH class ($H = 2.64$, $p < 0.50$), bark class ($H = 4.4$, $p > 0.10$), and decay class ($H = 6.0$, $p > 0.10$) (see Figures 24-26 for respective illustrations). Similarly, there were no statistical differences in the variables snag height, DBH, total limbs, and height to first limb for snags that remained standing between years were compared to those that fell between years (Table 11). Only the % of bark remaining was found to be statistically different between standing and fallen snags. On average, snags that remained standing had 13 % more bark compared to snags that fell during the study.

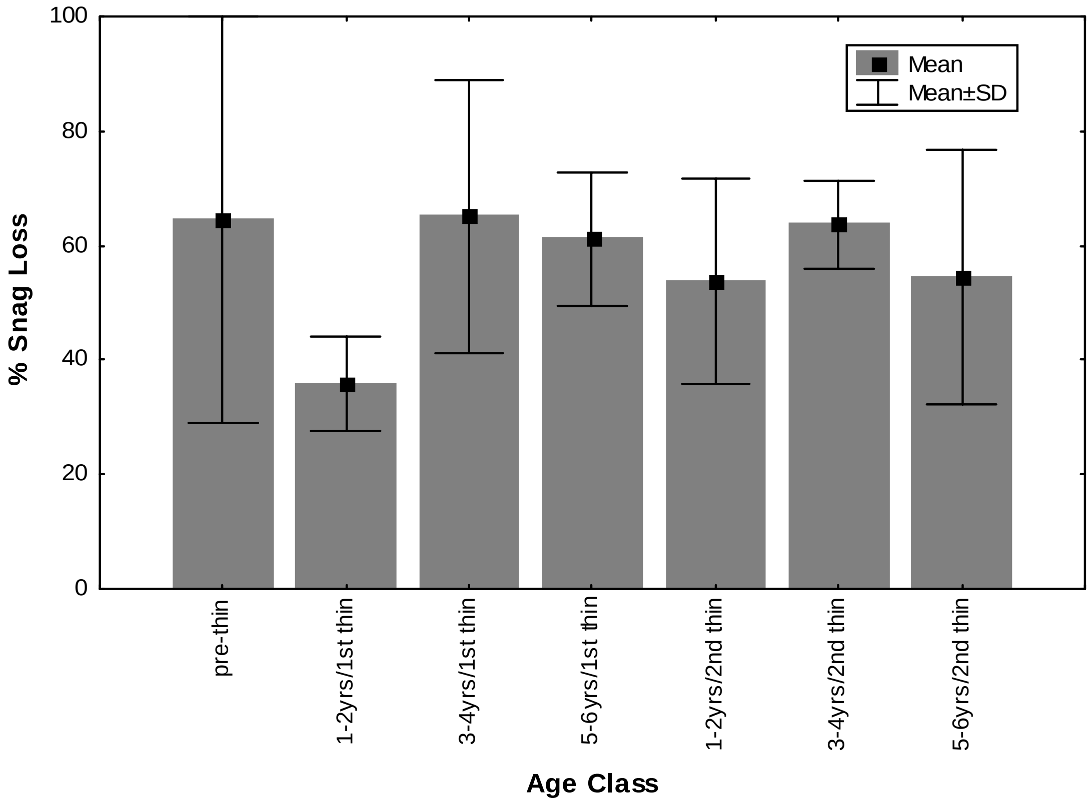

Figure 23. Mean snag loss rates (percent of total snags fallen) between survey periods of 2002 and 2003 across age classes.

Table 11. Mean values and Mann-Whitney U test results for the comparison of snag characteristics between snags that remained standing between 2002 and 2003 and snags that fell during this time.

Variable	Mean Value for snags standing ± SD (N= 515)	Mean Value for snags that fell ± SD (N = 649)	Mann-Whitney U	*p*
Snag Height	6.82 ± 3.80	6.57 ± 3.37	164224.0	> 0.50
DBH	17.38 ± 6.96	17.48 ± 6.48	163095.5	> 0.10
Total Limbs	6.89 ± 10.87	5.91 ± 9.17	166185.5	> 0.50
Height to 1st Limb	2.17 ± 3.38	2.07 ± 3.13	166004.5	> 0.50
% bark remaining	0.68 ± 0.29	0.55 ± 0.34	133952.5	< 0.001
# of cavities	0.17 ± 0.84	0.29 ± 0.97	157009.0	> 0.05

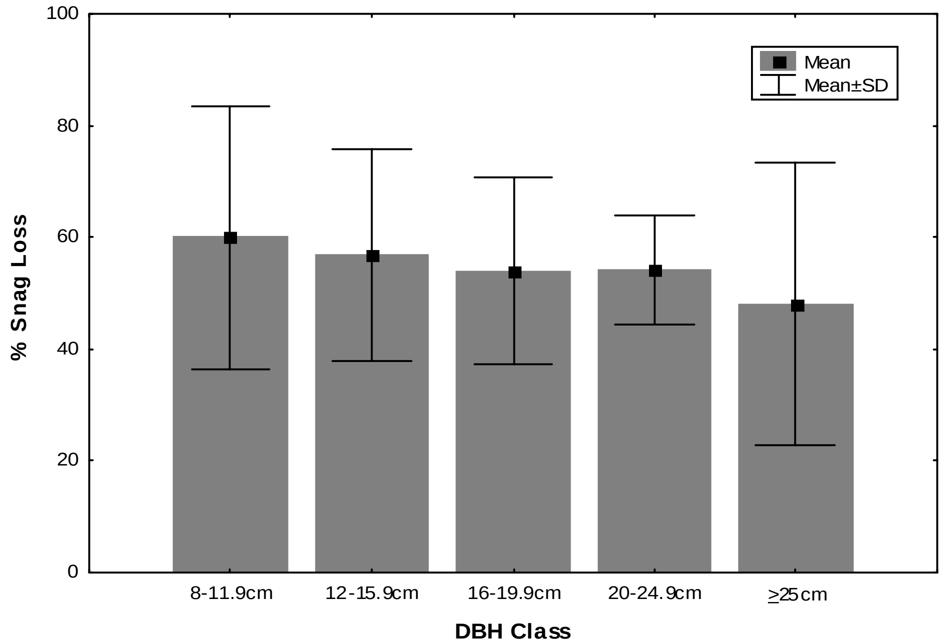

Figure 24. Mean snag loss rate (percent of total snags fallen) between 2002 and 2003 among DBH classes.

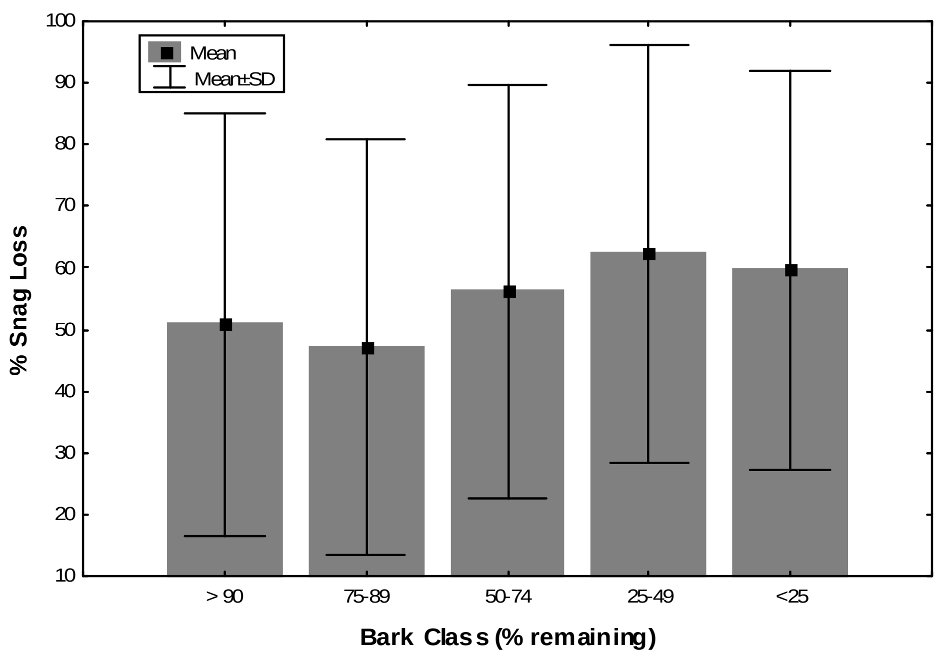

Figure 25. Mean snag loss rates (percent of total snags fallen) between 2002 and 2003 among bark classes.

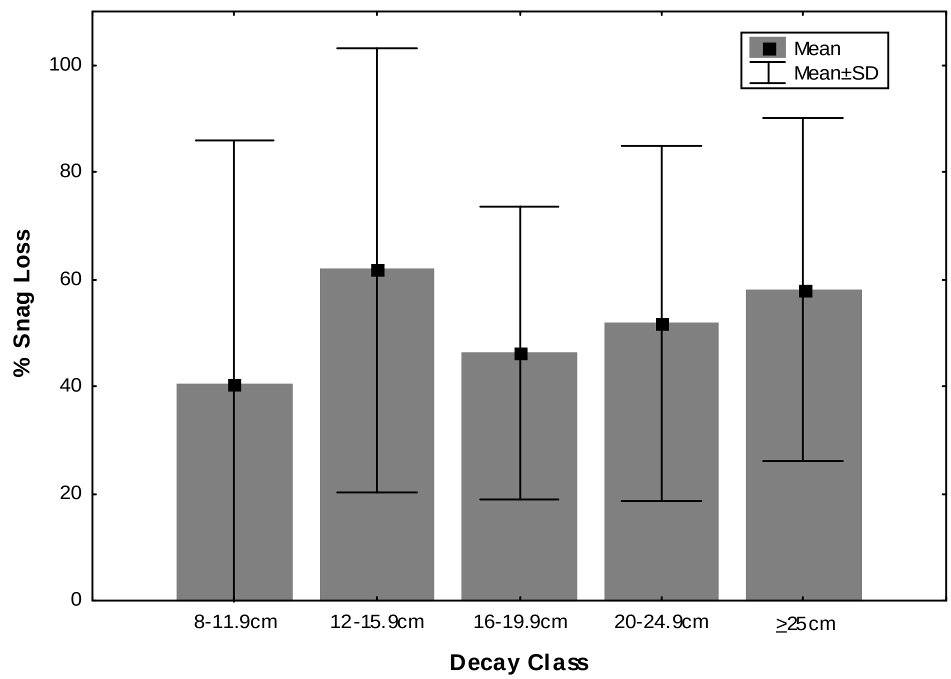

Figure 26. Mean snag loss rates (percent of total snags fallen) between 2002 and 2003 among decay classes.

Snag loss rates were also compared between snags with cavities and snags without cavities. Overall, 71 % of snags with cavities and 54 % of snags without cavities originally identified in 2002 fell between years. However, there was no statistically significant difference in the falling rates between snags with or without cavities (Mann-Whitney U = 345.0, $p > 0.10$). This result remained consistent when examined solely within the two oldest stand age classes that contained the greatest proportion of cavity bearing snags (Mann-Whitney U = 7.5, $p > 0.10$).

The 75 new snags that were recruited into the population between years significantly deviated from an expected even distribution across stand age classes (Chi-square statistic = 43.4, $p < 0.001$) (Figure 27). Recruitment was highest in stands 1-2 years after first thin, 1-2 years after second thin, and 3-4 years after second thin. Statistical testing to compare the characteristics of new snags to those in the 2002 cohort was not possible because of low sample sizes. In general, newly recruited snags were similar in DBH and height within respective age classes as the 2002 cohort (Figure 28). Sixty three percent of new snags were in mid stages of decay (decay class = 3) (Figure 29) and 57 % of new snags were covered by 75 % or more bark (Figure30).

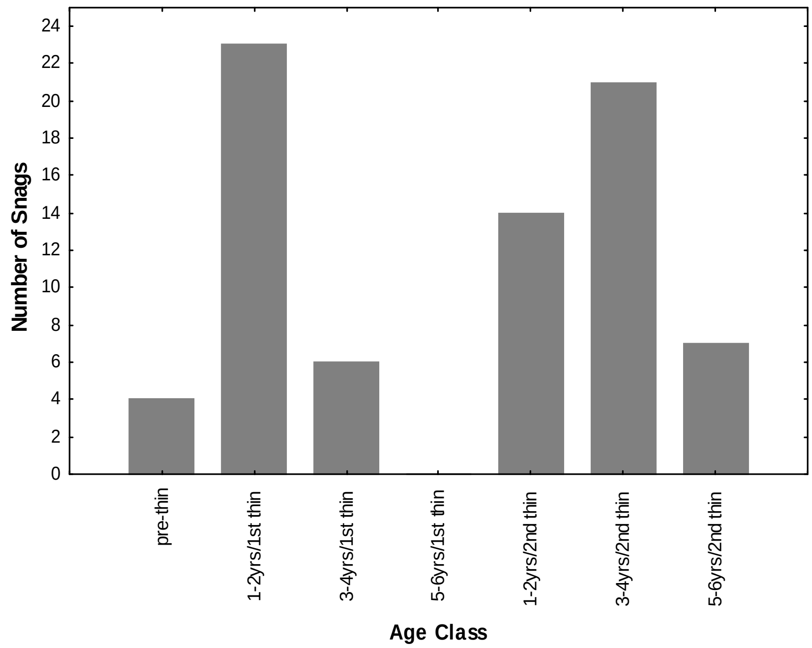

Figure 27. Frequency distribution of newly recruited snags detected across age classes in 2003.

Figure 28. DBH composition of newly recruited snags detected across age classes in 2003.

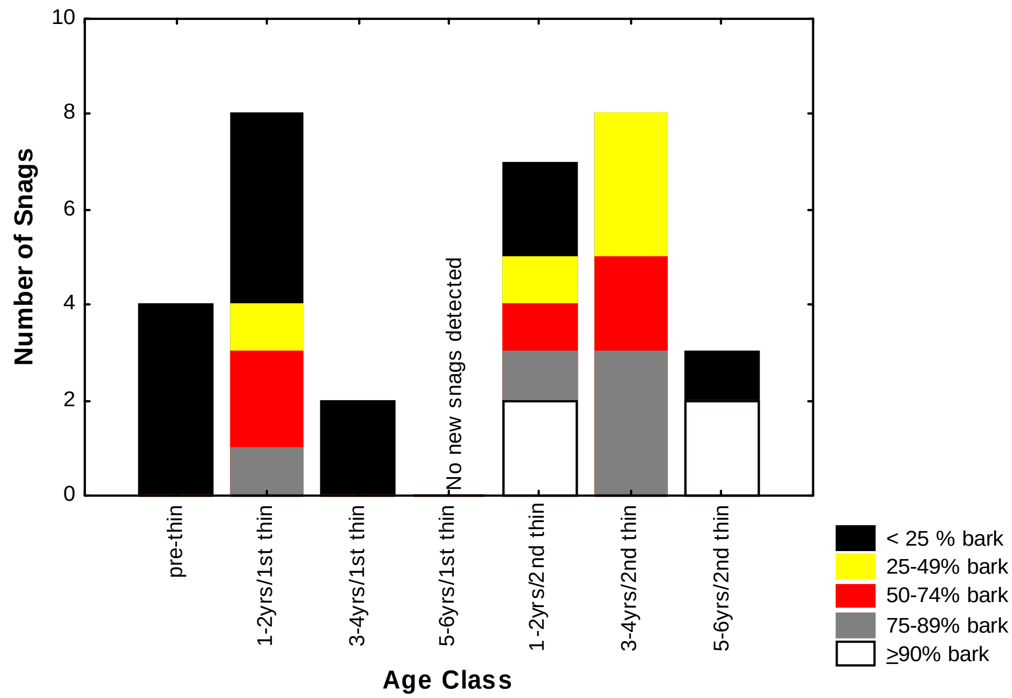

Figure 29. Frequency and composition of newly recruited snags among bark classes and age classes that were detected in 2003.

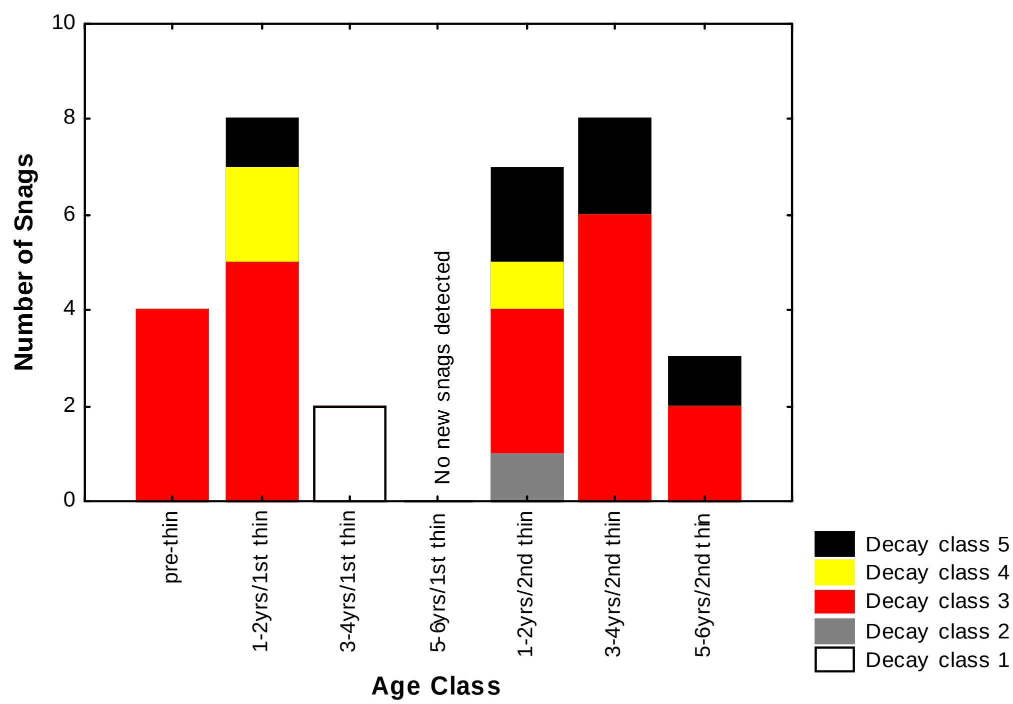

Figure 30. Frequency and composition of newly recruited snags among decay classes and age classes that were detected in 2003.

Transitional Characteristics of Snags

Transformations in the characteristics of snags were determined for 277 snags that remained standing between years. The number of snags detected with cavities among this subsample increased from 25 to 42 (9.0 to 15.0%) between years. In 2003, cavities were detected within 23 snags that were not detected with cavities in 2002. Conversely, 6 snags detected with cavities in 2002 no longer contained cavities in 2003. The latter result is due to the portions of snags containing cavities breaking off between years. The 23 snags that bore cavities for the first time in 2003 were evenly distributed among stand age classes (Chi-square statistic = 9.1, $p > 0.10$).

Overall, a total of 47 or 21.0% of the 277 standing snags were fractured and lost at least 2m or more of their initial height between years. Among all fractured snags, the proportional loss in height was significantly and positively correlated with initial snag height (Pearson $r = 0.48$, $p < 0.05$) (Figure 31) and DBH ($r = 0.21$, $p < 0.05$) (Figure 32). In other words, larger snags tended to lose proportionately greater amounts of dead wood when fractured.

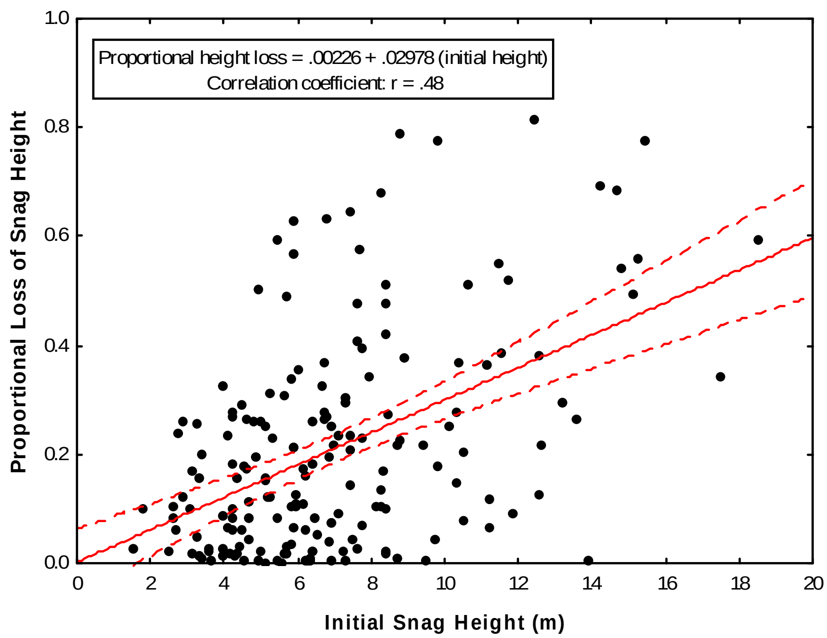

Figure 31. Scatterplot of the relationship between initial snag height and proportional loss of snag height after breaking off between years.

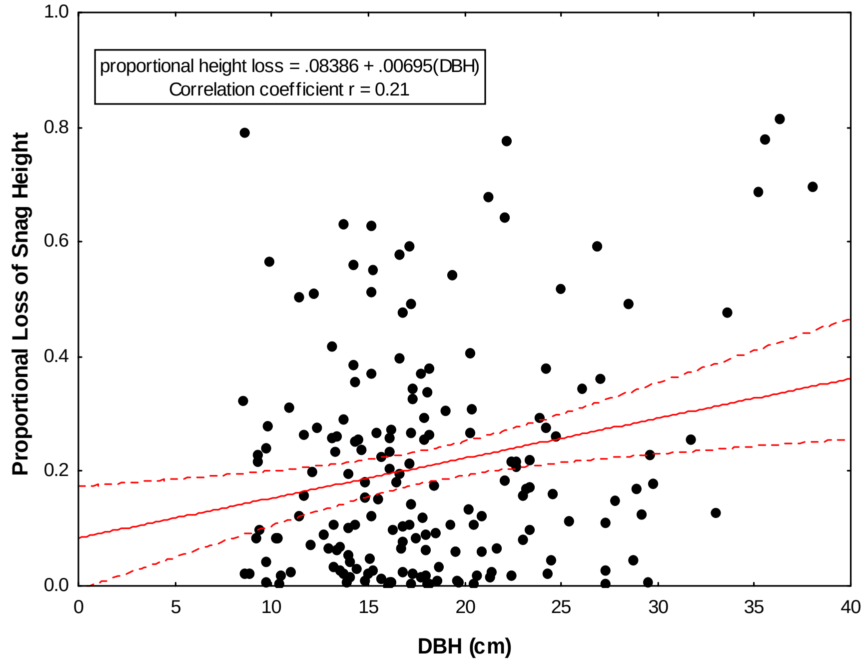

Figure 32. Scatterplot of the relationship between snag DBH and the proportion of snag height loss after breaking off between years

DISCUSSION

The staggered management regime that creates a matrix of different aged stands also influences the recruitment and loss of snags within these stands. The number and characteristics of snags change throughout the management cycle, and are influenced by commercial thinning activities.

Data collected in the initial year of survey indicate that thinning activities appear to both create and contribute to the loss of older snags. Within pre-thinned stands snag numbers were low. Snags that did occur within pre-thinned stands were generally short, had small DBH measurements, retained much bark and were not in advanced stages of decay. Snags with smaller DBH measurements decay at much greater rates than larger snags and thus have greater falling rates than larger snags (Raphael and Morrison, 1987). The detection of fewer snags in advanced stages of decay within this age class may be due to the rapid falling rate once the decay process begins.

A dramatic increase in the number of snags was observed immediately after the first commercial thin. It appears that unintentional mortality of young pines occurs during first thinning event. The number of snags/ha was greatest in the age class immediately after the first commercial thin (1-2 years after first thin). Snags within the 1-2 years after first thin age class had fairly small DBH measurements, high percentages of retained bark and had not undergone any substantial decay. As stands matured, through the age classes of 3-4 and 5-6 years after first thin, snag number declined slightly while the average DBH measurements and degree of decay increased. Reduction in snag density and increases in DBH measurements is attributed to snags within the smaller DBH classes decaying quicker and falling at greater rates than slightly larger snags.

Marked decreases in snag density and increases in snag DBH were observed after the second commercial thin. Second thinning activities are likely to increase the falling rate of smaller snags while creating new snags of greater size. As these stands matured the density of snags remained fairly constant with less variation than that observed in younger stands.

There was a large discrepancy between snag loss and birth patterns expected based on the first year of study compared to actual losses between years. Snag mortality between years was high and constant across stand age, dbh, decay, and bark classes. Overall, snag falling rates were 8 times greater than snag recruitment rates resulting in a 52 % population decline between years. If this decline represented normal annual patterns, snag populations would be expected to be extirpated within 8 years. It is more likely however that weather events during the winter of 2002-03 resulted in higher mortality rates than would typically be associated with snag age and stand management. Winter weather events produced higher than average precipitation and an ice storm that flooded much of the J&W tract until mid-summer. Snag birth rates are also difficult to determine because it is not known how many new snags fell before being surveyed. Those snags that remained standing did generally fit the population distribution observed in 2002 and inferences based on the creation of snags with thinning. New snags were detected in greater than expected frequency in stands 1-2 yrs after commercial thinning.

Snag loss and recruitment rates reported from studies of other pine plantations provide a more balanced description of snag population dynamics. For instance, Moorman et. al. (1999) reported relative snag losses of 25% that coincided with 25% recruitment rates from 25-40 year old loblolly pine plantations in South Carolina. In that study, recruitment and loss rates were negatively correlated with snag DBH. This account is in general agreement with what was observed in this current study and provides support for population dynamics inferred from the 2002 data. Some results of this study are expected to vary from Morman et al. because of the addition of pulses of snag recruitment from commercial thinning.

Cavity-bearing snags were nonexistent within pre-thinned stands. Snags present within this age class are too small and decay and fall at rates that make them unsuitable for cavity excavation. Cavity-bearing snags were most frequently detected in stands of 5-6 years after first thin and older. A higher proportion of snags from these older age classes were of greater DBH and had undergone decay to a degree that made them ideal for cavity excavation. Although stands in the age classes of 1-2 and 3-4 years after first thin had a greater number of snags, these snags had not undergone a significant amount of decay to facilitate cavity excavation.

Within older stands a higher proportion of snags supported multiple cavities. The older, larger, and more decayed snags that occurred at higher frequencies in older stands had greater numbers of cavities per snag. This is attributed to the fact that snags with greater DBHs have falling rates much lower that than smaller snags (Moorman et. al. 1998 Morrison and Raphael, 1993). Older snags are present for longer periods of time making them available for multiple excavations, and are of large enough size to support multiple excavations. However, larger – taller snags also show a greater propensity to break off large portions of dead wood between years such that the amount of substrate available for cavity excavation is reduced. Cavity use was lower than expected and may be due to missing early nesting attempts that occurred prior to the start of surveys. Cavity-bearing snags that were occupied consisted of a cross-section of available cavity-bearing snags. No clear preference was observed in cavity selection.

Snag populations in short-rotation pine plantations are considered less abundant than in older, less intensively managed stands (Moorman et. al. 1998, Rosenburg et. al. 1988, McComb et. al. 1986). McComb et al. (1986) and Harlow and Guynn (1983) suggest t a minimum of 5.3 snags / ha be maintained to support primary cavity nesting species.   Snag populations on the J&W tract were much lower than the suggested value in 2002 and were severely lower following reduction between years.

In addition to density, snag dbh, height, decay and stand condition are important habitat features for cavity nesting birds. The entire suite of conditions required by cavity nesters may only occur in the last 7-10 years of the stand growing cycle. Cavity users did not appear in appreciable numbers until after the first thinning event. An increase in the number of available snags, created by thinning practices, results in increased numbers of cavity users moving into thinned stands to utilize the newly available foraging, nesting and roosting sites. Wilson and Watts (1999a, 1999b) found that the presence of brown-headed nuthatches was associated with thinning events and snag presence, and were detected at greater frequencies in stands 1-2 years after thinning then declined with time since thinning. While individual species were not detected in sufficient numbers during this study to permit species-level analyses, cavity users as a group responded positively to thinning events.

Commercial thinning appears to be beneficial to the guild of birds that utilize snags and cavities. The unintentional creation of snags during thinning events provides foraging, roosting and nesting site for these species. The first commercial thin creates many smaller snags that decay quickly and have high falling rates. The second commercial thin appears to contribute to the decrease in total number of snags but the remaining snags and the new snags created are of larger DBH classes and have lower falling rates. These larger snags are available for longer periods of time and are more likely to have one or more cavities.

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Appendix I. List of species detected during transect counts, with alpha code (for appendix II), scientific name, and migratory status.

Common Name	Code	Scientific Name	Migratory Status
Northern Bobwhite	NOBO	*Colinus virginianus*	Resident
Mourning Dove	MODO	*Zenaida macroura*	Temperate Migrant
Turkey Vulture	TUVU	*Cathartes aura*	Temperate Migrant
Red-shouldered Hawk	RSHA	*Buteo lineatus*	Temperate Migrant
Barred Owl	BAOW	*Strix varia*	Resident
Yellow-billed Cuckoo	YBCU	*Coccyzus americanus*	Neotropical Migrant
Black-billed Cuckoo	BBCU	*Coccyzus erythropthalmus*	Neotropical Migrant
Hairy Woodpecker	HAWO	*Picoides villosus*	Resident
Downy Woodpecker	DOWO	*Picoides pubescens*	Resident
Red-bellied Woodpecker	RBWO	*Melanerpes carolinus*	Resident
Red-headed Woodpecker	RHWO	*Melanerpes erythrocephalus*	Resident
Northern Flicker	YSFL	*Colaptes auratus*	Temperate Migrant
Great-crested Flycatcher	GCFL	*Myiarchus crinitus*	Neotropical Migrant
Eastern Phoebe	EAPH	*Sayornis phoebe*	Temperate Migrant
Eastern Wood-peewee	EAWP	*Contopus virens*	Neotropical Migrant
Acadian Flycatcher	ACFL	*Empidonax virescens*	Neotropical Migrant
Ruby-throated Hummingbird	RTHU	*Archilochus colubris*	Neotropical Migrant
American Crow	AMCR	*Corvus brachyrhynchos*	Resident
Blue Jay	BLJA	*Cyanocitta cristata*	Temperate Migrant
Carolina Chickadee	CACH	*Poecile carolinensis*	Resident
Tufted Titmouse	ETTI	*Baeolophus bicolor*	Resident
White-breasted Nuthatch	WBNH	*Sitta carolinensis*	Resident
Brown-headed Nuthatch	BHNH	*Sitta pusilla*	Resident
Carolina Wren	CARW	*Thryothorus ludovicianus*	Resident
Blue-gray Gnatcatcher	BGGN	*Polioptila caerulea*	Neotropical Migrant
Gray Catbird	GRCA	*Dumtela carolinensis*	Neotropical Migrant
Eastern Bluebird	EABL	*Sialis sialis*	Temperate Migrant
American Robin	AMRO	*Turdus migratorius*	Temperate Migrant

Appendix I contd.

Common Name	Code	Scientific Name	Migratory Status
Wood Thrush	WOTH	*Hylocichla mustelina*	Neotropical Migrant
Red-eyed Vireo	REVI	*Vireo olivaceus*	Neotropical Migrant
White-eyed Vireo	WEVI	*Vireo griseus*	Neotropical Migrant
Yellow-throated Warbler	YTWA	*Dendroica dominica*	Neotropical Migrant
Black-and-white Warbler	BAWW	*Mniotilta varia*	Neotropical Migrant
Pine Warbler	PIWA	*Dendroica pinus*	Neotropical Migrant
Prairie Warbler	PRAW	*Dendroica discolor*	Neotropical Migrant
Worm-eating Warbler	WEWA	*Helminotheros vermivora*	Neotropical Migrant
Hooded Warbler	HOWA	*Wilsonia citrine*	Neotropical Migrant
Common Yellowthroat	COYE	*Geothlypis trichas*	Neotropical Migrant
Yellow-breasted Chat	YBCH	*Ictera virens*	Neotropical Migrant
Ovenbird	OVEN	*Seiurus aurocapillus*	Neotropical Migrant
Louisiana Waterthrush	LOWA	*Seiurus motacilla*	Neotropical Migrant
Brown-headed Cowbird	BHCO	*Molothrus ater*	Temperate Migrant
Baltimore Oriole	BAOR	*Icterus galbula*	Neotropical Migrant
Summer Tanager	SUTA	*Piranga rubra*	Neotropical Migrant
Northern Cardinal	NOCA	*Cardinalis cardinalis*	Resident
American Goldfinch	AMGO	*Carduelis tristis*	Temperate Migrant
Eastern Towhee	EATO	*Pipilo erythrophthalmus*	Temperate Migrant
Indigo Bunting	INBU	*Passerina cyanae*	Neotropical Migrant
Blue Grosbeak	BLGR	*Guiraca caerulea*	Neotropical Migrant

Appendix II. Bird species and total counts within each management stand.

Stand	NOBO	MODO	TUVU	RSHA	BAOW	YBCU	BBCU	HAWO	DOWO	RBWO
42003	2	2	0	0	0	0	0	0	0	0
42009	4	4	0	0	0	0	0	0	1	0
42015	7	7	0	0	0	0	0	0	0	0
42036	1	0	0	0	0	0	0	0	0	0
42154	2	1	0	0	0	0	0	0	0	0
42155	2	1	0	0	0	0	0	0	0	0
42206	3	3	0	0	0	0	0	0	1	1
42299	2	2	0	0	0	0	0	0	0	0
42385	2	0	0	0	0	0	0	1	0	0
42402	2	0	0	0	0	0	0	0	1	0
42406	2	2	0	0	0	0	1	3	0	0
42430	4	2	1	0	0	0	0	0	0	0
42444	3	3	0	0	0	0	0	0	0	0
42462	0	0	0	0	0	0	0	1	2	1
42463	1	1	1	1	0	0	0	0	0	0
42469	3	3	0	0	0	0	0	0	1	0
42470	1	1	0	0	0	0	0	1	3	1
42472	4	4	0	0	0	0	0	0	0	0
42607	3	2	0	0	0	0	0	0	0	0
42682	4	4	0	0	0	0	1	0	0	0
42739	2	2	0	0	0	0	0	0	2	0
42792	5	5	0	0	0	0	0	0	0	0
44026	1	1	0	0	0	0	0	0	0	0
44298	1	1	0	0	0	2	0	0	1	0
44299	1	1	0	1	2	0	0	0	0	0
44306	2	1	0	0	0	0	0	1	0	0
44406	5	4	0	0	0	0	0	1	0	0
44429	2	1	0	0	0	0	0	0	1	0
44621	0	0	0	0	0	0	0	0	0	0
44715	2	2	0	0	0	0	0	0	0	0
44830	4	2	0	0	0	0	0	1	0	0
44931	4	2	0	0	0	0	0	0	4	1
44990	5	3	0	0	0	0	0	0	0	0
45071	6	2	0	0	0	0	0	0	0	1
45153	1	1	0	0	0	0	0	0	1	0
45212	4	3	0	0	0	0	0	0	0	0
Totals	97	73	2	2	2	2	2	9	18	5

Stand	RHWO	YSFL	GCFL	EAPH	EAWP	ACFL	RTHU	AMCR	BLJA	CACH
42003	0	1	1	0	1	1	0	1	0	3
42009	0	0	1	0	1	2	0	2	0	7
42015	0	3	0	0	6	1	2	0	1	2
42036	0	0	0	0	1	0	1	3	0	5
42154	0	0	0	0	0	0	0	0	0	0
42155	0	0	0	0	1	0	0	2	0	1
42206	0	0	0	0	2	1	0	3	0	2
42299	0	0	0	0	0	0	0	0	0	0
42385	0	0	1	0	0	1	0	2	0	2
42402	1	0	0	0	0	0	0	2	0	0
42406	0	0	0	0	2	1	0	0	0	0
42430	0	0	0	0	1	0	0	2	0	0
42444	0	1	1	0	2	4	0	1	0	6
42462	0	0	2	0	1	1	0	0	0	3
42463	0	0	0	0	2	0	0	0	0	0
42469	0	0	1	0	4	0	0	0	0	5
42470	0	1	0	0	0	0	0	1	1	0
42472	0	5	2	1	4	1	0	0	0	8
42607	0	0	1	0	0	2	0	1	2	2
42682	0	0	2	0	3	0	0	0	0	2
42739	0	0	1	0	2	0	1	0	0	0
42792	0	0	0	0	1	0	0	0	0	2
44026	0	0	0	0	0	2	0	0	0	1
44298	0	2	1	0	0	0	0	4	0	4
44299	0	0	0	0	0	0	0	0	0	0
44306	0	0	1	0	2	1	0	2	0	1
44406	0	4	0	0	0	0	0	3	0	3
44429	0	0	0	0	1	1	0	0	0	6
44621	0	0	0	0	1	0	0	8	0	2
44715	0	0	0	0	1	0	0	0	0	0
44830	0	0	0	0	0	0	0	1	0	3
44931	0	1	0	0	0	0	0	1	0	3
44990	0	1	0	0	0	0	0	6	0	4
45071	0	0	0	0	2	0	0	7	0	0
45153	0	0	0	0	0	1	0	0	0	2
45212	0	1	0	0	2	0	0	3	0	2
Totals	1	20	15	1	43	20	4	55	4	81

Stand	ETTI	WBNH	BHNH	CARW	BGGN	GRCA	EABL	AMRO	WOTH	REVI
42003	2	0	1	2	4	4	0	0	0	0
42009	2	1	1	1	4	0	0	0	1	0
42015	0	0	0	4	7	9	0	0	2	0
42036	0	0	1	0	2	2	0	1	1	0
42154	3	0	2	3	2	4	0	0	0	1
42155	0	0	2	2	4	4	0	0	0	0
42206	0	0	0	2	1	1	0	0	1	0
42299	0	0	0	2	0	2	0	0	0	0
42385	0	0	0	1	4	2	0	0	1	0
42402	0	0	1	1	1	5	0	0	0	0
42406	0	0	0	2	2	5	0	0	3	2
42430	0	0	0	1	0	5	0	0	0	0
42444	1	0	0	0	4	6	0	0	1	0
42462	0	0	1	1	4	2	0	0	5	1
42463	0	0	1	1	4	9	0	0	1	0
42469	2	0	0	2	3	8	0	0	2	1
42470	0	0	0	2	7	4	0	0	1	0
42472	1	0	1	0	7	7	0	0	1	0
42607	1	0	0	1	2	3	1	0	0	0
42682	2	0	0	0	3	7	0	0	4	1
42739	3	0	1	1	5	6	0	0	0	0
42792	0	0	0	1	1	5	0	0	0	0
44026	1	0	2	4	4	7	0	0	3	0
44298	2	0	0	1	3	0	0	0	0	0
44299	1	0	2	0	2	6	0	0	0	0
44306	1	0	0	2	0	0	0	0	1	0
44406	0	0	1	0	5	2	0	0	0	0
44429	4	0	0	3	4	3	0	0	0	0
44621	1	0	0	1	2	2	0	0	1	0
44715	1	0	0	3	7	10	0	0	0	0
44830	1	0	0	2	4	7	0	0	5	0
44931	0	0	3	1	0	1	1	0	0	0
44990	2	0	0	0	1	1	1	0	0	0
45071	1	0	0	0	1	6	0	0	0	0
45153	0	0	0	0	0	5	0	0	2	1
45212	2	0	0	2	3	2	0	0	2	0
Totals	34	1	20	49	107	152	3	1	38	7

Stand	WEVI	YTWA	BAWW	PIWA	PRAW	WEWA	HOWA	COYE	YBCH	OVEN
42003	2	0	0	0	0	1	0	13	0	0
42009	2	4	0	0	2	0	0	10	0	2
42015	9	0	3	0	0	1	1	11	0	2
42036	3	0	0	2	1	0	0	11	1	1
42154	9	0	5	0	1	0	0	7	1	3
42155	6	0	2	0	1	0	0	12	0	2
42206	10	0	0	3	2	0	0	11	1	3
42299	1	0	0	0	0	0	1	0	0	1
42385	6	0	0	0	2	0	0	8	0	3
42402	6	0	0	0	0	0	0	14	0	1
42406	6	0	1	1	1	0	1	4	1	3
42430	5	0	0	0	0	0	0	17	2	0
42444	5	0	1	2	0	0	0	10	0	1
42462	7	0	2	2	2	1	2	8	0	1
42463	6	0	1	1	0	1	0	9	1	2
42469	2	0	0	3	0	0	1	10	0	2
42470	10	0	1	1	0	0	0	10	1	1
42472	9	0	2	1	0	0	0	12	0	0
42607	3	0	0	0	1	0	0	6	0	1
42682	4	0	2	4	0	0	0	9	0	2
42739	4	0	1	0	3	0	0	8	1	0
42792	5	0	0	1	0	0	0	8	0	1
44026	6	0	1	0	0	0	1	3	0	2
44298	6	0	0	1	3	0	0	9	0	2
44299	1	0	0	0	0	0	0	10	0	0
44306	7	0	0	0	2	0	1	6	0	4
44406	5	0	0	1	2	0	0	8	2	1
44429	5	0	0	2	0	0	0	3	2	0
44621	2	1	0	3	0	1	0	8	0	8
44715	4	0	0	0	4	0	1	9	0	0
44830	2	0	0	1	0	0	0	7	1	2
44931	3	0	0	2	0	0	0	19	0	0
44990	0	0	0	0	0	0	0	12	1	3
45071	2	0	0	1	0	0	0	13	1	0
45153	3	0	0	1	2	1	0	21	0	2
45212	5	0	1	0	1	0	0	13	0	0
Totals	171	5	23	33	30	6	9	349	16	56

Stand	LOWA	COGR	BHCO	BAOR	SUTA	NOCA	AMGO	EATO	INBU	BLGR
42003	0	0	0	0	0	0	1	13	0	0
42009	0	0	0	0	0	2	0	12	0	0
42015	1	0	0	0	0	2	2	6	0	0
42036	0	0	1	0	0	0	5	15	0	0
42154	0	0	0	0	0	3	0	6	0	0
42155	0	0	0	0	0	0	0	11	0	0
42206	0	0	2	0	1	2	0	8	0	0
42299	0	0	0	0	0	0	0	4	0	0
42385	0	0	0	0	1	2	2	5	0	0
42402	0	0	0	0	0	1	0	9	0	0
42406	0	0	0	0	0	0	0	3	0	0
42430	0	0	0	0	0	1	0	12	0	0
42444	0	0	0	0	0	3	0	10	0	0
42462	0	0	0	0	0	1	0	5	0	0
42463	0	0	0	0	0	0	0	9	0	0
42469	0	0	0	0	1	4	0	8	0	0
42470	0	0	0	0	0	1	0	11	0	0
42472	0	0	0	0	0	3	0	7	0	0
42607	0	0	0	0	0	0	0	5	1	0
42682	1	0	0	0	1	2	0	9	1	0
42739	0	0	0	0	0	3	0	7	0	0
42792	0	0	0	0	0	0	0	5	0	0
44026	0	0	0	0	0	2	0	4	0	0
44298	0	0	0	0	2	0	0	5	0	0
44299	0	0	0	0	0	0	0	10	1	0
44306	0	0	0	0	0	2	1	2	1	0
44406	0	0	0	0	0	0	0	1	1	0
44429	0	0	0	0	3	1	1	15	0	0
44621	0	0	0	0	0	2	0	8	0	0
44715	0	0	0	0	0	0	0	8	0	0
44830	0	0	0	0	0	3	0	11	0	0
44931	0	0	0	1	1	1	3	20	3	1
44990	0	4	0	0	0	1	0	6	0	0
45071	0	0	1	0	0	3	1	9	0	0
45153	0	0	0	0	2	0	0	16	0	0
45212	0	0	0	0	2	0	2	10	0	0
Totals	2	4	4	1	14	45	18	305	8	1