Final Report for the 2008 Aspen Woodland Study in the BLM's Rock Springs Field Office, Southwestern Wyoming

Conducted under the terms of
Cooperative Agreement KAA089015
between
the Wyoming Natural Diversity Database of the University of Wyoming
and the USDI Bureau of Land Management

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June 30, 2009

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ABSTRACT

Stands of aspen (*Populus tremuloides* Michx.) provide the only deciduous woodland habitat on uplands in the Green River Basin of southwestern Wyoming, and they add important structural habitat to the landscape. Information collected from 18 aspen stands shows that the stands growing throughout the lower elevations, away from the foothills of the surrounding mountains, are small in size and found almost exclusively on north- to southeast-facing slopes. Most individual stands are composed of 2 or more patches of trees that differ from one another in tree size and density.

The large majority of aspens are < 1 inch dbh, and trees larger than 4 inches dbh are uncommon. Aspens larger than 8 inches dbh are rare. The small trees generally have vigorous canopies and are only lightly browsed. Trees in the larger size classes have less vigorous canopies and more trunk wounds, and a greater proportion of aspens in those size classes are dead. Proportions of the live trees, dead trees, and fallen trunks in different size classes suggest that these aspen stands have, for some time, been composed mainly of small trees, and large trees have been uncommon. Although many aspen woodlands at higher elevations in the foothills may be succeeding to conifer woodland, this phenomenon is very rare in the lower-elevation stands.

Stem densities in individual stands range widely, primarily due to the great variation in density of the smallest trees. Most stands are composed of live small aspens and relatively few medium-sized and large trees. Stands of larger trees are present; the trees are less dense in those stands, and many are dead. The low proportion of woodlands with dense stands of live trees < 1 inch dbh, and the low numbers of live aspens 1 inch to 4 inches dbh, suggest that poor regeneration of aspen may be a cause of concern.

The BLM's digital vegetation map of the Rock Springs Field Office area shows many small, low-elevation aspen stands. This map by itself is of limited use for locating stands on the ground because many of the aspen stands that it shows are actually other vegetation types (mainly big sagebrush shrubland) and a number of aspen woodlands documented during field survey are not shown on the map. The utility of the digital map likely can be increased if high-resolution aerial photographs are used to check the areas where it indicates the presence of aspen stands. Aerial photographs also can be used to find aspen woodlands that do not appear on the digital vegetation map.

ACKNOWLEDGEMENTS

Jim Glennon and John Henderson in the BLM's Rock Springs Field Office provided helpful advice in the development of field sampling methods and in selecting sampling locations. Brandon Faulder at the Wyoming Natural Diversity Database entered data from field forms into spreadsheets and tables.

INTRODUCTION

Aspen woodlands[1] provide the only upland deciduous forest habitat in the basins and foothills of southwestern Wyoming (Merrill *et al.* 1996). The possible decline in aspen woodlands throughout the western United States is a subject of considerable concern to biologists and resource managers (Shepperd *et al.* 2000), but discussion of this topic seems to have focused on aspen woodlands in the mountains, with little attention given to these lower-elevation stands that provide a large proportion of the habitat structure in areas such as the basins of southwestern Wyoming.

In 2008, the Bureau of Land Management and the University of Wyoming entered into a cooperative project for the survey of aspen woodlands at lower elevations in the Green River Basin of southwestern Wyoming, on public lands managed by the BLM's Rock Springs Field Office (Figure 1). Sites where aspen likely grows had been identified in a previous project that compared three digital vegetation layers of the area (Jones 2007), and additional stands were noted during the field sampling conducted in September of 2008 by George Jones, vegetation ecologist with the University's Wyoming Natural Diversity Database. At each site, Jones noted whether or not aspen trees were present and, if so, recorded their size, density, and vigor, and described the composition and structure of the vegetation. At sites identified in the previous project but at which no aspen grew, Jones noted the type of vegetation present.

The information from this project reveals the nature of the aspen woodlands at low elevations in the Rock Springs Field Office area and provides an indication of the whether or not these patches of important animal habitat are likely to persist on the landscape without efforts by the BLM.

METHODS

IDENTIFICATION OF POTENTIAL SAMPLING SITES

In a previous cooperative project between the BLM and the Wyoming Natural Diversity Database, biologists at the Database combined three digital vegetation layers to identify points where aspen likely grows on public lands managed by the Rock Springs Field Office (Jones 2007). One-hundred twenty-five of those points were selected for possible field sampling, and are referred to hereinafter as "known points".

Initial field work on this project suggested that approximately 50 points could be visited during the time available in the 2008 season. Faced with this limitation, G. Jones of the Natural Diversity Database suggested, and BLM staff agreed, that the work be concentrated on the little-known aspen stands at lower elevations in the central part of the study area, while work on the better-known, large stands at the higher elevations be deferred. This decision resulted in the field survey being directed mainly at known points that had been identified in the previous project from the BLM's digital vegetation map only (Figure 2, map A). The known points that were excluded from immediate study are those that had been identified from at least two digital vegetation layers and that are found mainly at the higher elevations: in the foothills of the Wind River Mountains in the north of the Rock Springs Field Office area, on Pine Mountain and Little Mountain in the south-central part of the area, and on Cedar and Hickey Mountains in the southwest (Figure 2, maps B, D, and F).

The geographic coordinates had been ascertained for the known points, and each of the potential sampling points was mapped on the appropriate 1:100,000-scale BLM Surface Management Status map. Jones used the maps and a geographic positioning system receiver (Garmin *etrex* Legend) to navigate to these potential sampling points in the field.

Initial field work showed that aspen stands grow at additional locations that were not on the list of known points. Jones sampled some of those previously unknown stands, even though they had not been identified during the GIS analysis of vegetation layers, because so many of the locations on the list

[1] Stands of trees in which *Populus tremuloides* Michx. contributes much of the tree canopy cover

of known points lacked aspen that the field survey seemed to be producing little information on the nature and condition of the aspen woodlands in the area. The locations discovered in the field are referred to hereinafter as “new points”.

ASSESSMENT OF POTENTIAL SAMPLING SITES IN THE FIELD

For each known point, the first step in field work was to decide if the vegetation should be sampled there or the point should be moved. The decision was made as follows:

1. If aspen, alive or dead, was present within 50 meters of the point, then data were collected at that point.
2. If aspen was visible from the point but farther away than 50 meters, then the point was moved to the nearest visible stand of aspen and data were collected there.
3. If no aspen, alive or dead, was present within 50 meters of the point or was visible from the point, then the point was abandoned and Jones noted the kind of vegetation present and went to the nearest known point.

COLLECTION OF INFORMATION

Information and data were recorded in a hierarchical manner, starting with the sampling point, then for the woodland or forest stand, then for the area sampled within the stand, and finally for each patch of trees within the sampling area. The data forms used for recording each type of information are shown in Appendix 1.

Sampling Point

For each sampling point, Jones recorded the following information:

1. Geographic coordinates (UTM Zone 12N, NAD83) and the accuracy in meters of the position, with a global positioning system receiver (Garmin *etrex* Legend);
2. Whether the sampling point had been moved from its original coordinates and, if so, why
3. Whether or not photographs were taken and, if so, a description of each photograph
4. Whether or not the vegetation was sampled; if not, why not; if so, in how many patches of trees.

If no aspen were present, or if Jones decided for some other reason to not sample the vegetation at a point, no additional information was recorded.

Stand

A stand was defined as the area of vegetation in which live aspen or dead aspen trunks (standing or fallen) were found, throughout which the same overstory vegetation layer was present and the same plant species contributed the most canopy cover. The edges of the stand were defined by a substantial change in the structure or species composition of the overstory layer. Only one stand was selected around or near each sampling point.

Jones recorded the following information for each stand:

1. Which one of 4 size categories included the stand: $\leq$ 0.1 ha, 0.1-1 ha, 1-5 ha, or >5 ha.
2. The number of aspen patches (defined below), up to 3, in the stand. For each patch, Jones noted whether or not it was sampled, estimated the percentage of the stand that it contributed, and briefly described it.
3. Notes about additional salient features, if any, of the stand.

Sampling Area

Time was too short for collecting detailed data throughout the entire stand at every sampling point, so a circle of 50 meters radius (0.79 ha), centered on the sampling point, served as the sampling area. Data were collected from as many patches intersected by the sampling area as time allowed. Patches present in the stand but not intersected by the sampling area were noted, but not sampled.

Jones recorded the following information about each sampling area:

1. The aspect and the steepness of the slope (both in degrees) and the shape of the slope (straight, convex, or concave),
2. The type of geological surface material (residual, colluvial, landslide, aeolian, or alluvial),
3. The topographic position (interfluve, shoulder, backslope, footslope, toeslope, step in slope, or valley floor),
4. Signs of disturbance,
5. Noxious weeds present, and
6. The percentage of the sampling area within the aspen stand (to the nearest 10%)

Patch

Often, a single stand of aspen includes areas with different sizes or densities of trees. For example, in a stand of medium-sized trees of nearly uniform density, aspen saplings or suckers may form a dense understory in part of the area and be absent from the rest. Or, a single stand may comprise one area of sparse, large trees and another of denser, smaller trees. In this project, a **patch** was defined as an area of vegetation within which the layers present, the sapling and tree density, and the mix of tree stem sizes appeared homogeneous after a brief examination by the surveyor. The edges of the patch were marked by a change in at least one of these vegetation features, and a patch was distinguished from adjacent patches (if any) by a substantial, obvious difference in layers present, or tree density, or mix of tree stem sizes.

At each sampling point, the following information was collected from as many patches that intersected the sampling area as time allowed:

1. Vegetation description: The vegetation layers present, the height of each layer, the amount of cover contributed by each plant growth form in each layer, and the 3 or 4 most common plant species in each layer were recorded.

2. Abundance of fallen stems. A tape laid out through the patch and stretched tightly served as a line transect. Every fallen trunk intersected by the tape was identified to species and classified into a size class. Dead trunks still rooted in the ground and leaning at an angle $\leq 45^{o}$ to the ground were considered fallen and were counted on the line transects; trunks leaning at an angle of $> 45^{o}$ to the ground were considered standing and were counted in the belt transect, as described below.

Relatively short transects (15 to 30 meters) were used in small patches and patches with many fallen stems, and relatively long transects (30 to 50 meters) were used in large patches and patches with few fallen stems. The length of the transect was recorded in every patch.

3. Size class composition of the tree component. Jones delineated a belt transect along the line transect through the patch, by walking along the right side of the tape with a pole held horizontally and perpendicular to the tape, and with one end above the tape. Each standing tree stem rooted in the belt transect thus delineated was counted, identified to species, classified as alive (possessing twigs with the year's leaves) or dead (no sign of the year's leaves), and classified into a size class (Table 1). Stems rooted in the ground and leaning at an angle $> 45^{o}$ were considered standing, while stems leaning at an angle $\leq 45^{o}$ were considered fallen and were recorded along the line transect as described above.

In patches with dense standing stems, the belt transect was 1 meter or 2 meters wide. In patches with sparse to moderately dense stems, the belt transect was 3 to 5 meters wide. In most patches, the belt transect and the line transect were the same length, but in several stands with very dense standing trees, the belt transect extended only part of the length of the line transect. The length and width of the belt transect were recorded in every case.

4. Condition of stems. These data were collected on stems in the belt transects. On each stem larger than a sucker (size class 1), the presence of wounds and signs of disease on each stem were noted (Table 2), and for dead trees, the presence of bark or twigs was noted.

5. Vigor of live trees: For live trees of all sizes in the belt transects, the percentage of live canopy was recorded by category (Figure 3). Branches with live leaves were considered part of the live canopy.

Additional Observations

In addition to sampling as described above at some known points and a few new points, Jones also noted the presence or absence of aspen at 8 known points that he observed during travel in the Rock Springs Field Office area. Limited time prevented the collection of information at these points but those with aspen are suitable for sampling in the future.

Results

Jones visited or observed 59 points during the field survey, 52 of them known points and 7 of them new points (Table 3). Of the 52 known points, 48 had been identified solely from the BLM vegetation map and 4 solely from the Wyoming Land Cover Dataset. This preponderance of BLM points was due to the concentration in this field season on aspen stands at lower elevations; as Figure 2 shows, the BLM data layer maps aspen throughout the Rock Springs Field Office area (map A), but the Wyoming Land Cover Dataset maps aspen only on the margins of the field office area, at higher elevations (map C).

Among the 59 points, Jones sampled or described the vegetation at 51 points, and simply noted presence or absence of aspen at the remaining 8 points.

Occurrence and Nature of Aspen Stands

Aspen grew at 23 of the 59 points, scattered throughout the field office area (Figure 4). Jones sampled the vegetation at 18 of those aspen points, in 24 patches, and simply noted the presence of aspen at 5 points. The sampling areas at the 18 points where aspen patches were sampled were found at elevations from 7,350 feet (2,240 meters) to 8,561 feet (2,609 meters) (Table 4). All fell on residual surface deposits (in contrast to such materials as landslide deposits, alluvium, or aeolian deposits). Slope steepness varied from essentially level to 36^{o}, and all but one of the sampling areas were found on convex or flat slopes. Sixteen of the 18 sampling areas faced between north-northwest and southeast (Figure 5). Sampling areas were found on all parts of slopes, but the majority occurred on the upper parts (Figure 6).

Of the 18 aspen stands in which patches were sampled, half were 0.1 ha to 1 ha in size and nearly half were 1 ha to 5 ha (Figure 7). Only one stand was smaller than 0.1 ha. Most of the aspen stands where information was collected were composed of more than one patch: 7 stands contained three patches of aspen, 4 contained 2 patches, and 7 contained only 1 patch. (Figure 8).

Tree Density and Species

Density of trees varied enormously among the 24 patches sampled, from 57 trees/acre (0.014 tree/square meter) in patch RSA000001.1 to 36,828 trees/acre (9.1 trees/square meter) in patch RSA102114.1 (Figure 9). In 18 of the 24 patches sampled, tree density was at least 1,000 trees/acre (0.25 tree/square meter). Aspen was the only tree present in 20 of the 24 patches. Limber pines were counted in 4 of the patches and accounted for a substantial proportion of the trees only in patches RSA101120.1 and RSA102120.2. (Note that those two patches were in the same stand of trees.)

Tree Sizes

Averaged across the 24 sampled aspen patches, live aspens in the smallest size class (< 4.5 feet tall) reached the greatest densities by far (Figure 10). These smallest aspens were counted in 19 of the 24 patches sampled (Table 5). Average densities were much lower in the larger size classes for both live trees and dead trees (Figure 10). Only dead aspens in the 1 in. to 4 in. dbh class were found in more patches than were the smallest live aspens (Table 5). The largest class of trees (> 8 in. dbh) was especially rare, being counted in only 5 of 24 patches. All of those large trees were aspens. Average densities of limber pines in all size classes were uniformly low.

Distributions of trees among size classes varied widely among the sampled patches (Figure 11) and generalizations about the patches are difficult to make. In a group of 10 patches (RSA000003.1, RSA000004.1, RSA000005.1, RSA000006.1, RSA000006.2, RSA101103.3, RSA101120.1, RSA101314.1, RSA102114.1, and RSA102203.1), aspens in the two smallest size classes were by far the most common trees. Some of these patches also contained trees in the larger size classes. Various proportions of dead trees were counted in different size classes, but they were less common than live trees. Density of all stems varied over 150-fold, from approximately 160 stems/acre to almost 25,000 stems/acre. In a group of three other patches -- RSA101103.2, RSA101108.1, and RSA101119.1 -- the tree component contained substantial proportions of live aspens in a range of size classes. Density differed over five-fold among these three patches.

In contrast to the patches dominated by live trees, a group of nine patches (RSA000001.1, RSA000002.1, RSA000004.2, RSA000006.3, RSA000007.1, RSA101108.3, RSA101217.1, RSA101218.1, and RSA102226.1), were dominated by dead trees, throughout the size classes.

Vigor of Aspen Trees

Four types of data indicate the vigor of the aspen trees in the sampled patches: numbers of live trees vs. dead trees, percent of the potential tree canopy that is occupied by live branches, the numbers of trees with different types of wounds, and the amount of browsing on the smallest trees.

<u>Proportions of Live Trees and Dead Trees</u>

Only in the smallest size class (<4.5 ft. tall) did the live trees clearly outnumber the dead trees. Calculated across the 19 patches in which aspens in the smallest class were counted, over 80% of the aspens were alive (Figure 12). Examination of tree density estimates from the individual patches (Figure 11) shows that this high average proportion of live trees results from a preponderance of live trees in most of the patches, not just in a few unusual patches: the number of live aspens exceeded the number of dead aspens in 15 of those 19 patches.

Among the other size classes, though, the average proportions of dead trees generally equaled or exceeded the proportions of live trees (Figure 12). In the second-smallest class (4.5 ft.- 6.6 ft. tall and <1 in. dbh), live trees and dead trees each accounted for approximately half of the aspens. Live aspens in this size class were counted in only 11 of the 24 patches; in 7 of those 11 patches, the number of live trees exceeded the number of dead trees (Figure 11). In the intermediate size class (1 in.- 4 in. dbh), dead aspens accounted for three-quarters of the trees in all patches combined (Figure 12). Live aspens were counted in only 15 of the 24 patches, and the number of live trees exceeded the number of dead trees in only 7 of those 15 patches (Figure 11).

In the second-largest size class (4 in.- 8 in. dbh), approximately half of the aspens were alive and half dead (Figure 12). Live trees of this size were counted in 14 of the 24 patches, and live trees outnumbered dead trees in 8 of those patches (Figure 11). In the largest size class (>8 in. dbh), the proportion of live trees in all patches slightly exceed the proportion of dead trees (approximately 55% to 45%; Figure 12), but these averages are based on counts from only 5 of the 24 patches. Live trees outnumbered dead trees in 3 of those patches, and by a large margin in 2 of them (Figure 11).

<u>Live Canopy</u>

The amount of the potential canopy volume on each tree that was actually occupied by live branches (Figure 3) was estimated by percentage class, as an indication of vigor. These estimates were made for every tree in every size class within the belt transect in 23 of the 24 patches sampled. The numbers of trees in each percentage class were pooled for all 23 patches and the proportion of trees in each percentage class was calculated from the pooled data.

On approximately half of the trees in each of the two smallest size classes (<4.5 ft. tall, and 4.5 ft.-6.6 ft. tall and < 1 in. dbh), live canopy occupied at least 75% of the potential canopy volume (Figure 13). Canopies were especially full in the 4.5 ft - 6.6 ft tall size class. In the intermediate size class (1 in.- 4 in. dbh), tree canopies were less full. The proportion of trees with > 75% live canopy barely exceeded the proportion with only 25% - 50% live canopy. In the two largest size classes (4 in.-8 in. dbh and >8 in. dbh), at least three-quarters of the trees had canopies that were only 25% to 75% alive.

In each of the size classes, trees with < 25% of the canopy alive accounted for only about 12% or less of the trees.

Presence of Wounds

The presence of each of three types of wounds on the trunks of live aspen (wounds caused by animal bites [most likely by elk], dry cracks in the bark, and cracks that produced liquid) was noted on each tree counted in each patch. Each of these wounds was present on < 5% of the trees in the smallest size class (Figure 14). The proportion of trees with animal bites was < 0.05 in the 4.5 ft. - 6.6 ft. tall size class as well, and increased steadily in the next two size classes. The proportion of trees with cracks increased steadily from the smallest size class through the second, third, and fourth size classes. The proportion of each type of wound was < 0.10 among the few trees of the largest size class.

The proportion of trees per patch that exhibited wounds varied greatly among patches, even when the patches with few live aspens are discounted (Figure 15). Among the 14 patches with at least 10 live aspens, the proportions of trees with trunk wounds ranged from 0.0 to 1.0. In nine of those 14 patches, at least one kind of trunk wound was noted on over 10% of the trees. In only two of them did all of the trees have a trunk wound.

Trees were examined for the presence of fungal fruiting bodies but none were noted.

Amount of Browsing on Small Aspens

The percentage of terminal buds browsed was recorded (by percentage class) on 420 live aspens < 4.5 feet tall in 18 patches. On over half of these trees, none of the terminal buds appeared to be browsed; up to 50% of the terminal buds per tree had been browsed on approximately 10% of the trees; and over half of the terminal buds per tree had been browsed on approximately 25% of the trees (Figure 16). Ten of the patches had at least 10 small aspen from which data were collected, and in six of those 10 patches, over 70% of the trees had no terminal buds browsed (Figure 17). In only 3 of those patches did at least 40% of the trees have over half of their terminal buds browsed.

Fallen trunks

Fallen tree trunks encountered along line transects were tallied into 4 size classes. The number of logs encountered per meter of transect ranged from 0.21 log/meter to 2.4 logs/meter (Figure 18). In 17 of the 24 patches sampled, numbers of fallen logs exceeded 0.5 log/meter of transect. Logs < 4 in. diameter accounted for the great majority of fallen logs in most stands.

The distributions among the four size classes of fallen logs, live aspens, and dead aspens were similar when data from the 24 patches were combined (Figure 19). (Trees in the two smallest size classes -- <4.5 ft. tall, and 4.5 ft. - 6.6 ft. tall and <1 in. dbh -- were combined for this comparison.) Stems < 4 in. dia. accounted for almost 80% of fallen logs, live trees, and dead trees. Among both the fallen logs and the dead trees, most of the stems (50-60%) were in the 1 in. - 4 in. dia. class, and stems 4 in. - 8 in. dia class constituted 20-25% of the stems. The live trees were somewhat smaller, with many more stems < 1 in. dia (almost 80%, compared to approximately 30% of dead stems and approximately 12% of fallen logs), substantially fewer stems 1 in. - 4 in. dia. (approximately 10%, compared to 50-60%), and fewer stems 4 in. - 8 in. dia (only 10%, compared to 20-25%). Among all three categories, stems >8 in. diameter were rare.

Figure 20 shows the distributions of live aspens, dead aspens, and fallen logs by diameter class for patches individually. As the combined data suggest, in most patches the proportions of stems among the four diameter classes were similar for the three categories, but live aspens were somewhat smaller. This was true in patches where all or most of the live aspens were < 1 in. dia. (RSA000004.1, RSA 000005.1, RSA000006.1, RSA000006.2, RSA000006.3, RSA101103.3, RSA101120.1, RSA101314.1, RSA102114.1, RSA102203.1, and RSA102226.1) as well as patches in which a substantial proportion of the live aspens were in the larger diameter classes (RSA101103.2, RSA 101108.3, RSA101119.1, RSA101217.1, and RSA102120.2).

In a few patches, the pattern was reversed, with live aspen being slightly larger than the dead aspen or the fallen logs, or both. This group consists of patches (RSA000002.1, RSA000004.2, RSA000007.1,RSA10108.1, and RSA102120.1). Note that a number of the proportions in these patches are calculated from very few trees.

The remaining three patches show a different patterns of stem diameters. In RSA000003.1 and RSA101218.1, the fallen logs were substantially larger than the live aspens. In RSA000003.1 and RSA000001.1, greater proportions of the dead aspens were in larger diameter classes than were the fallen logs. Note the small numbers of trees and logs from which many of the proportions were calculated in these patches.

Aspen Regeneration

Presence of aspens of different sizes has been used in different studies to indicate regeneration of aspen trees. In the California Aspen Delineation Project (California Department of Fish and Game 2002), aspens <1 in. dbh, in densities ≥500 stems/acre, are interpreted as indicating successful regeneration. These small trees fall into the first two size classes used in this project: trees <4.5 ft. tall, and trees 4.5 ft. - 6.6 ft. tall and < 1in. dbh. Figure 21 shows the density of live aspen trees in those two size classes in each patch. In 11 of the 24 patches sampled, live trees in these size classes were recorded in densities of ≥ 500 stems/acre. In 13 of the patches, the live small trees either were not encountered at all (5 patches) or were encountered in densities below that threshold (8 patches).

The amount of live canopy present in aspens of the two smallest size classes differed widely among patches (Figure 22). In seven of the 11 patches where live small trees met the recruitment threshold of 500 trees/acre (RSA000003.1, RSA000004.1, RSA000005.1, RSA000006.2, RSA101120.1, RSA102114.1, and RSA102203.1), approximately 40% of more of the small trees had full canopies (>75% live canopy volume). Few trees in those seven patches had < 50% live canopy. In only three of the 11 patches (RSA101103.2, RSA101119.1, and RSA102120.2) did most of the trees have < 25% of the potential canopy volume occupied by live canopy.

Browsing on terminal buds was noted only on trees in the smallest size class (< 4.5 ft. tall). Browsing appeared to be light in most of the 11 patches with > 500 small live aspens/acre (Figure 17). In six of those patches, no browsed buds were noted on at least 70% of the smallest aspens. But in four of the patches, over half of the buds had been browsed on at least 40% of the smallest trees. Very few of the live aspens in the two smallest size classes had animal bites, dry cracks, or wet cracks on the trunks (Figure 23).

Patches where small aspen met the recruitment threshold density of 500 stems/acre usually accounted for a substantial area of the stands in which they were found: in 6 of those 10 stands, the patches of small aspen accounted for ≥ 80% of the stand area (Table 6).

Barnett and Stohlgren (2001), working in the Gros Ventre Mountains of northwestern Wyoming, considered aspens >6.6 feet tall but <4 in. dbh (>2 m tall and <10 cm dbh) as signs of new, successful regeneration. (They suggested no threshold density for successful regeneration in a stand.) Trees of this size correspond to the intermediate size class (1 in. - 4 in. dbh) used in this project. Live aspens in that size class were counted in 15 of the 24 patches sampled (Figure 24). In seven patches, only dead aspen in that size class were counted. Densities of live trees were generally low, with < 200 trees/acre in 10 of the 15 patches. Note that five of the patches where the smallest aspens reached densities of > 500 trees/acre (the threshold for successful regeneration in the California Aspen Delineation Project; California Department of Fish and Game 2002) had no aspen in this 1 in. - 4 in. dbh size class.

Unfortunately, estimates of percent live canopy in trees of this size class were taken sporadically and very few estimates are available from most of the patches (Figure 25). Among the three patches where estimates were made on five or more trees (RSA101119.1, RSA101108.3, and RSA101217.1), 40% or fewer of the trees had > 75% live canopy. The combined estimates from all 59 trees in this size class show that the trees were about equally divided among the 25-50% live canopy class, 50-75% class, and >75% class (Figure 13).

Data on presence of bark wounds is equally scarce (Figure 26). Among the patches with at least 5 live trees, over half of the trees per patch had animal bites, half or more per patch had dry cracks, and presence of wet cracks ranged from none to half of the trees. The degree of browsing on terminal buds was not recorded for trees in this size class.

Aspen Regeneration and Structure at Sampling Points

Information relevant to aspen regeneration, and to possible changes in structure of the tree layer, is aggregated for each sampling point in Table 6. Successful regeneration of aspens would seem to require dense growth of small trees, in reasonably large stands, with vigorous canopy growth and relatively light browsing. The California Aspen Delineation Project (California Department of Fish and Game 2002) uses a criterion of 500 stems/acre of aspens < 1 in. dbh. Of the 18 aspen stands from which data were collected in this survey, 10 had aspen patches that met that threshold density of small trees. Small live aspens were present in an additional 4 stands but at densities <500 stems/acre. In 4 more stands, no live aspen < 1 in. dbh were counted.

The sizes of these stands of dense small aspen are not known accurately, but the information on the sizes of stands and percentages of stands in the patches of small aspens (Table 6) suggests a wide range in sizes. Of the 10 stands with ≥ 500 aspens/acre < 1 in. dbh, 1 stand was ≤ 0.1 ha, and the patch of small aspens accounted for 90% of it, for a maximum possible area of 900 sq m. Four stands were 0.1 - 1 ha in size, and the largest patch among these accounted for 95% of the patch, or a maximum possible size of 9,500 sq m. The remaining 5 stands were 1 - 5 ha in size and 3 of these stands were 100% small aspen patches, so these patches could each be 5 ha. Note that these estimates of patch size are in turn based on estimates made quickly in the field, not on measurements.

The data on percent of live canopy was used to calculate a weighted average percent live canopy for the aspens < 1 in. dbh in every patch (Table 6), as a single-number index of the vigor of their canopies. This weighted average has a potential minimum value of 12.5 (where all of the small aspens are in the <25% live canopy class) and a potential maximum of 87.5 (where all of the trees are in the >75% live canopy class). The weighted averages among patches in the 10 stands with ≥ 500 live small aspens/acre ranged from 22.5 to 82.5. In six of the 10 stands, the weighted average was within 75% of the possible maximum value.

The amount of browsing on the small aspens also is expressed in Table 6 as the weighted average of the browse class values for the small trees in each patch. The potential minimum value for this browse average is 0 (where all of the trees were scored as having no terminal buds browsed) and the potential maximum value is 75 (where all of the small trees have > 50% of their buds browsed). The calculated averages among the 10 stands with ≥ 500/acre aspens < 1 in. dbh. ranged from 0 to 65, and in 5 stands the average was approximately 5 or less. The averages in the remaining 5 stands were as high as 36.72.

Table 6 also shows the density of aspens 1 in. - 4 in. dbh in each patch in each stand. These are trees that Barnett and Stohlgren (2001) suggest indicate successful recent aspen regeneration. Densities of these trees ranged from 0 to 1,619. Three of the density estimates were substantially higher than the other estimates, and these three very high values for 1 in. - 4 in. dbh trees were from patches (and stands) that also had high densities of the smaller aspens. Densities of 1 in. - 4 in. dbh trees were not uniformly high, though, in the other 7 patches with >500 stems/acre of aspens < 1 in. dbh.

RELIABILITY OF DIGITAL LAYERS IN IDENTIFYING ASPEN STANDS

Of the 52 known points (i.e., those where the digital vegetation layers indicated aspen), only 16 points (31%) had aspen (Table 3). Thirty-six points (69% of the known points) were incorrectly represented on at least one digital layer as having aspen. At 33 of those 36 incorrectly classified points, Jones gathered information to show what sort of vegetation grew at the point. (At the remaining 3 points, only the absence of aspen was noted.) This information from 33 points, combined with the information from the 16 known points that had aspen, is sufficient to identify the vegetation types present at 49 known points, and to show what kinds of vegetation were mistaken as aspen on the digital vegetation layers.

Forty-eight of the known points had been identified solely from the BLM vegetation map, and 13 of those points (27%) had aspen (Table 3); 73% were incorrectly classified. Fourteen of the BLM points were classified in the vegetation layer as aspen woodland, and 7 of those (50%) had aspen (Table 7). Five of those points were in aspen woodland and 2 in aspen-limber pine woodland. The other 31 BLM points were classified as aspen-conifer woodland, and only 6 of those (19%) had aspen (all pure aspen woodland). The remaining 25 of those predicted aspen-conifer points (81%) did not have aspen; only 3 of them were in limber pine or juniper woodland, 20 of them were in big sagebrush shrubland, and 2 were in greasewood shrubland.

The BLM layer, then, commonly mis-identified other vegetation types (mainly sagebrush shrubland, but also conifer woodland and greasewood shrubland) as aspen vegetation. The BLM layer has the highest percentage of correct identifications when it predicts the presence of aspen woodland; the success in predicting aspen-conifer woodland is much lower.

Accuracy of prediction was higher for the few points identified from the Wyoming Land Cover Dataset, with 3 of the 4 known points (75%) having aspen and only 1 lacking aspen (Table 7). The 3 aspen points had been correctly classified in the dataset as deciduous woodland. The mis-identified point was mountain big sagebrush shrubland.

DISCUSSION

The survey supports the impression that many of the aspen stands scattered throughout the lower elevations of the Rock Springs Field Office area are small, but it also shows that a number of them cover at least 1 ha (Figure 7, Table 6). Most stands are composed of at least 2 patches that differ in tree size and density (Figure 8, Table 6). The aspens grow predominantly on slopes facing between north and east-southeast (Figure 5), which are the lee slopes in the prevailing west-to-southwest winds of the region (Martner 1986). These slopes may be the only positions on the landscape that provide the water supply necessary for aspen growth, due to greater input from drifted snow and smaller loss of soil water to evaporation; they may protect the aspens from mechanical damage by the wind and from excessive evapotranspiration; or they may be suitable for a combination of those factors.

When the trees from all stands are considered together, the density of trees decreases with increasing tree size (Figure 10). Suckers (trees < 4.5 ft. tall) are by far the most common of the aspens in the study area, and aspens larger than 8 in. dbh are very rare. The proportion of dead trees increases with increasing tree size (Figure 12). When just the live aspens are considered, tree vigor appears to decline with tree size: the larger trees have less live canopy (Figure 13) and a greater proportion of them have trunk wounds (Figure 14).

These general relationships between tree size, density, and proportions of live versus dead trees are clear also when the size class structures of individual patches are viewed in the context of the stands where they grow (Figure 11). In 9 of the 18 stands examined, suckers (trees < 4.5 ft. tall) and saplings (trees 4.5 ft. - 6.6 ft. tall and < 1 in. dbh) account for the large majority of live trees, whether larger trees are absent or rare (RSA000006, RSA000003, RSA000005, RSA101120, RSA101314, RSA102114) or more common (RSA000004, RSA101103, RSA102203). In only 3 stands with live aspen suckers and saplings were more of the live trees in the larger size classes (RSA101118, RSA101119 and RSA101218). In the stands with live suckers and saplings, the proportion of dead trees increased from the small size classes to the large, with the sole exception of RSA101108.

The low-elevation aspen stands are almost uniformly composed of trees < 8 in. dbh. Trees larger than 8 in. dbh were found in only 5 of the 18 stands sampled, and in 2 of those 5 stands, dead large trees outnumbered the live trees (Figure 11).

Browsing on the smallest aspens (< 4.5 ft. tall) seems to be generally light across the study area (Figure 16) and also within most individual stands (Figure 17), but some patches of small trees appear to be heavily browsed.

Despite the great densities of live aspen suckers in some stands (Figure 10) and the very high proportion of live suckers vs. dead suckers across the study area (Figure 12), poor regeneration of aspen in the study area may be a cause for concern. In only 10 of 18 stands did suckers and saplings together reach the densities that may indicate successful regeneration (California Department of Fish and Game 2002). And in 5 of the stands, no live trees < 1 in. dbh were counted.

Moreover, among the1 in. - 4 in. dbh size class, which may indicate successful recent aspen regeneration (Barnett and Stohlgren 2001), a very high proportion of the trees is dead, both in the study area generally (Figure 12) and in many individual stands (Figure 11). In fact, the paucity of live aspens and the abundance of dead aspens in this size class in many stands are obvious features of the data (Figure 11).

Whether aspens are regenerating well or not, few aspen stands at lower elevations are being succeeded by conifer woodlands. Limber pine (the only tree encountered besides aspen) was counted in only 2 stands, where it was the most common live tree in all (RSA101217) or most (RSA102120) of the size classes of trees present.

Changes in the structure of the aspen stands cannot be determined from the information gathered in this study, but the relative proportions of live aspens, dead trees, and fallen logs in different size classes may provide some hints. In most of the patches, the live trees were mainly in the < 1 in diameter class (comprising suckers and saplings) or the 1 in. - 4 in. diameter class (even though live trees of this size were relatively rare), while higher proportions of the dead trees and the fallen logs were in the 1 in. - 4 in. diameter class or the 4 in - 8 in. class. Even though the proportion of stems in the 4 in. - 8 in. diameter class were greater for dead trees and fallen logs than for live trees in many stands, this size class still accounted for relatively few of the dead trees and fallen logs; that is, in most stands, more dead trees and fallen logs were in smaller size classes. This is true for stems > 8 in. diameter as well.

This pattern of more dead trees and fallen logs in slightly larger size classes, few stems 4 in. - 8 in. diameter, and even fewer > 8 in. diameter, suggests that the aspen stands in the area have been composed of small trees as far back as the time represented by the fallen logs. Some stands may have had a few more large trees in the past than they do now. But if there has been a change in stand structure, it is likely to have been a shift to slightly smaller trees. Demonstrating this change, though, would require more precise measurements of stem sizes on more trees and fallen logs.

CONCLUSIONS

Given the small number of stands visited during the single field season, this project provides a limited basis for understanding the low-elevation aspen woodlands in the Rock Springs Field Office area. Nevertheless, this study shows that the low-elevation aspen woodlands exhibit a range in stand sizes, tree densities in different size classes, and tree vigor; it documents locations of different types of aspen stands; and it suggests that poor recruitment of aspens may be a cause for concern.. Even though limited, this information provides sufficient basis for a program to monitor changes in the vegetation.

Fortunately, as a consequence of this study, information could be quickly collected from additional aspen stands in the study area to give managers and biologists more confidence in their understanding of the aspen vegetation. Locations are already known for 8 stands that were noted during field work but not sampled. Examination of aerial photographs in the office would no doubt reveal locations of additional stands. Work during this project has shown that the digital data layers have limited utility in guiding survey of aspen stands, both because they indicate the presence of aspen woodlands where they do not grow, and they fail to indicate the presence of aspen where it does grow.

Limited work at the Wyoming Natural Diversity Database has shown that aspen woodlands can be readily identified on high-resolution aerial photographs (Douglas Keinath, personal communication). High-resolution aerial photographs are available for the Rock Springs Field Office area, both in true color (e.g., from the National Agricultural Imagery Program, http://datagateway.nrcs.usda.gov/Catalog/ ProductDescription/ NAIPM.html) and in color infrared (e.g., from the Wyoming Geographic Information Science Center, http://partners.wygisc.uwyo.edu/website/dataserver/viewer.htm). Examination of those photos, guided by information from the digital data layers, would significantly improve our ability to find aspen woodlands for sampling.

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FIGURES

Figure 1. Location of the BLM's Rock Springs Field Office in southwestern Wyoming.

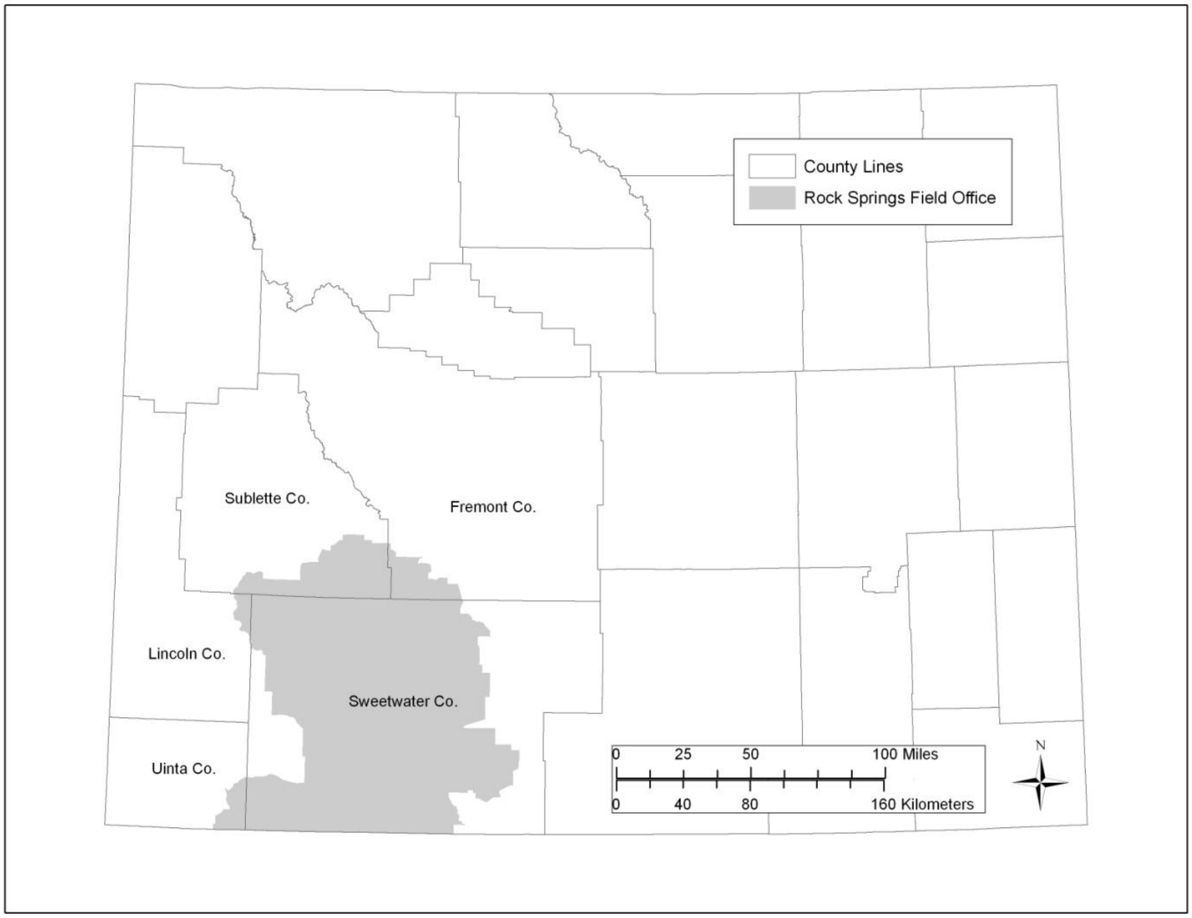
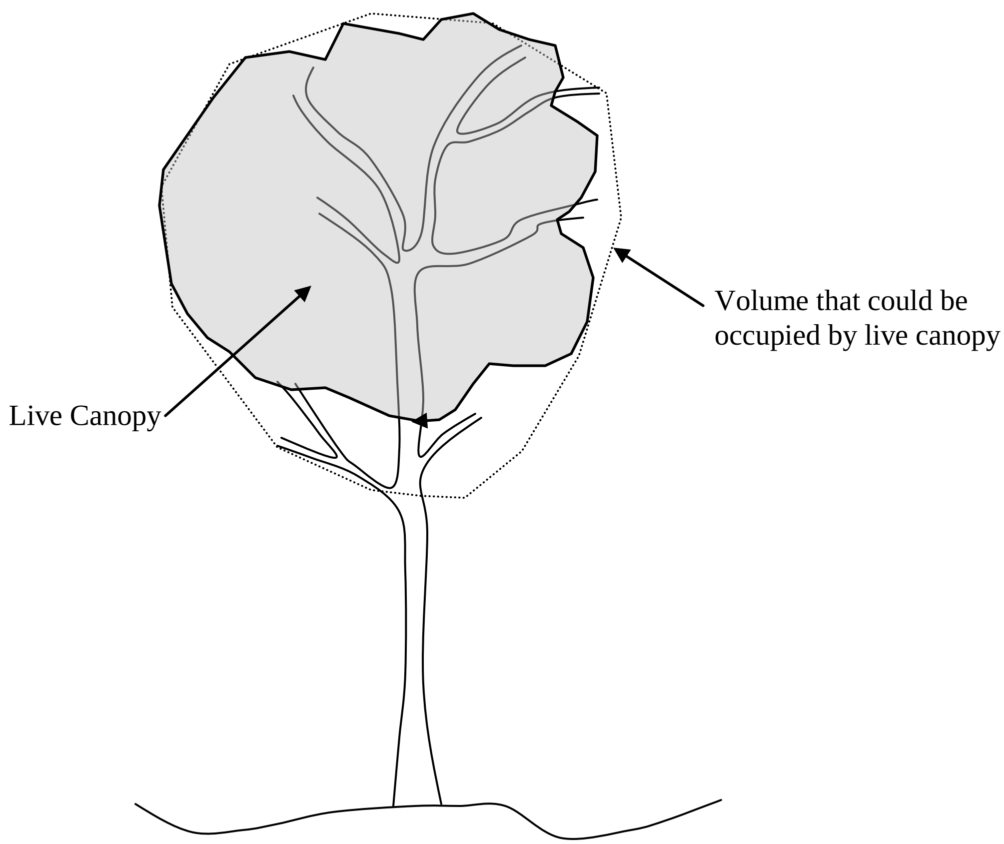


Figure 2. Locations of potential sampling points identified from different digital vegetation layers in the previous project (Jones 2007).

Each map shows the points at which aspen was mapped by one layer or a combination of layers: A, only by the BLM vegetation map; B, by both the BLM vegetation map and the GAP landcover layer; C, only by the WLCD layer; D, by both the WLCD layer and the GAP landcover layer; E, by both the BLM vegetation map and the WLCD layer; F, by all three layers.

Figure 3. Estimating percent live canopy of an aspen tree.



Percent live canopy was estimated as the volume of the potential tree canopy (the volume between the lowest and highest branches, and the widest branches) that was actually occupied by live canopy. In this case, the percent live canopy is approximately 80%.

Figure 4. Points Sampled or Noted in the 2008 Field Survey.

A: Points with aspen. B: points without aspen.

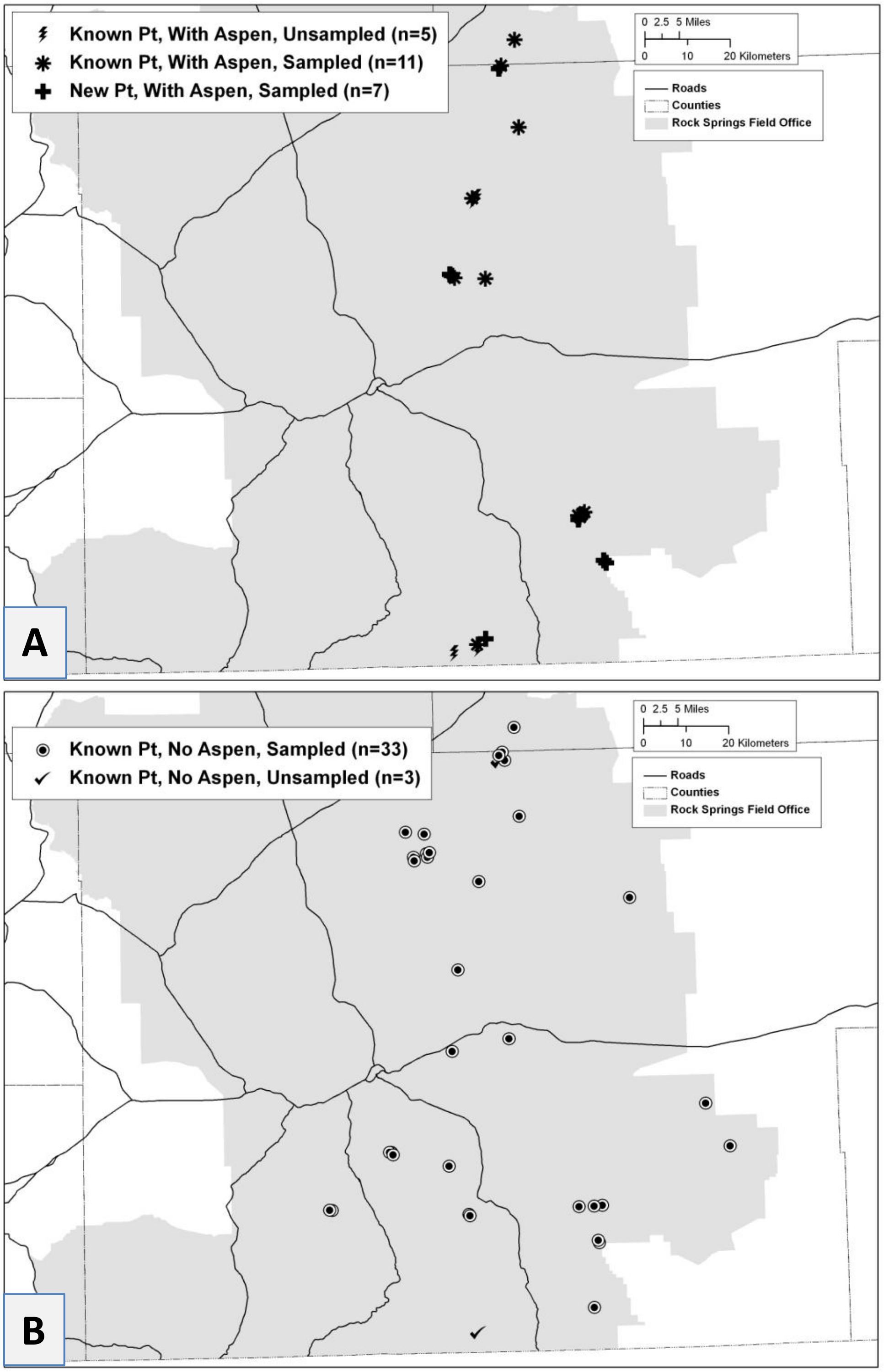


Figure 5. Aspects of 18 sampling areas.
Letters show cardinal directions. Numerals and circles indicate numbers of sampling areas. Heavy lines represent the numbers of sampling areas (length of line) on each aspect (direction of line). E.g., 4 sampling areas had aspects of 360^{o}.

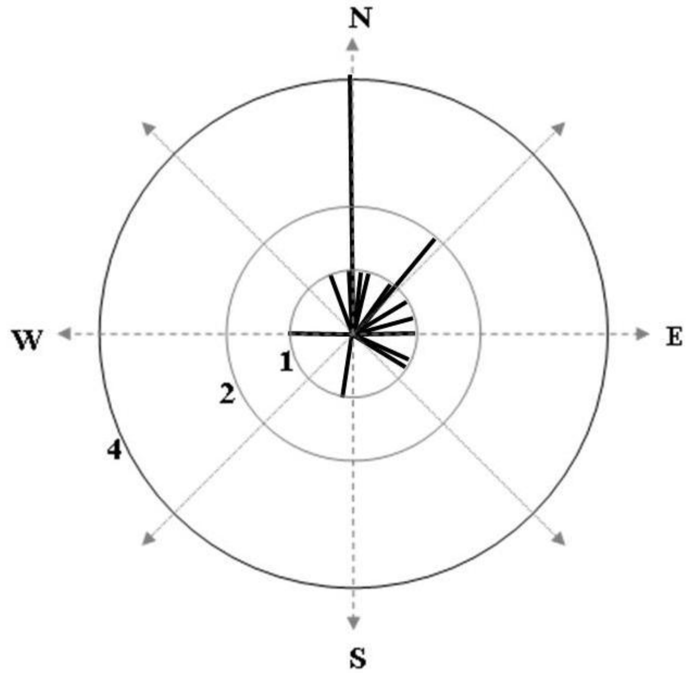


Figure 6. Positions of 17 sampling areas on the parts of an idealized slope.
The position of 1 area was not recorded.

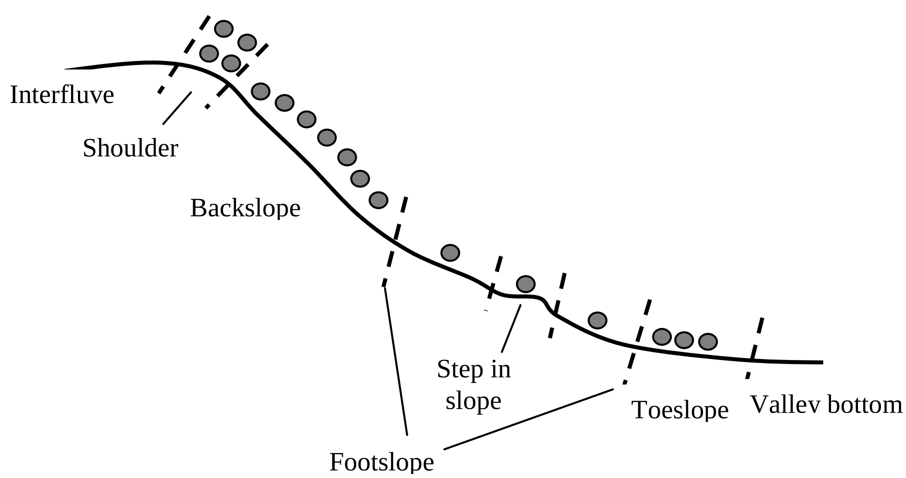


Figure 7. Sizes of 18 stands in which aspen patches were sampled.

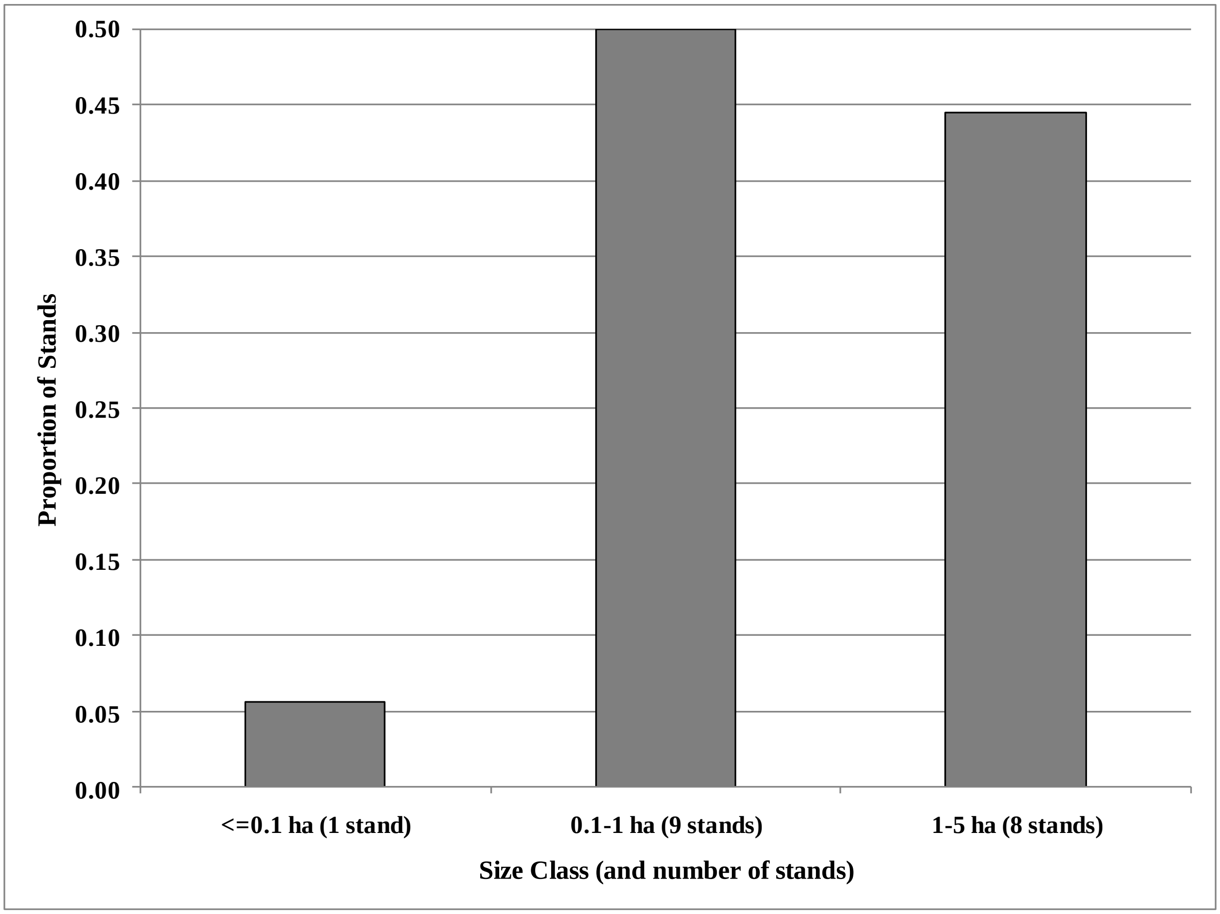


Figure 8. Numbers of patches per stand in the 18 aspen stands where information was collected.

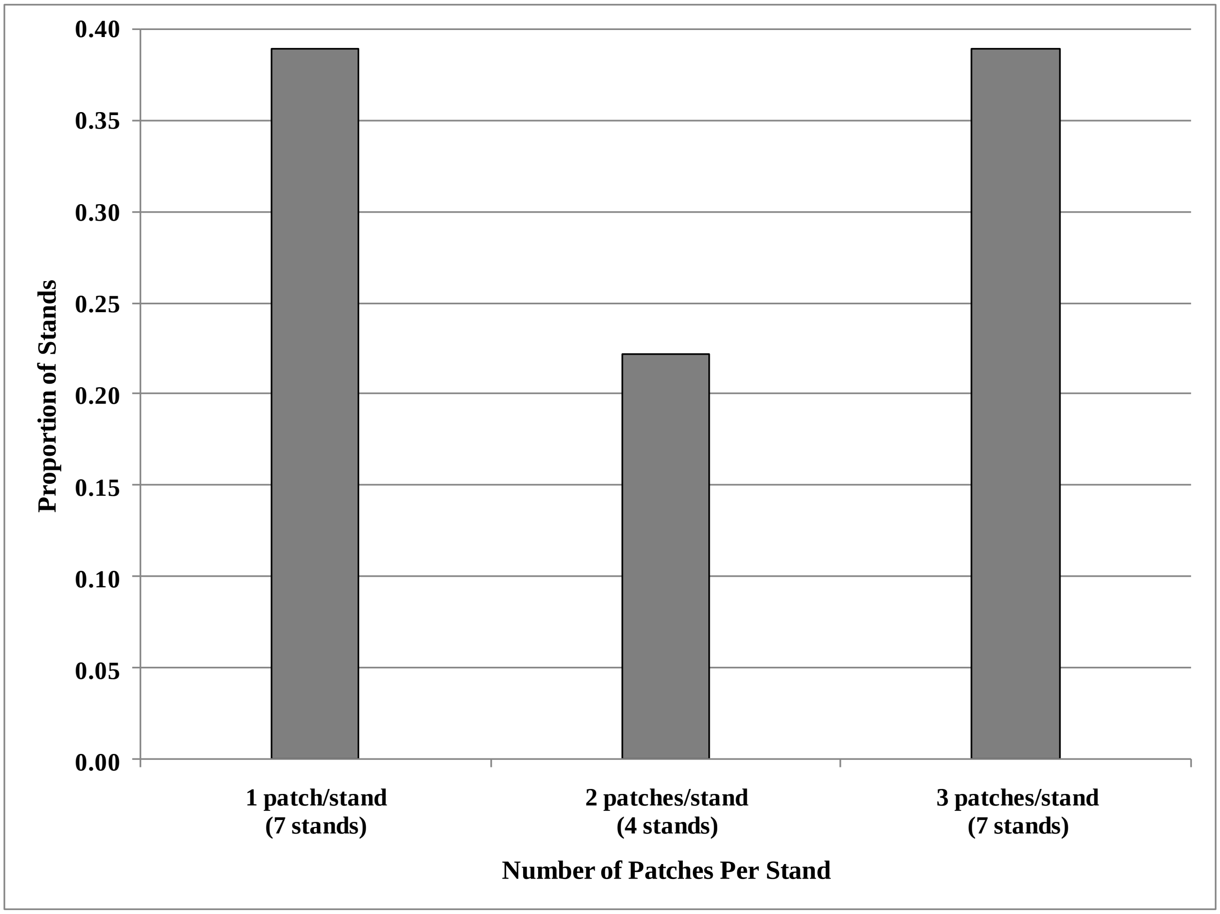


Figure 9. Density of trees, by species and condition, in each of the 24 patches sampled.

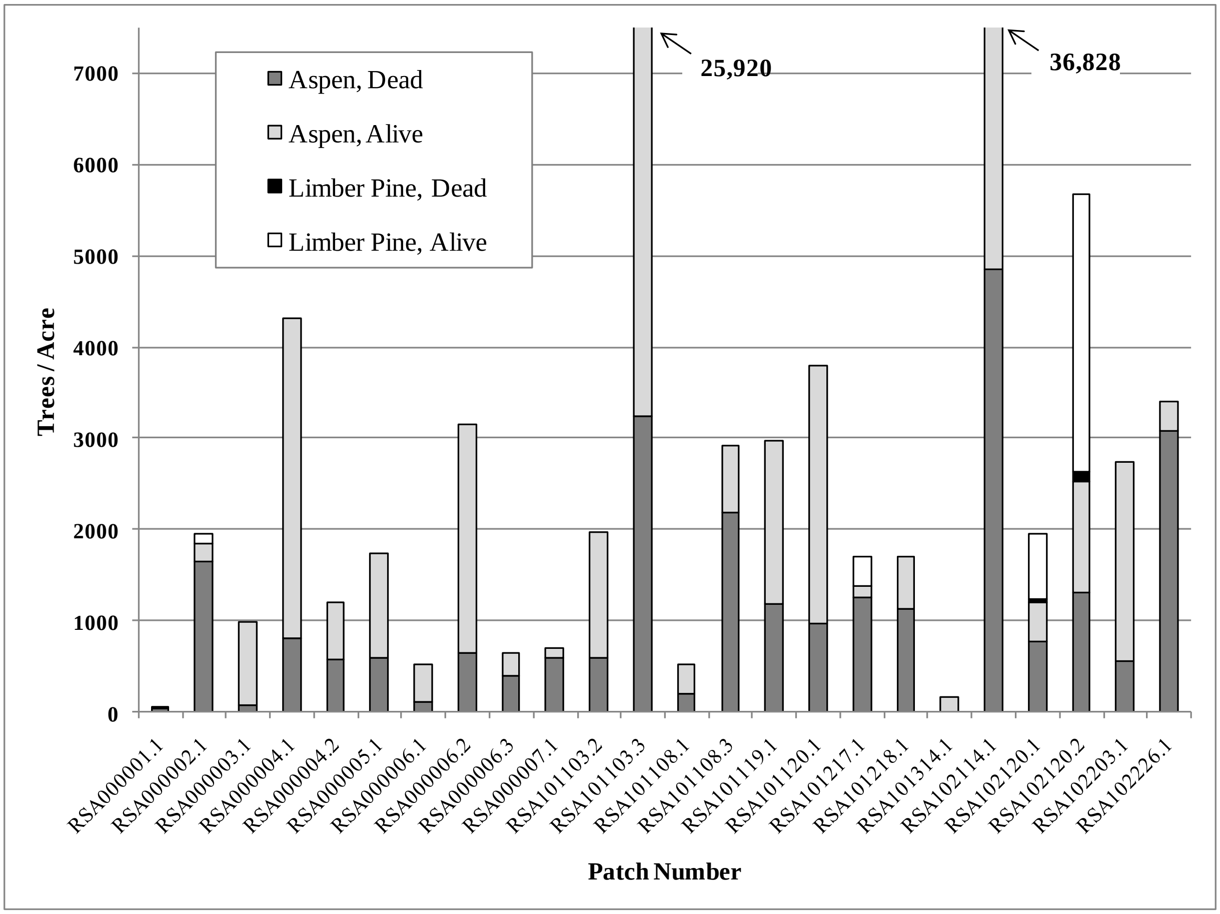


Figure 10. Densities of trees in different size classes, averaged over 24 patches. Columns show average densities. Bars are standard errors of the means.

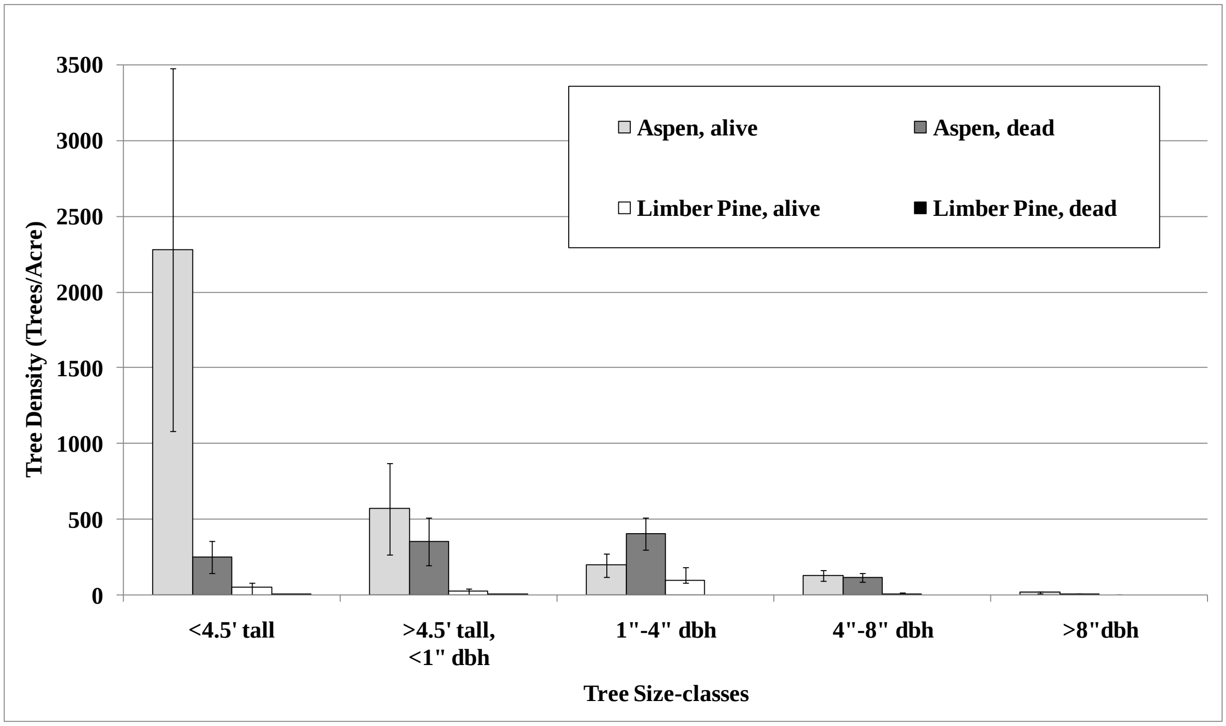


Figure 11. Distributions of trees by size class in 24 individual patches.
Patches from the same stand are enclosed by heavy lines. Other patches occurred in separate stands.

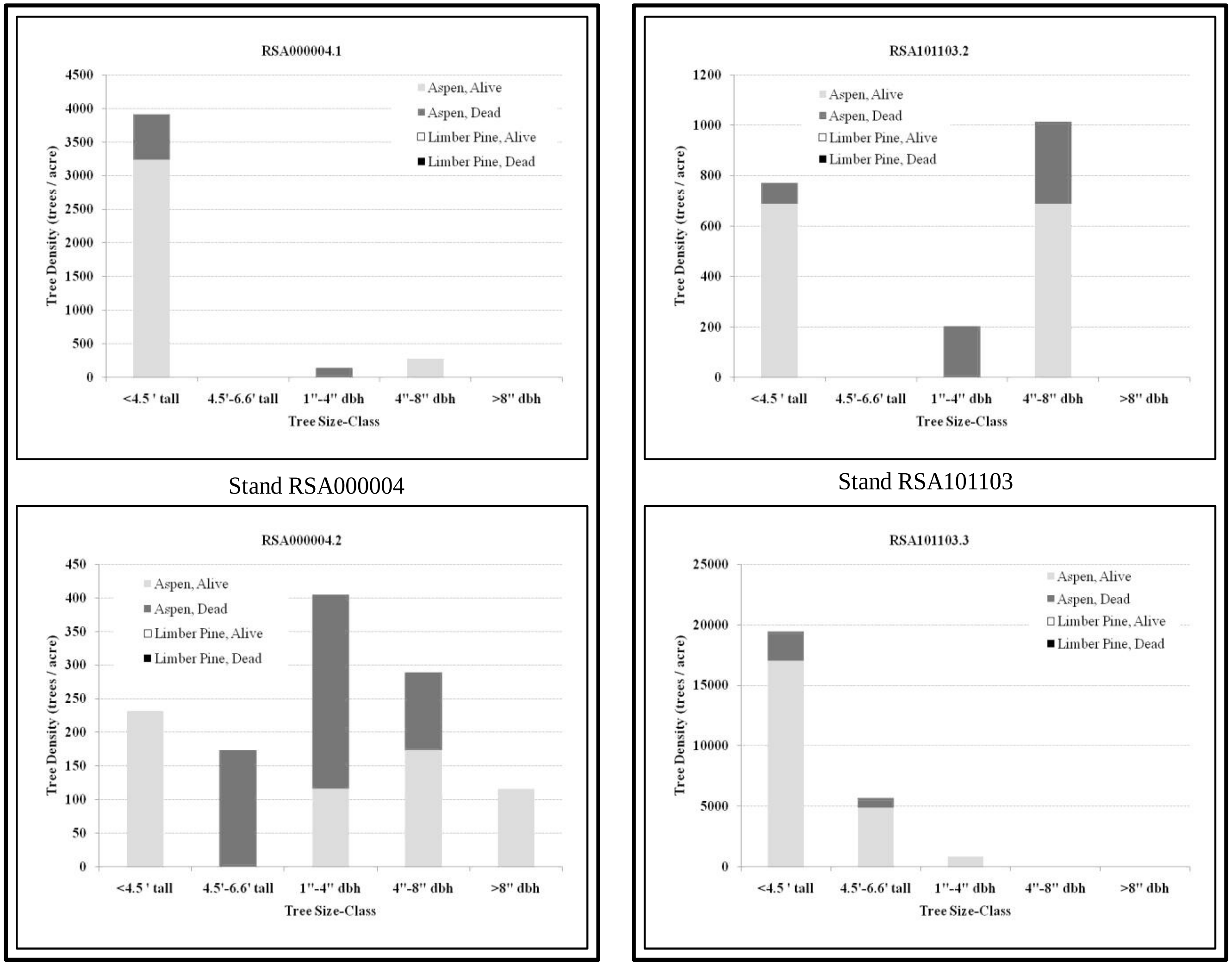


Figure 11 (continued).

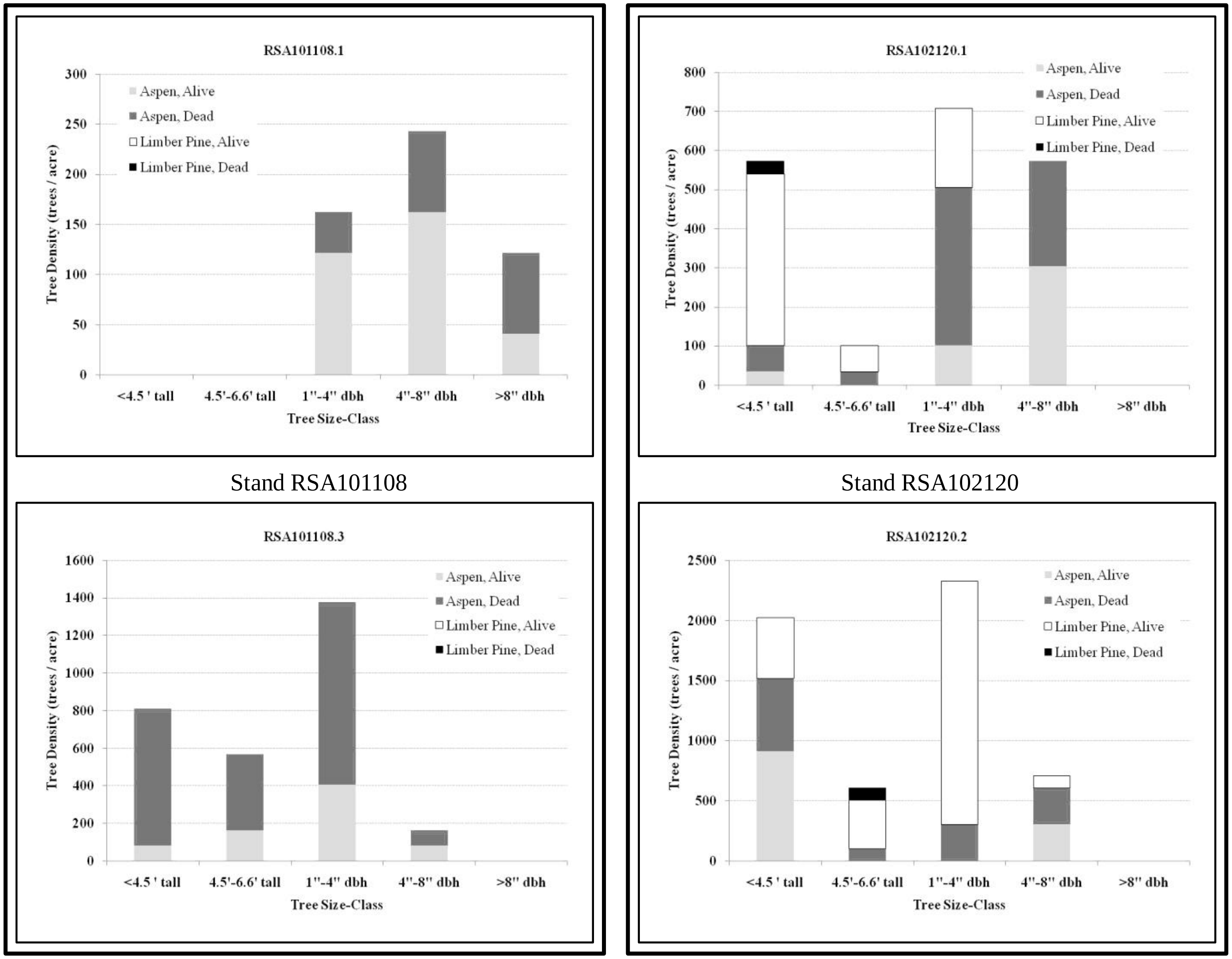


Figure 11 (continued).

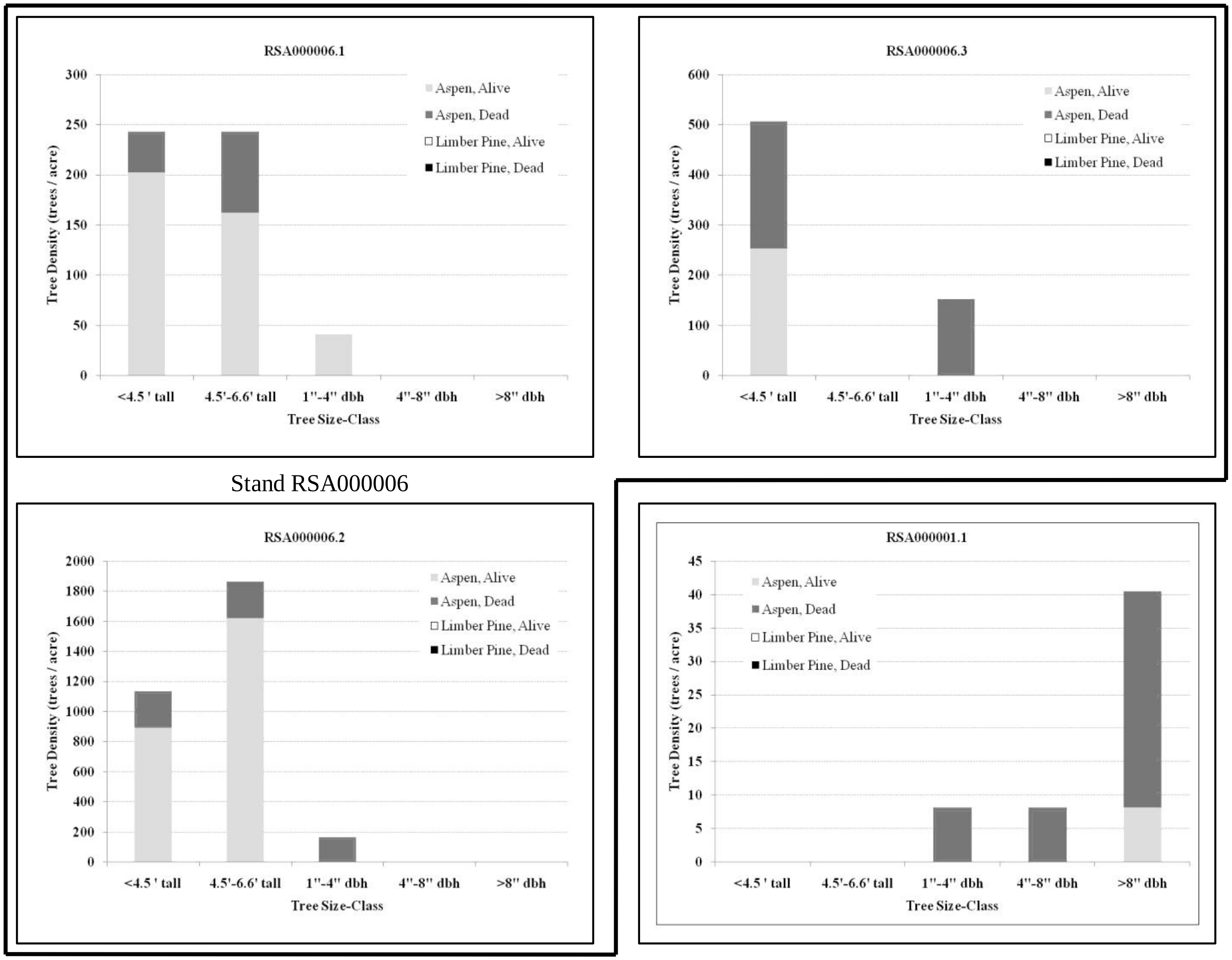


Figure 11 (continued).

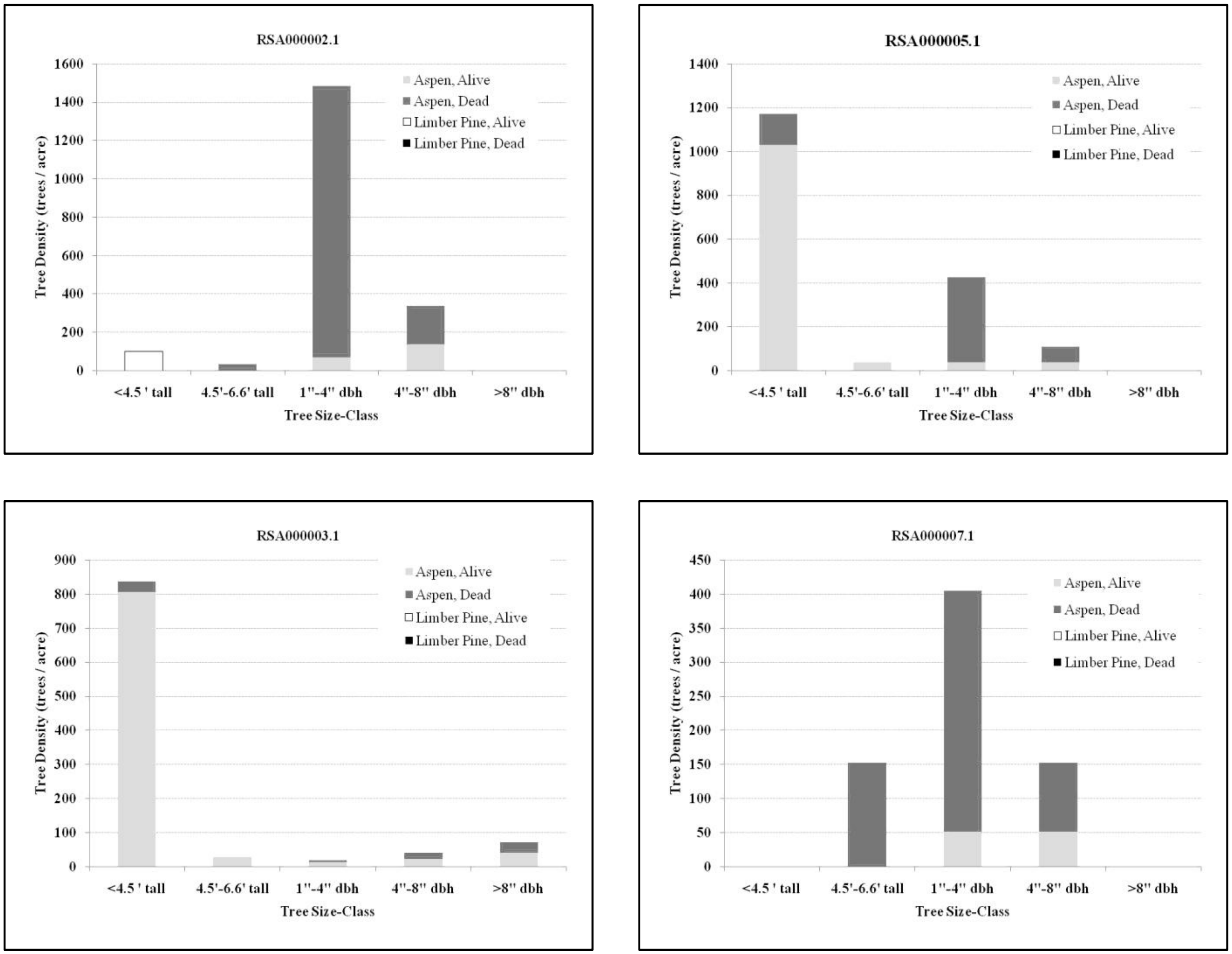
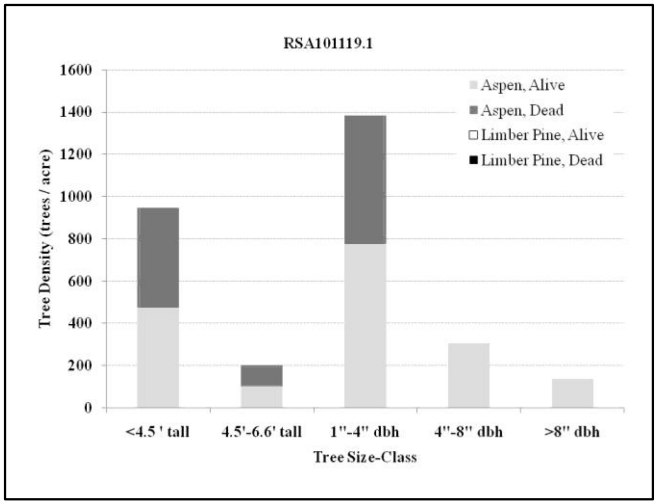
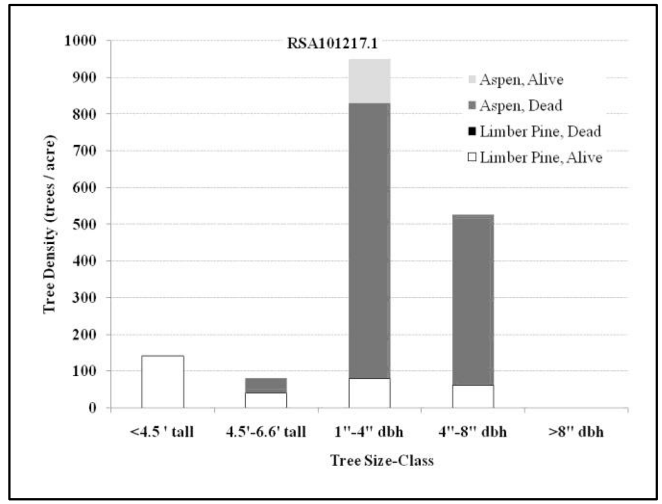
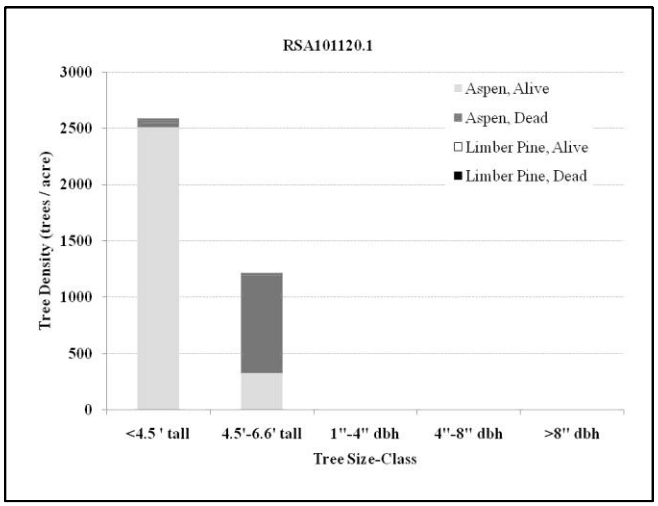
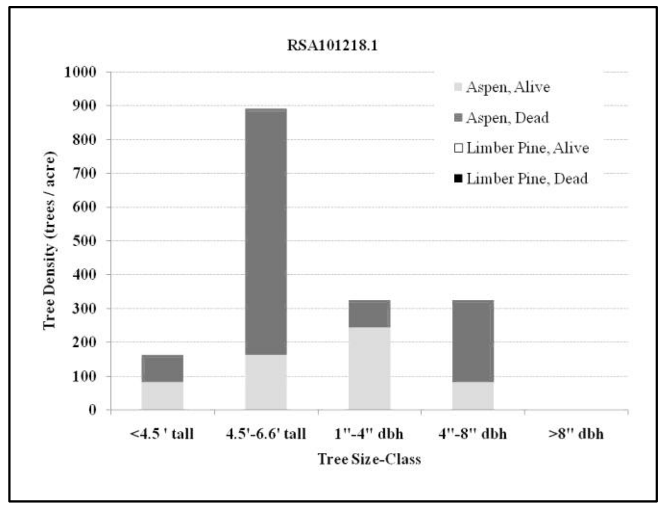


Figure 11 (continued).









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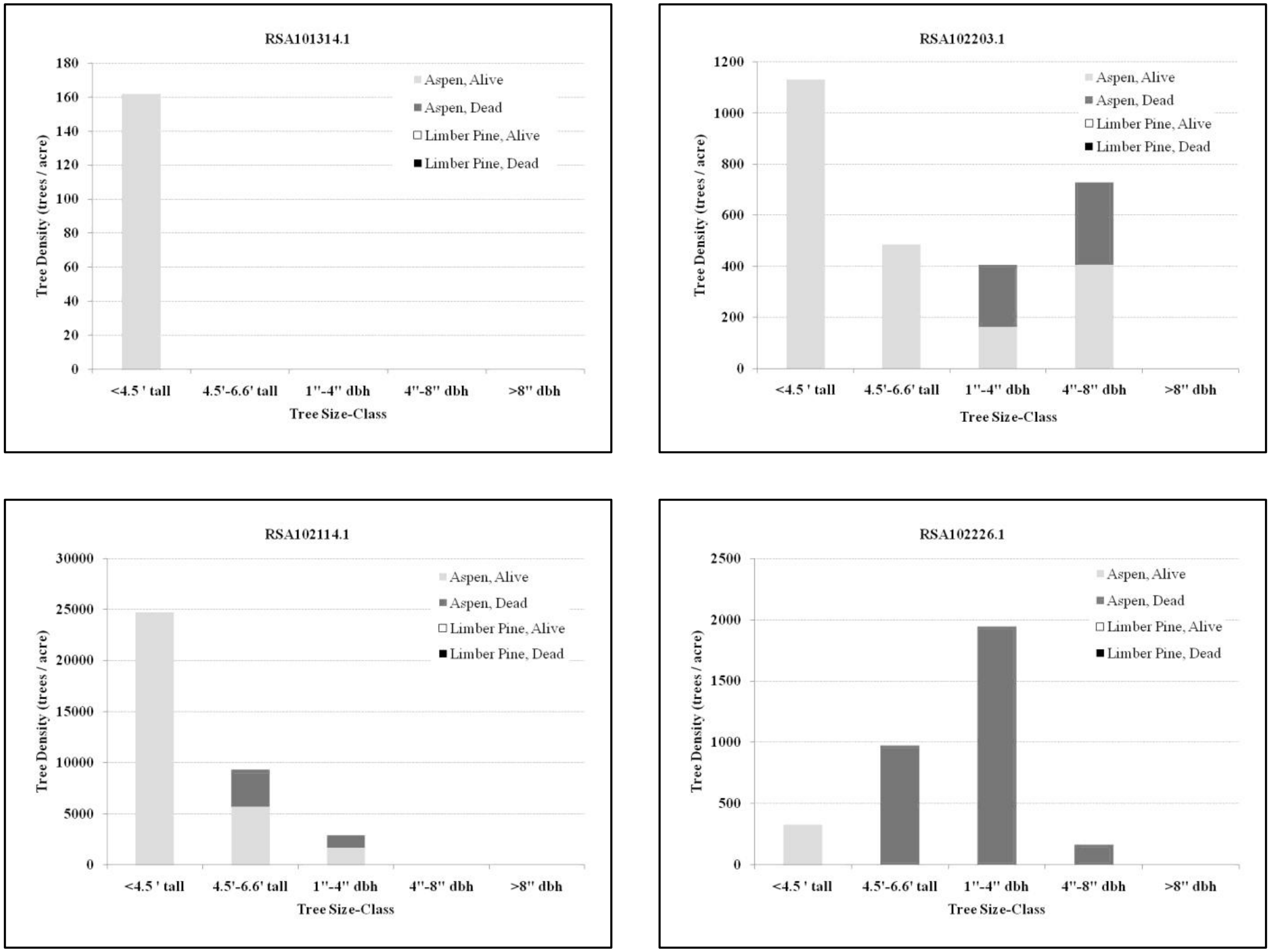


Figure 12. Proportions of live aspens and dead aspens in 5 size classes, averaged from 24 sampled patches.

Proportions were calculated from the combined numbers of trees in all patches.

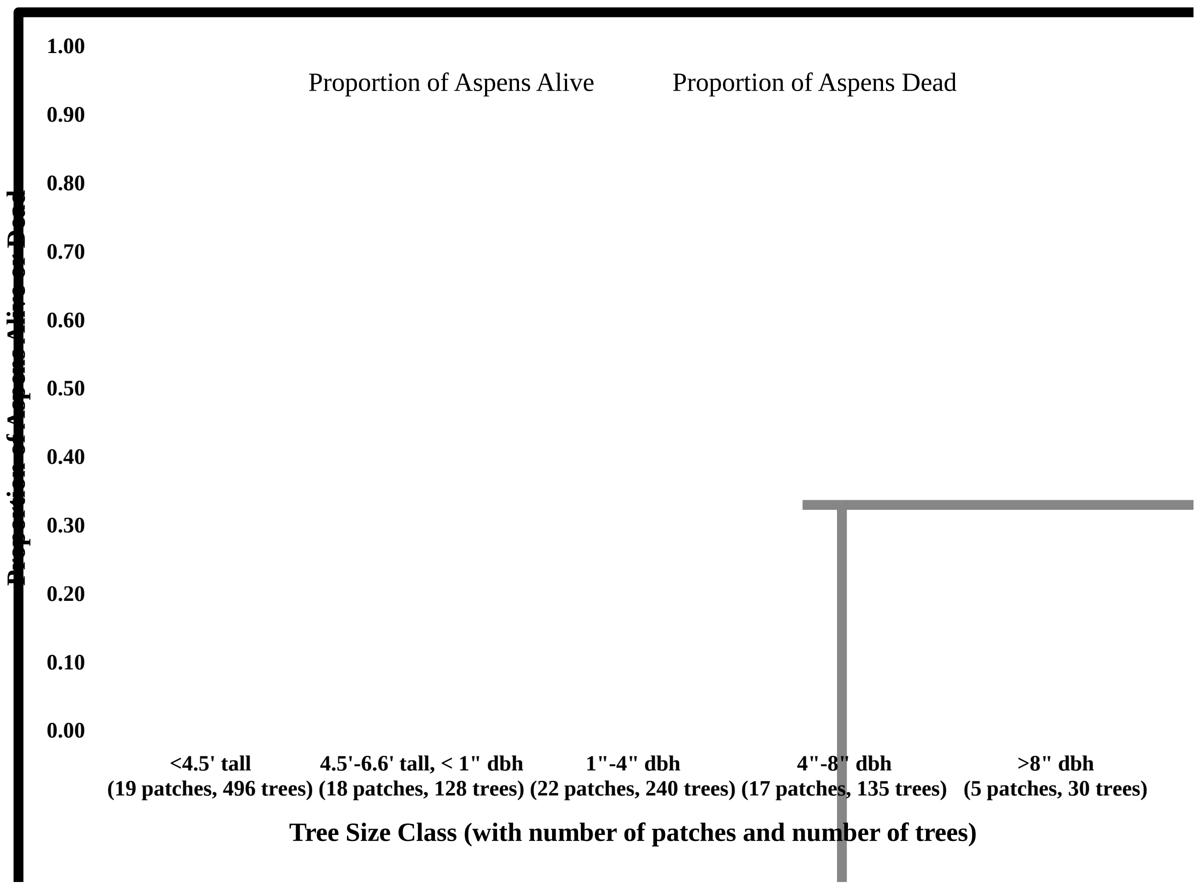


Figure 13. Percent live canopy on aspen trees in each size class, averaged from 23 sampled patches. (No estimates were recorded in one of the 24 patches sampled.)

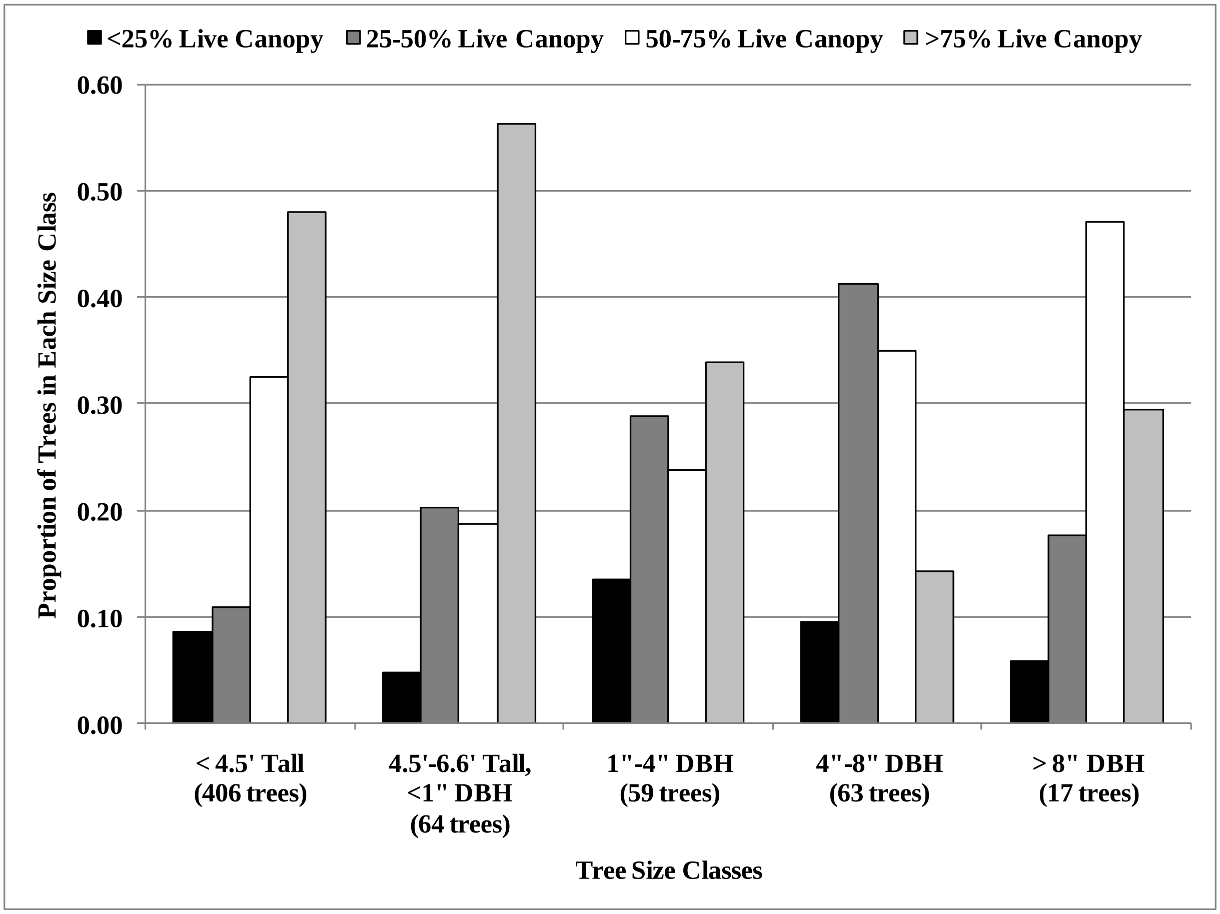


Figure 14. Proportions of live aspen trees in each size class with trunk wounds, averaged for the 24 patches sampled.

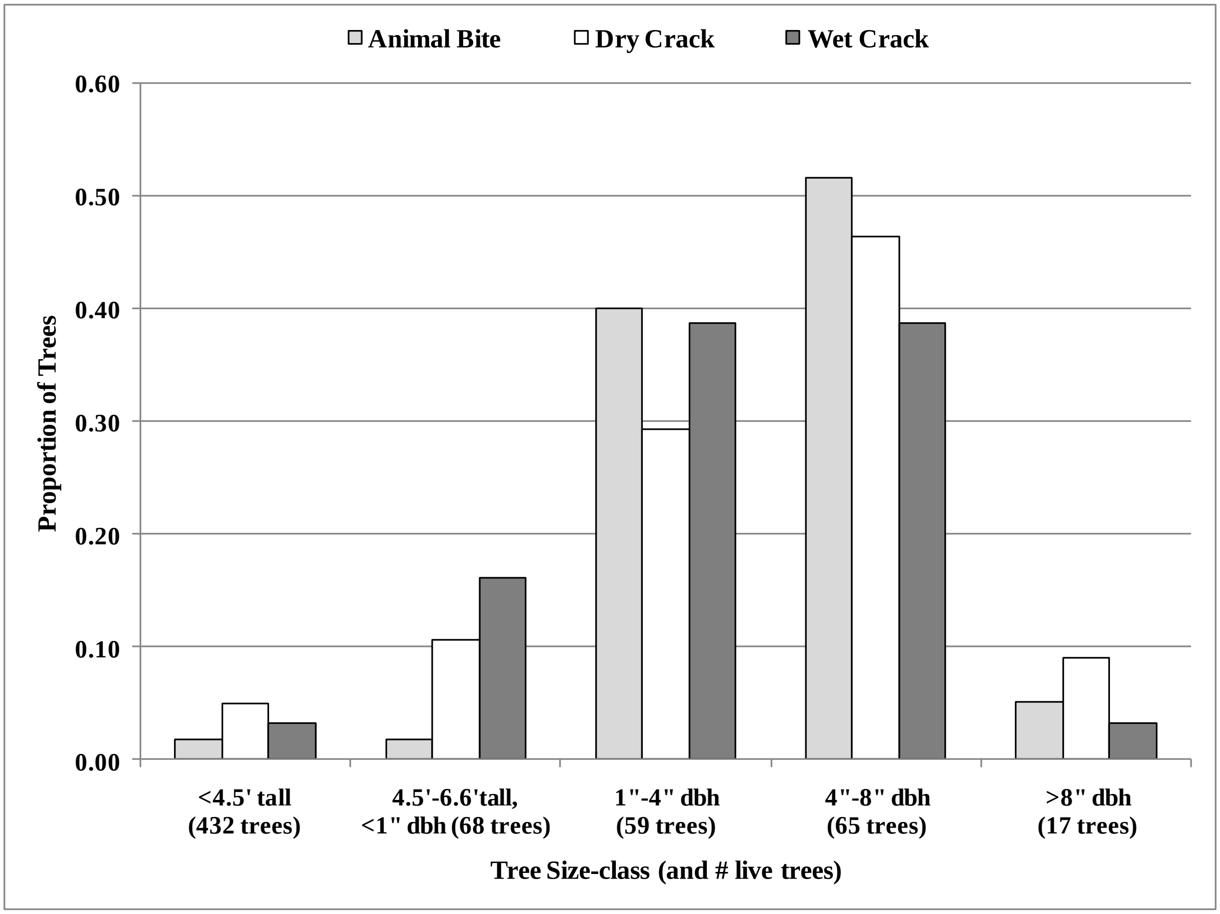


Figure 15. Proportions of live aspen trees with trunk wounds in each patch.

Note that patches are sorted along the X axis by increasing number of trees counted, to call attention to the small number of trees in many patches.

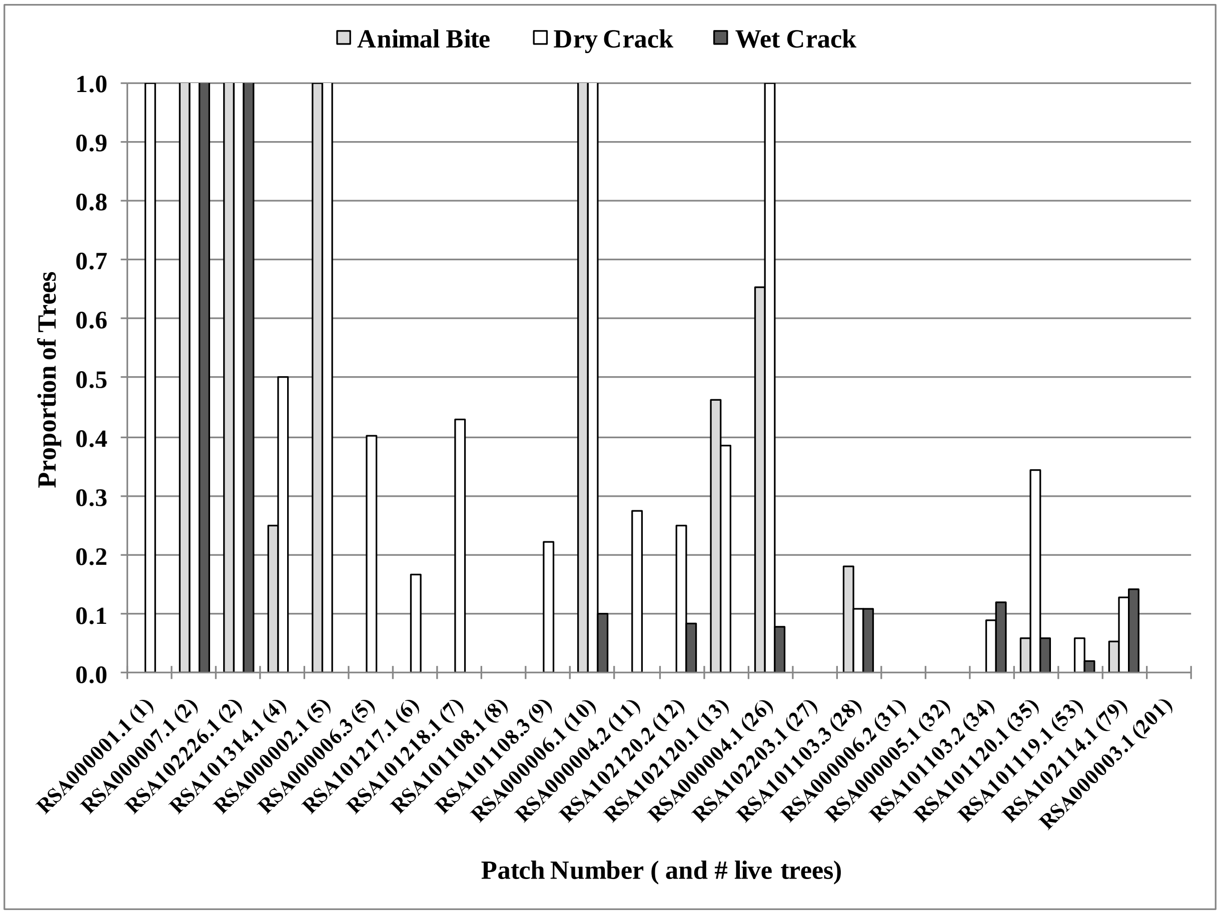


Figure 16. Degree of browsing on terminal buds of live aspen trees < 4.5 feet tall, averaged from 18 of the 19 patches in which small live aspens were counted.
(Data were not recorded in one patch.)

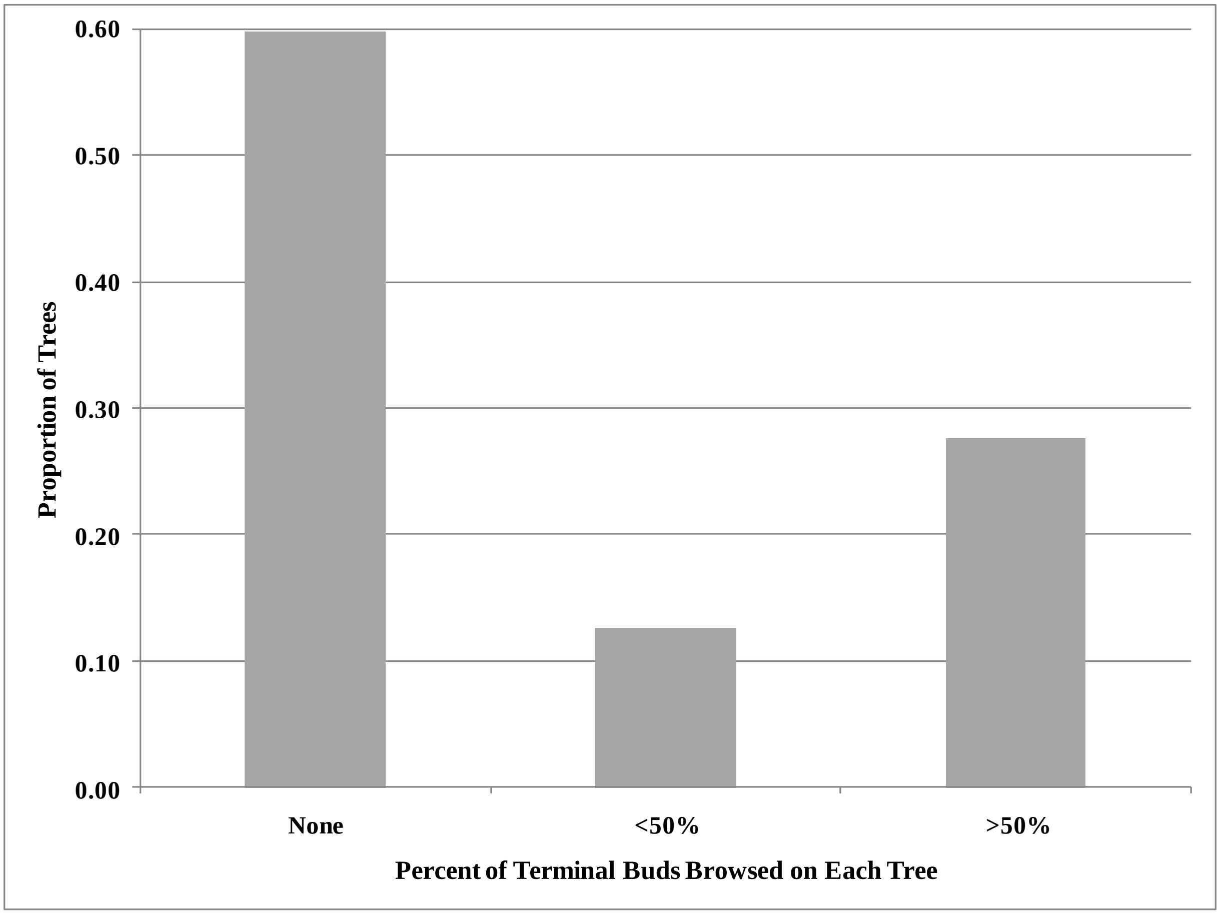


Figure 17. Degree of browsing on terminal buds of live aspen trees < 4.5 feet tall in each of the 18 patches with live small aspen trees for which data were collected.

Note that the order of the patches on the X axis is different than in Figure 15. Patches with ≥ 500 trees/acre in the two smallest size classes (<4.5 ft. tall, and 4.5-6.6 ft. tall and < 1 in. dbh) are indicated by "+". In some patches, percent class of terminal buds browsed was not recorded for some trees, and for those patches, the number of trees shown on this figure may appear too small to give the density shown for the patch as shown in Figure 21 (below).

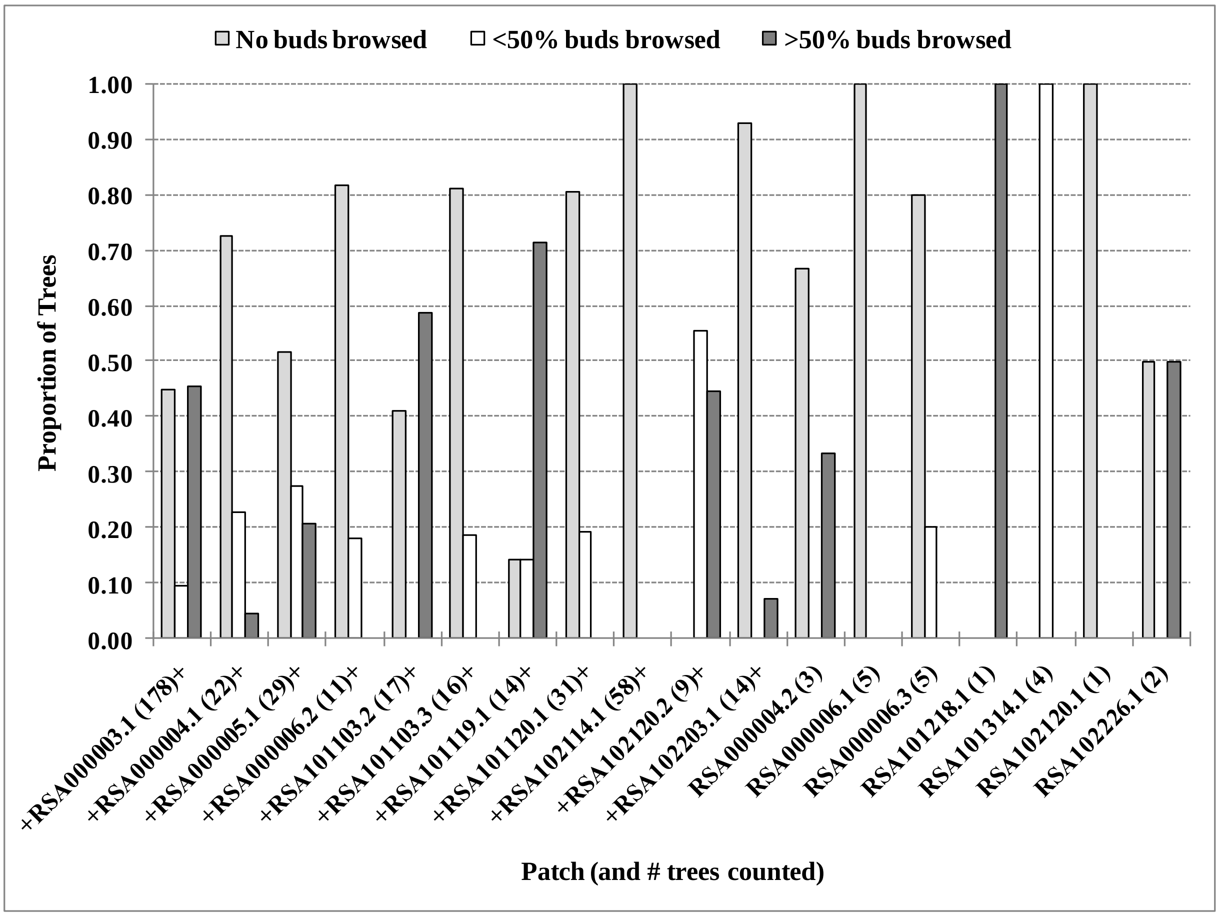


Figure 18. Number of fallen aspen logs per meter of line transect in each patch, by tree size class.

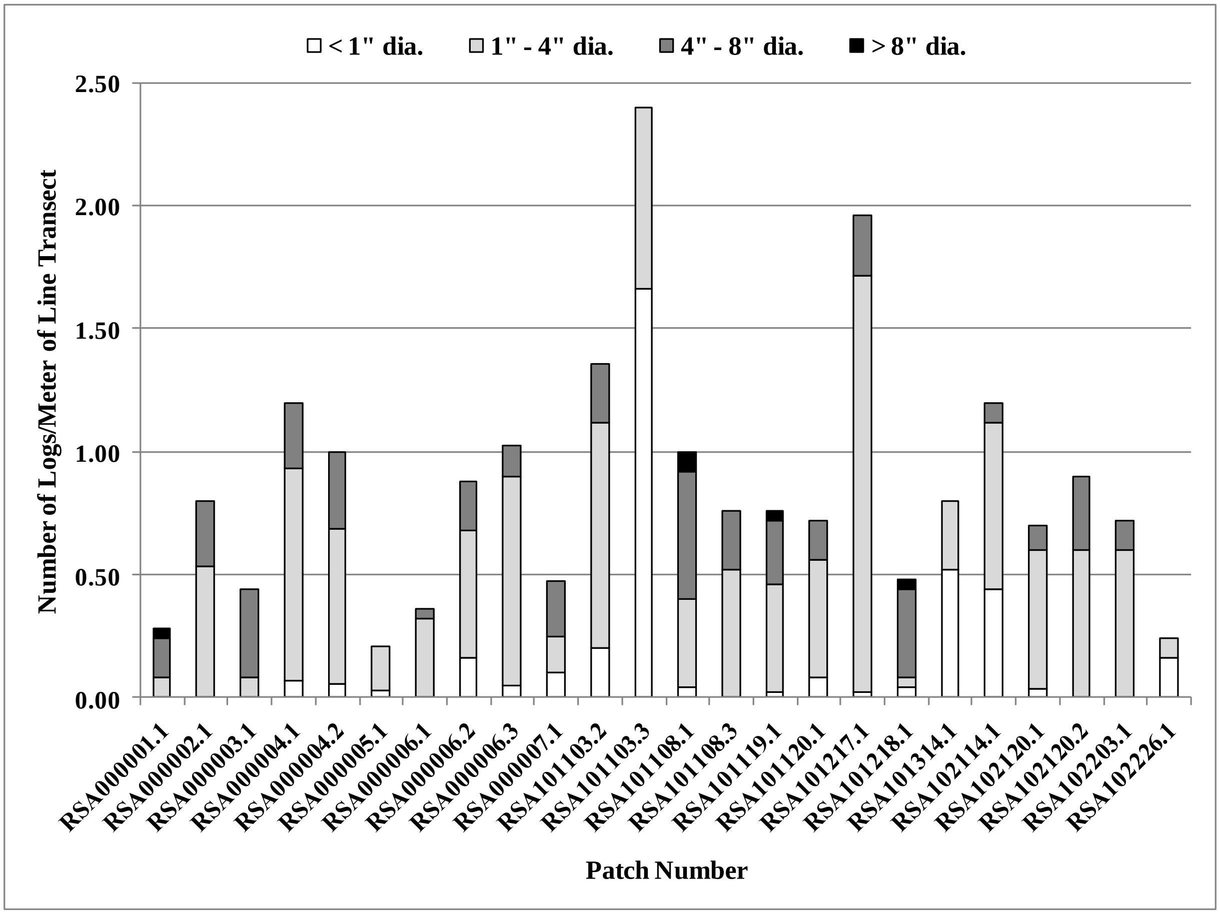


Figure 19. Proportions of live aspens, dead aspens, and fallen logs in each of 4 diameter classes, from numbers pooled from all 24 patches sampled

Logs were tallied in only 4 size classes, so the numbers of trees in the two smallest size classes (<4.5 ft. tall, and 4.5 ft. - 6.6 ft. tall & < 1 in. dbh) have been combined into the single < 1 in. dbh size class for this comparison.

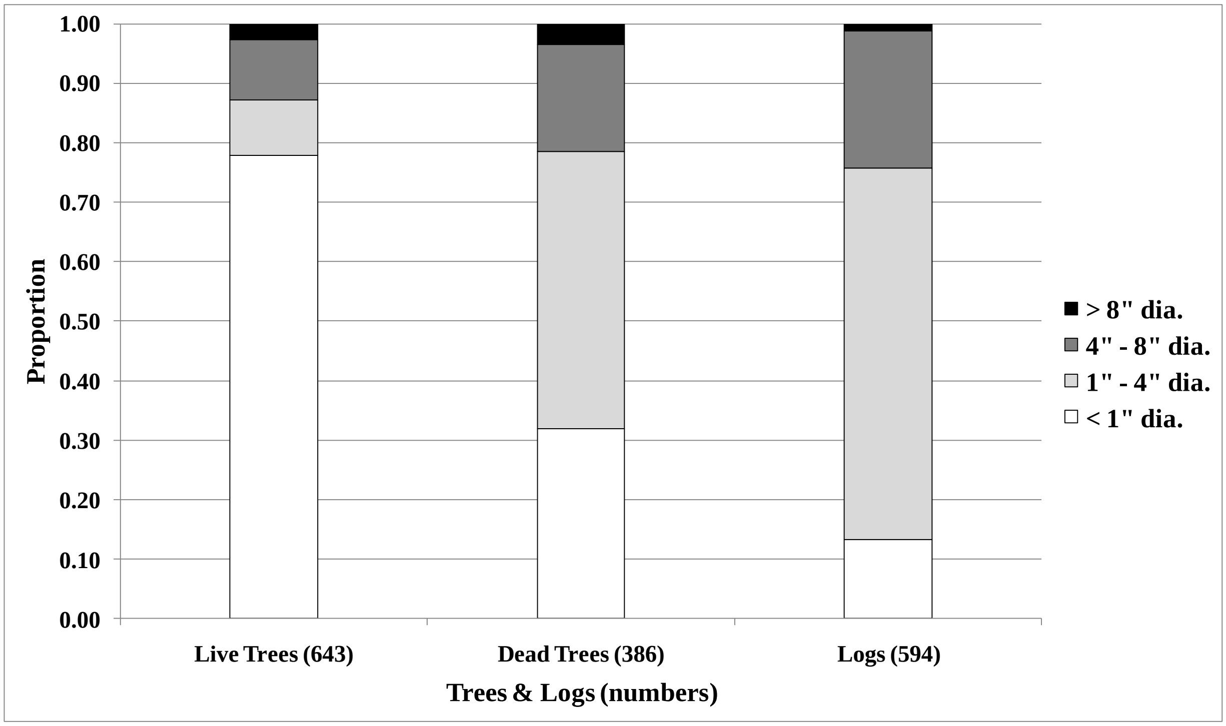


Figure 20. Proportions of live aspen trees, dead aspen trees, and fallen logs among 4 diameter classes. Patches from the same stand are enclosed by heavy lines. Other patches occurred in separate stands.

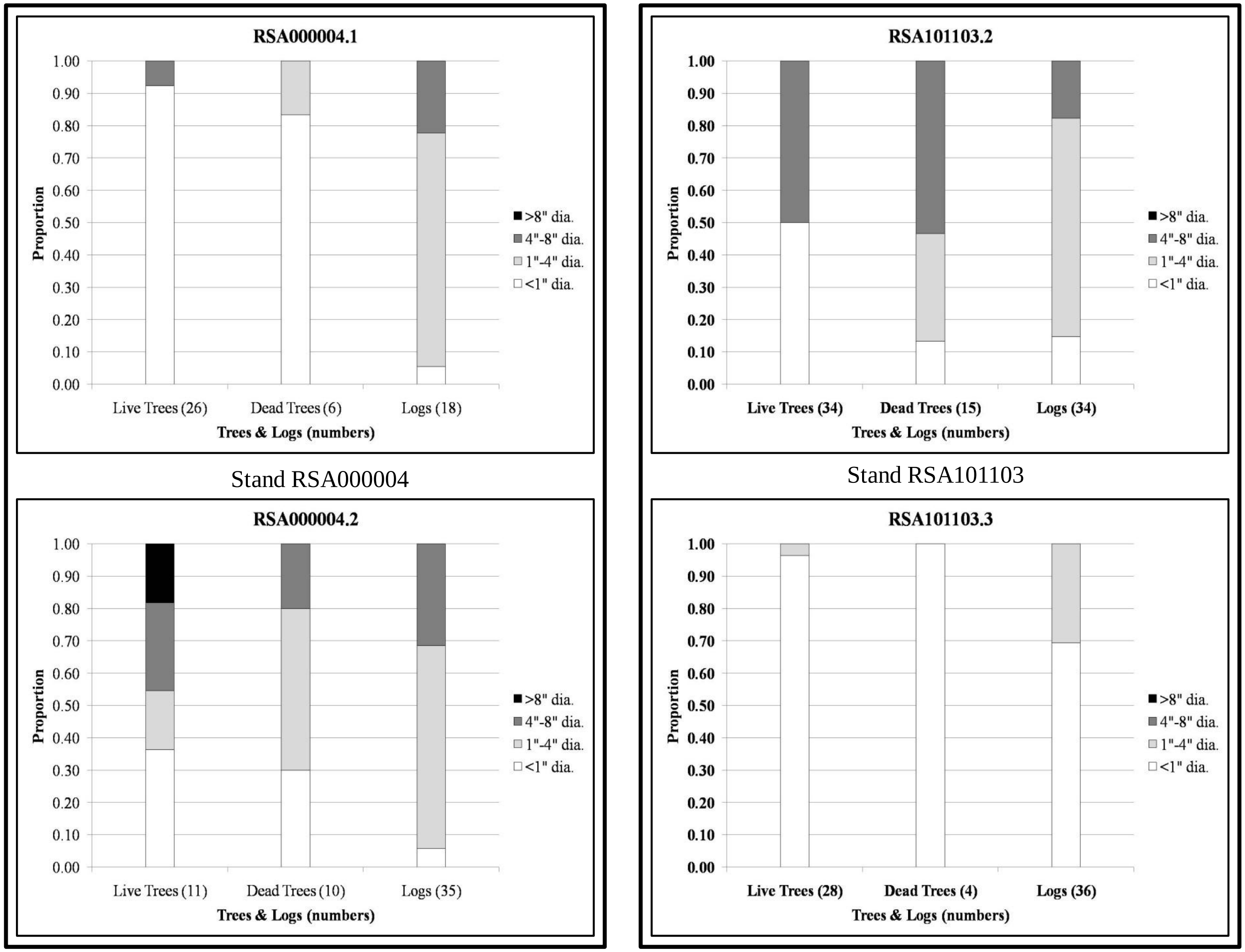
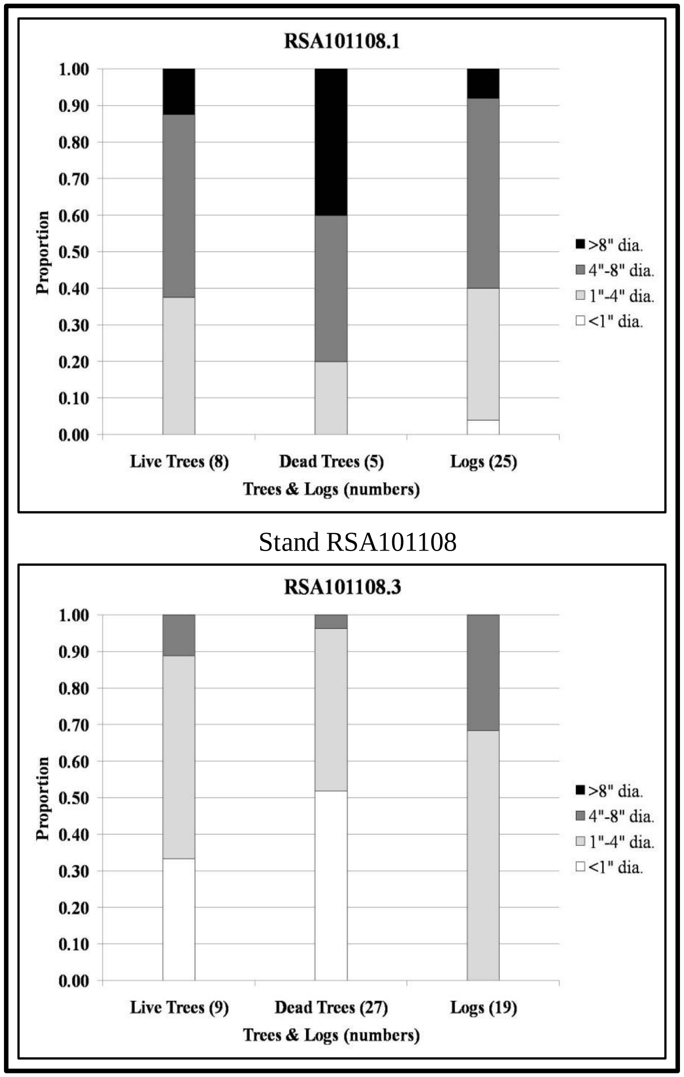


Figure 20 (continued).



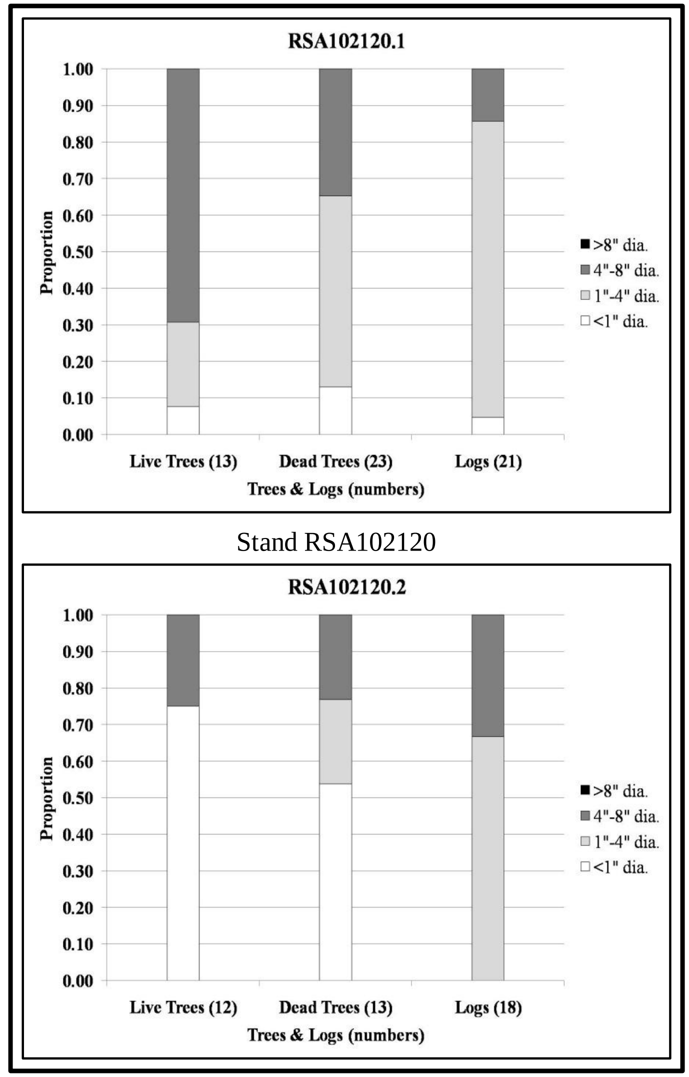


Figure 20 (continued).

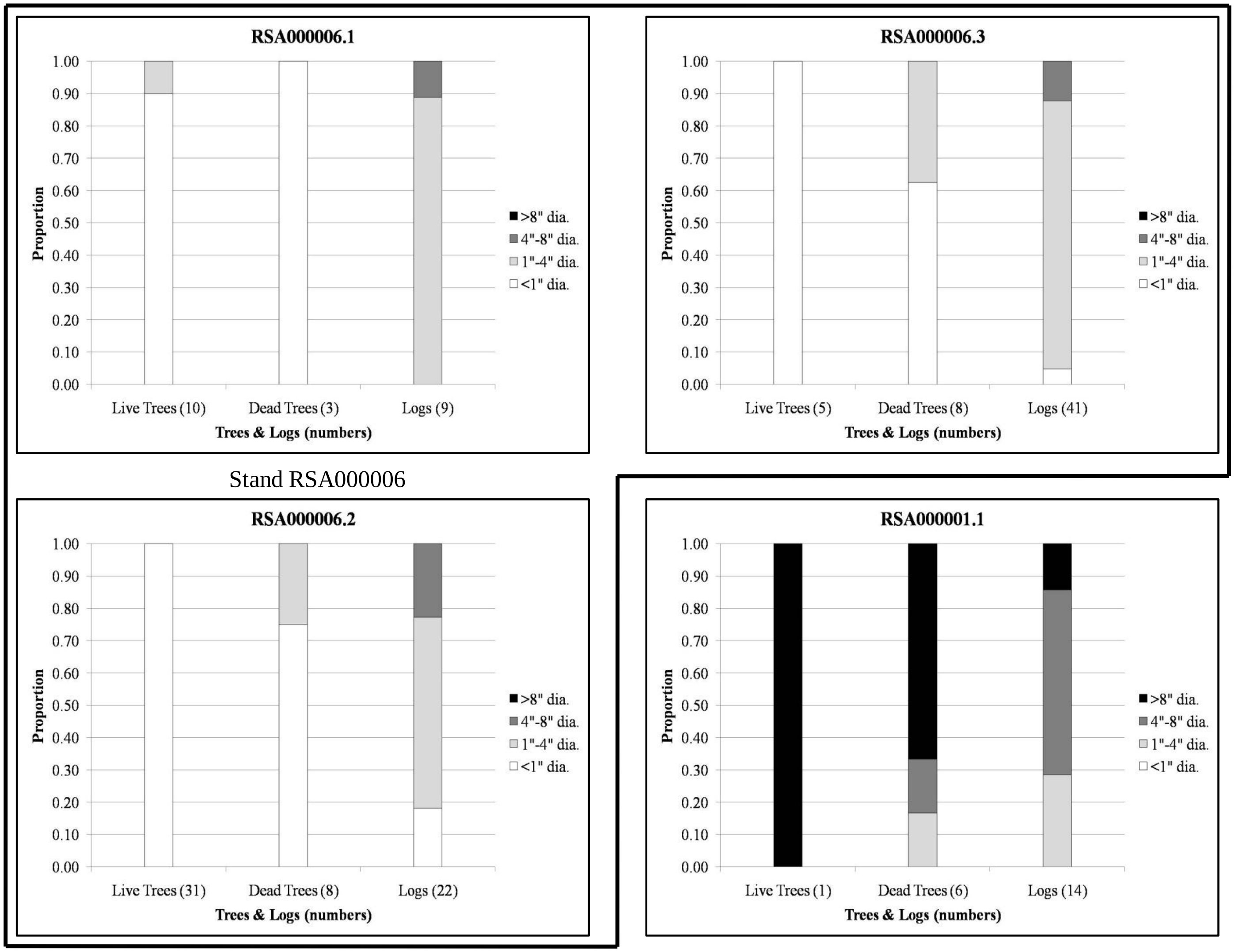
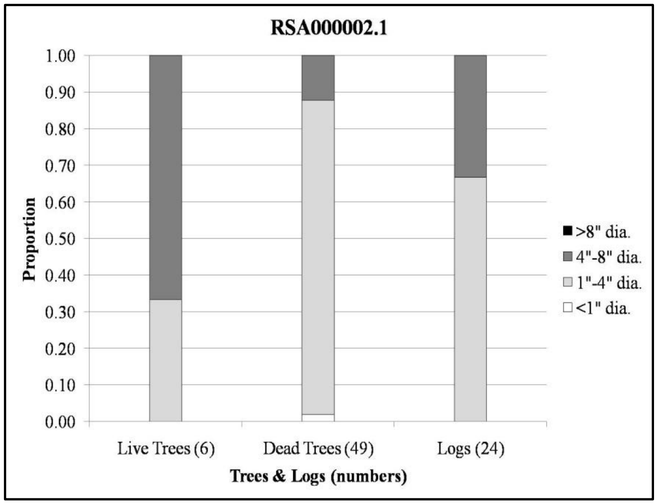
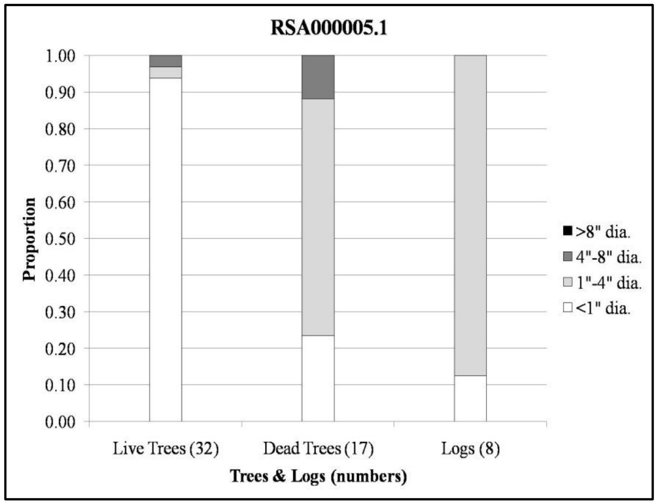
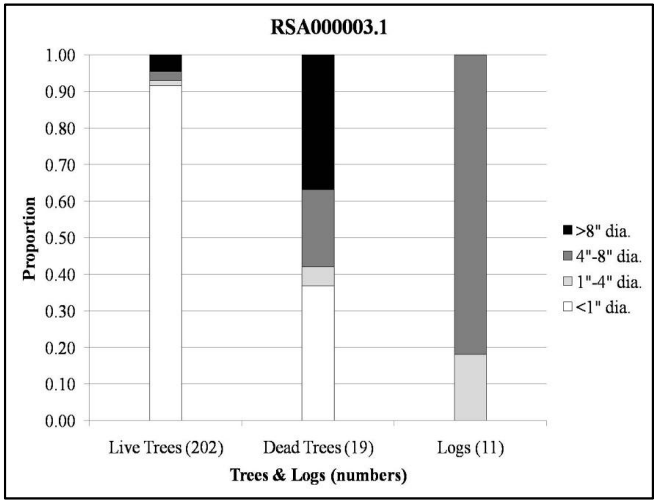


Figure 20 (continued)







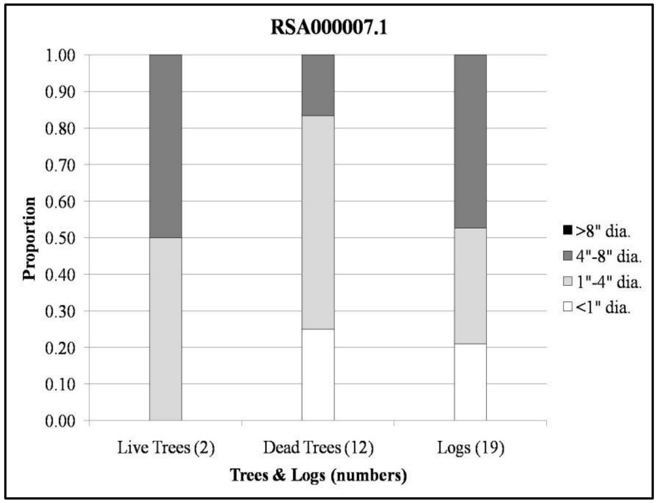


Figure 20 (continued).

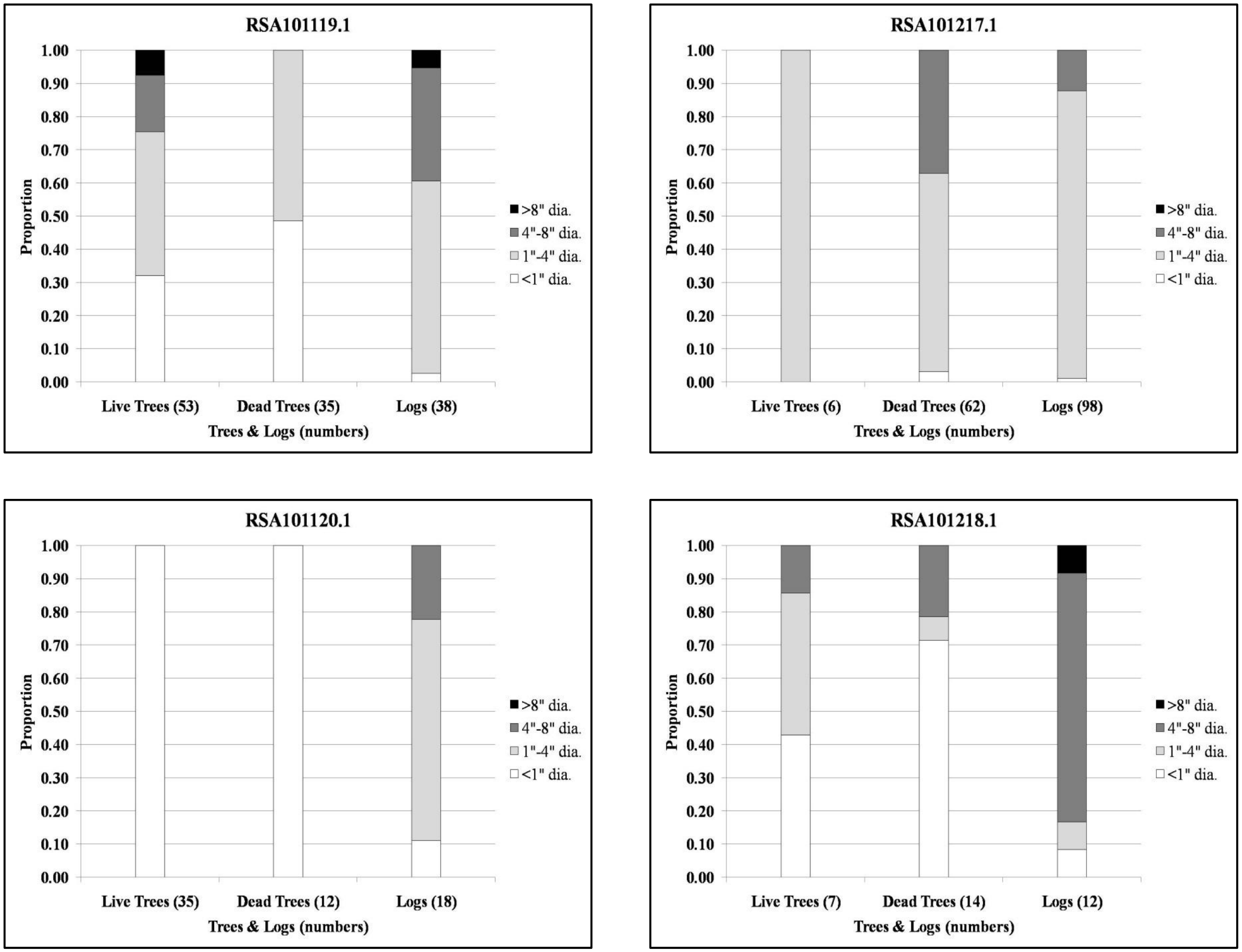
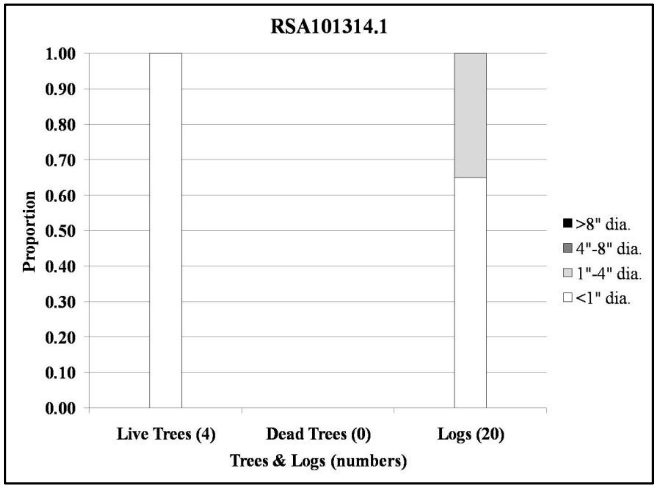
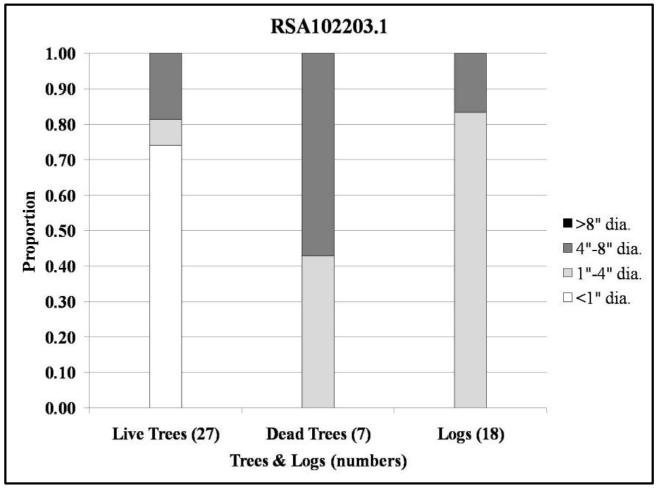
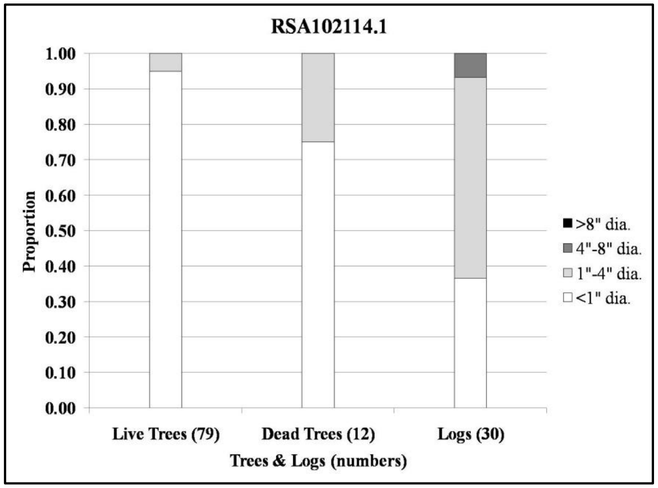


Figure 20 (continued).







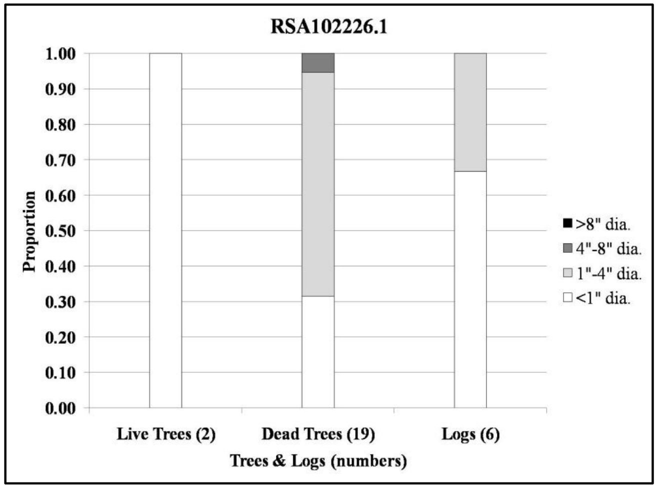


Figure 21. Density (trees/acre) of live aspen trees in the 2 smallest size classes (1 and 2) in each patch. Patches with > 500 live trees/acre are indicated by "+".

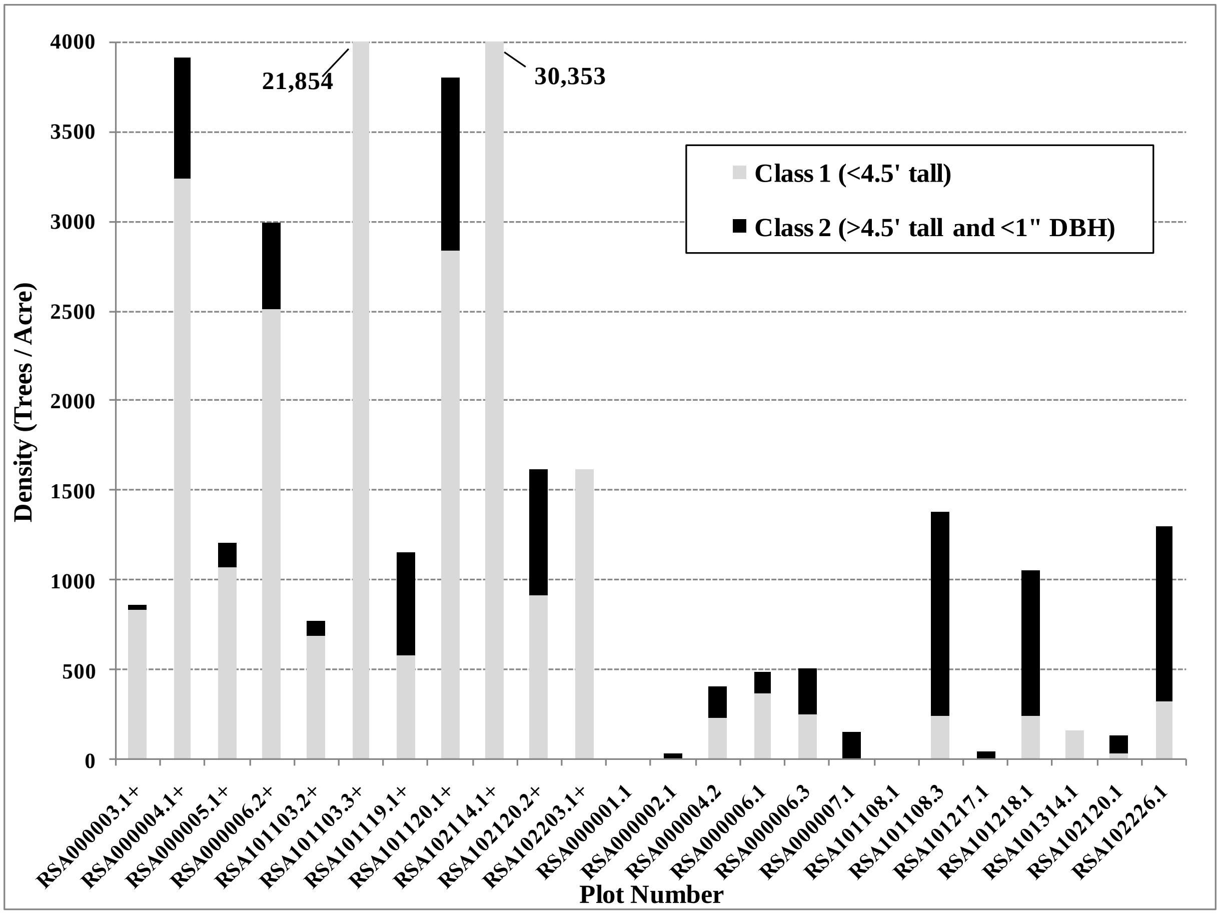


Figure 22. Amount of live canopy in aspens < 1 in. dbh, by patch.

Patches with ≥ 500 trees/acre in the two smallest size classes (<4.5 ft. tall, and 4.5-6.6 ft. tall and < 1 in. dbh) are indicated by "+". In some patches, live canopy percent class was not recorded for some trees, and for those patches, the number of trees shown on this may appear too small to give the density shown for the patch as shown in Figure 21.

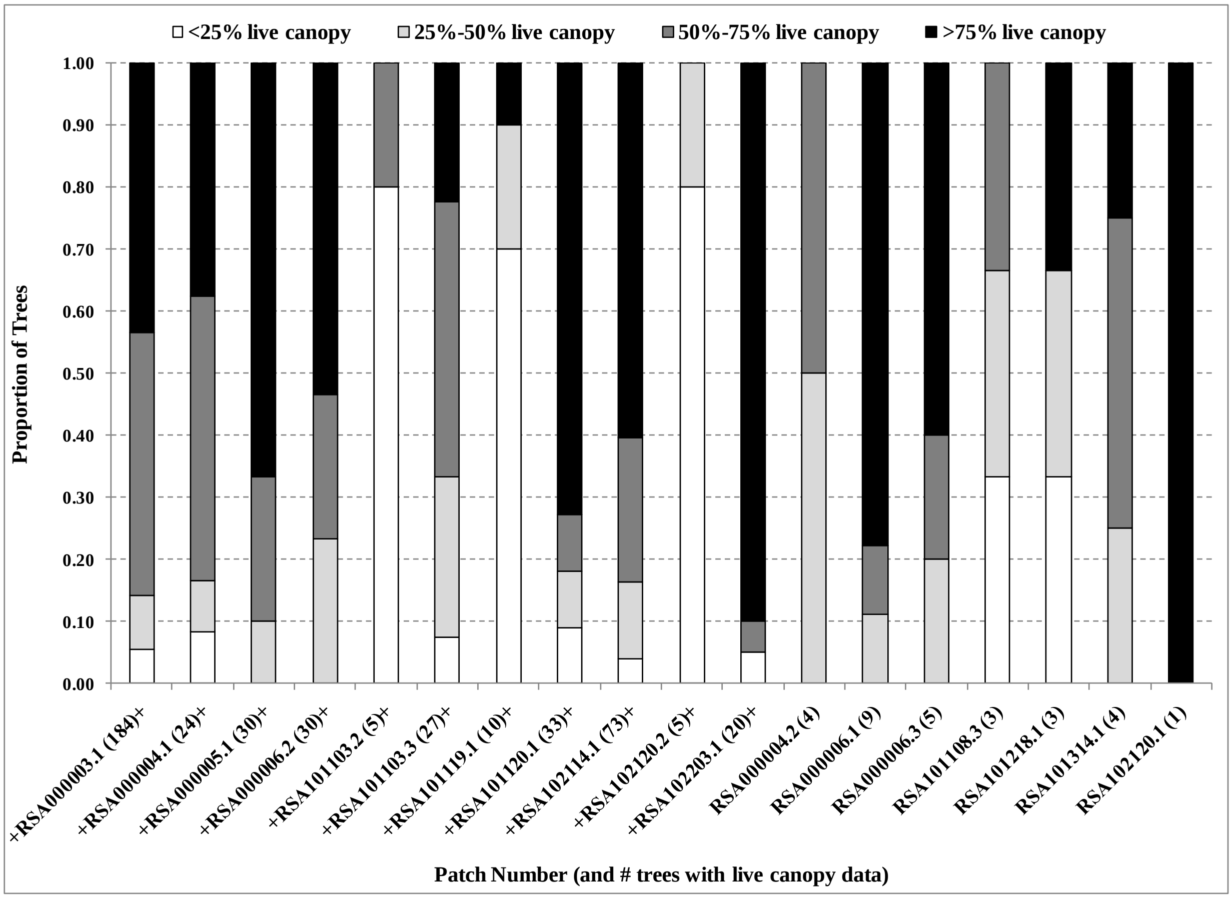


Figure 23. Proportions of live aspens in the two smallest size classes in each patch with bark wounds.

Patches with ≥ 500 trees/acre in the two smallest size classes (<4.5 ft. tall, and 4.5-6.6 ft. tall and < 1 in. dbh) are indicated by "+". In some patches, the presence of wounds was not recorded for some trees, and for those patches, the number of trees shown on this may appear too small to give the density shown for the patch as shown in Figure 21.

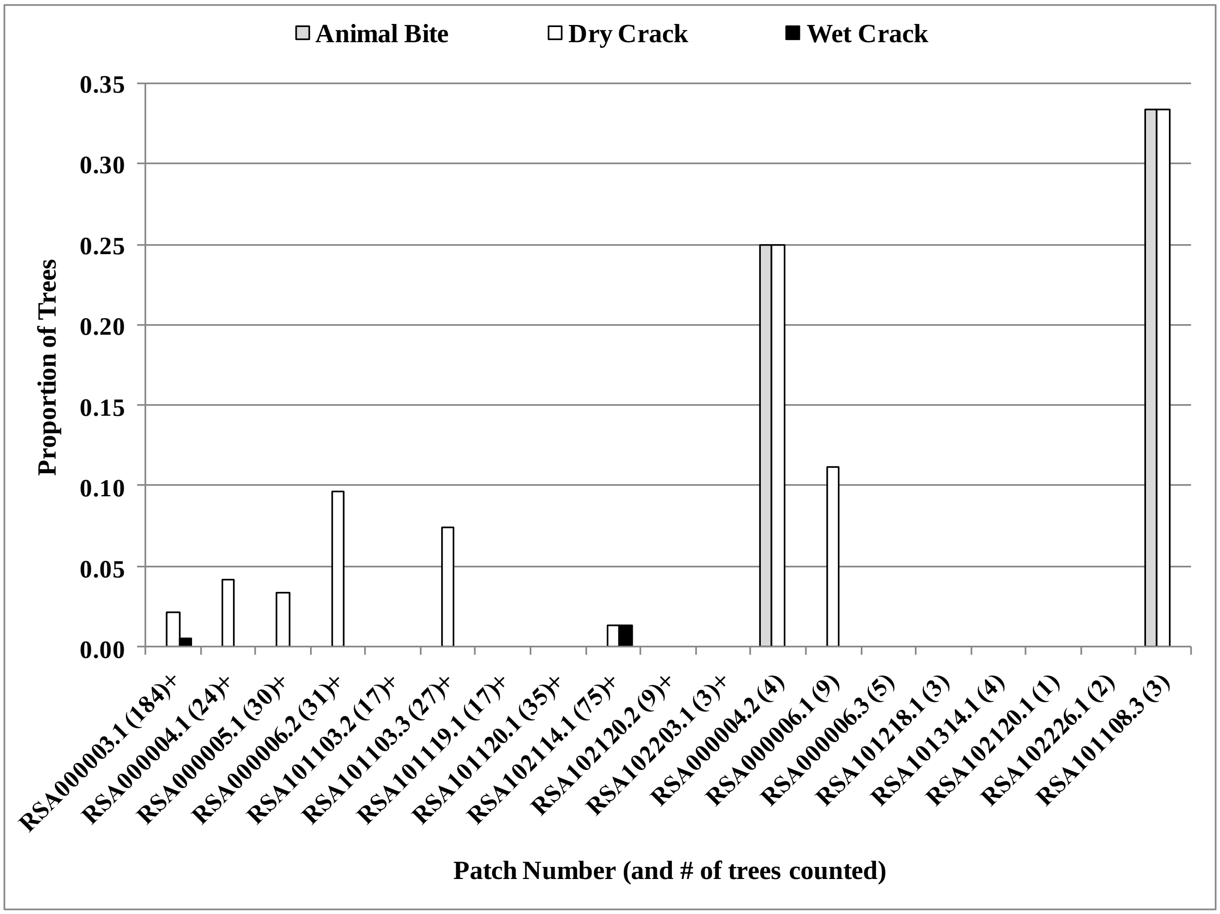


Figure 24. Density of live aspen and dead aspen 1 in. - 4 in. dbh in each patch.

Patches are arranged along the X axis by decreasing density of live trees. Patches marked with "+" are those with >500 trees/acre of live aspens in the smallest two size classes.

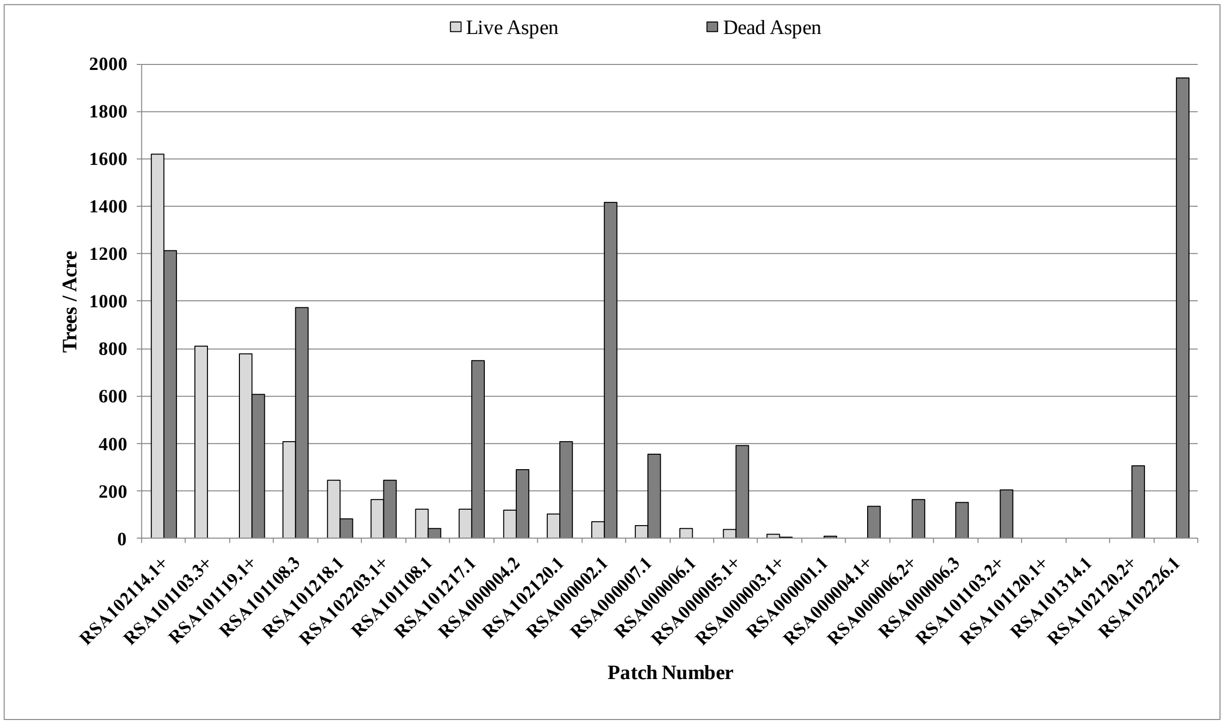


Figure 25. Amount of live canopy in aspens 1 in. - 4 in. dbh, in each of the 15 patches where live trees in this size class were counted.

Patches are arranged along the X axis by decreasing density of live trees. Patches marked with "+" are those with >500 trees/acre of live aspens in the smallest two size classes.

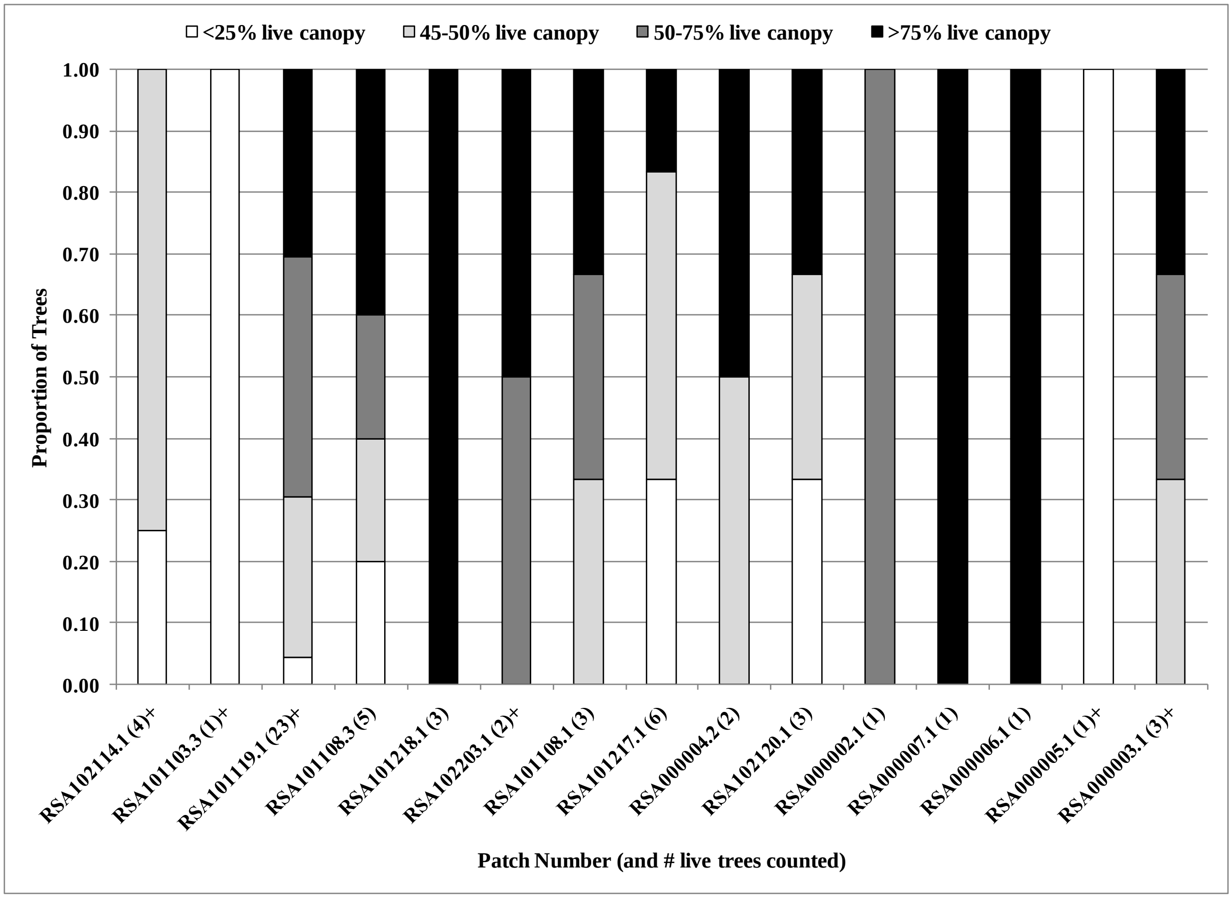
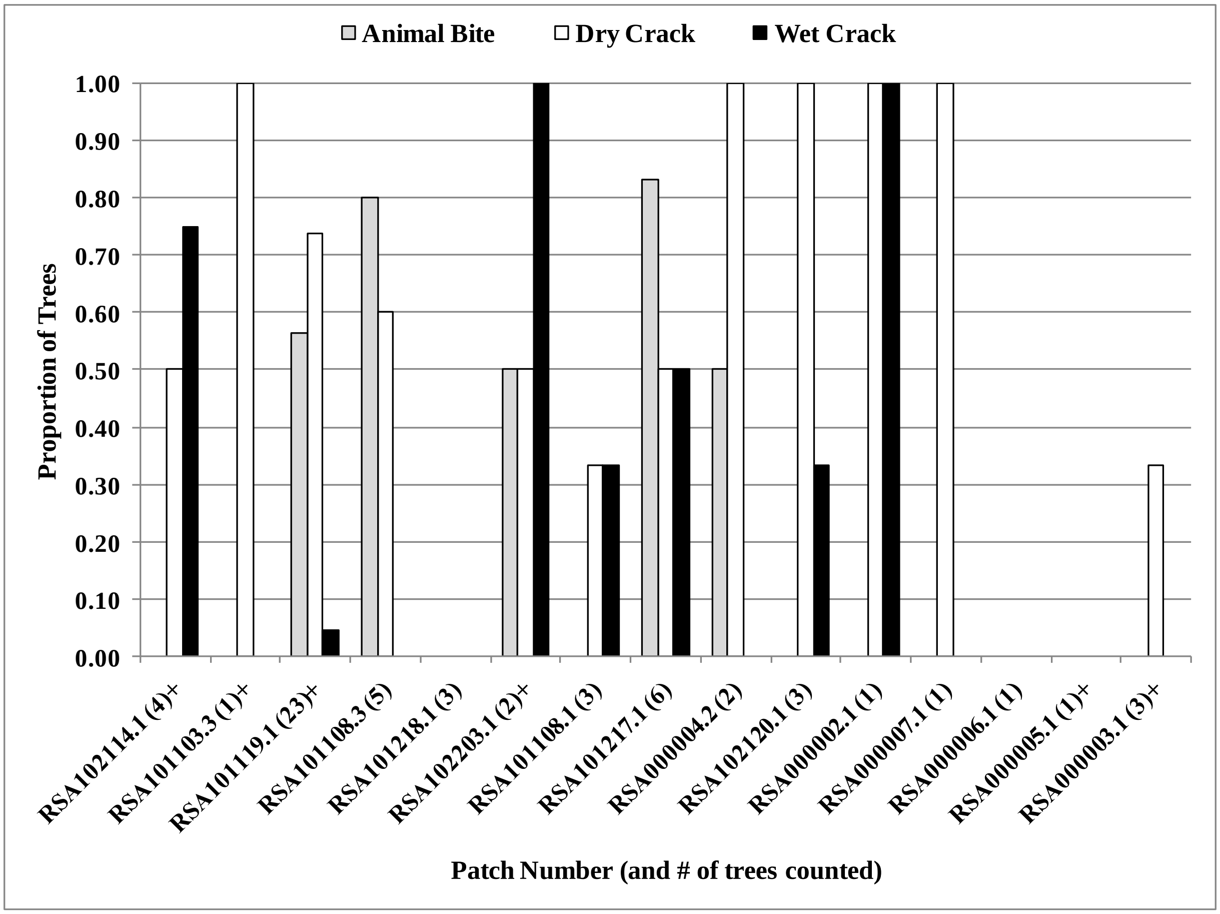


Figure 26. Proportions of live aspens 1 in. - 4 in. dbh with bark wounds, in each of the 15 patches where live trees in this size class were counted.

Patches are arranged along the X axis by decreasing density of live trees. Patches marked with "+" are those with >500 trees/acre of live aspens in the smallest two size classes.



TABLES

Table 1. Size classes used for aspen stems.

Category No.	Category Name	Height	Diameter at 4.5 ft. off ground
1	Sprout	< 4.5 feet (1.4 meter)	
2	Regeneration	4.5 - 6.6 feet (1.4 - 2 meters)	By 2 inch (5 cm) size class
3	Small tree	> 6.6 feet (2 meters)	1 inch - 4 inches (2.5 - 10 cm)
4	Medium-size tree	> 6.6 feet (2 meters)	4 in.- 8 in. (10 - 20 cm)
5	Large tree	> 6.6 feet (2 meters)	> 8 in. (20 cm)

Table 2. Signs of condition in aspen trees.

Sign	Description
Animal bite	Scars on bark that indicate scraping with teeth or biting
Dry wound	Crack or opening in bark with no liquid draining from it
Wet wound	Crack or opening in bark with liquid draining from it.
Conk	Fungal fruiting body
Bark	Dead trees only: bark still present on branches or trunk
Twigs	Dead trees only: small twigs still present on branches

Table 3. Numbers of points sampled or only observed (not sampled), with aspen and without.

Known points were identified from digital vegetation layers before field work. "BLM only" indicates known points that had been identified only on the BLM vegetation map, and "WLCD only" indicates points identified only on the Wyoming Land Cover Dataset layer. New points are those that were unknown before field work (because none of the digital vegetation layers showed that aspen was present there) but where aspen was noted in the field. Unsampled points are those where cursory observations were made but no data were collected; all were known points.

	Sampled (n=51)		Unsampled (n=8)		All Points (n=59)	
	With Aspen	Without Aspen	With Aspen	Without Aspen	With Aspen	Without Aspen
Known Points (n=52)	11	33	5	3	16	36
BLM only (n=48)	*10*	*33*	*3*	*2*	*13*	*35*
WLCD only (n=4)	*1*	*0*	*2*	*1*	*3*	*1*
New Points (n=7)	7	0			7	0
All Points (n=59)	18	33	5	3	23	36

Table 4. Landscape features of the 18 sampling points at which aspen patches were sampled.

Sampling Point Number	Aspect	Steepness	Slope shape	Surface deposit	Topographic Position	Elevation, meters	Elevation, feet
RSA000001	40	20	Flat	Residual	Toeslope	2582	8470
RSA000002	270	21	Concave	Residual	Footslope	2518	8262
RSA000003	190		Concave	Residual	Shoulder	2528	8293
RSA000004	8	8	Flat	Residual		2342	7683
RSA000005	120	34	Concave	Residual	Footslope	2431	7977
RSA000006	75	20	Concave	Residual	Shoulder	2345	7693
RSA000007	38	40	Concave	Residual	Backslope	2471	8106
RSA101103	0	10	Flat	Residual	Shoulder	2302	7554
RSA101108	0	5	Flat	Residual	Shoulder	2240	7350
RSA101119	90	1	Flat	Residual	Step in slope	2245	7367
RSA101120	360	24	Concave	Residual	Backslope	2608	8558
RSA101217	14	10	Concave	Residual	Toeslope	2485	8153
RSA101218	40	18	Flat	Residual	Backslope	2493	8179
RSA101314	60	30	Flat	Residual	Backslope	2369	7772
RSA102114	360	20	Concave	Residual	Backslope	2591	8501
RSA102120	340	7	Concave	Residual	Toeslope	2498	8197
RSA102203	115	22	Convex	Residual	Backslope	2609	8561
RSA102226	356	36	Flat	Residual	Backslope	2469	8102

Table 5. Occurrence and density of trees, by species, size class, and condition, in the 24 patches sampled.
"# patches" shows the number of patches in which trees of that size, species, and condition were found. Densities are trees/acre. Graphs showing the details for each patch are in Figure 11.

	TREE SIZE CLASSES					
	<4.5 ft. tall	<4.5-6.6 ft.tall & < 1in. dbh	1-4 in. dbh	4-8 in. dbh	>8 in. dbh	All Sizes
ASPEN, ALIVE						
Present (n=24 patches)	19	11	15	14	5	24
Max. Density (acre)	24687	5666	1619	688	135	31971
Ave. Density (acre)	2280	567	195	126	14	3182
Min. Density (acre)	0	0	0	0	0	8
ASPEN, DEAD						
Present (n=24 patches)	14	15	20	15	3	23
Max. Density (acre)	2428	3642	1943	465	81	4856
Ave. Density (acre)	247	350	403	115	6	1122
Min. Density (acre)	0	0	0	0	0	0
LIMBER PINE, ALIVE						
Present (n=24 patches)	4	3	3	2	0	4
Max. Density (acre)	506	405	2024	101	0	3035
Ave. Density (acre)	49	21	96	7	0	174
Min. Density (acre)	0	0	0	0	0	0
LIMBER PINE, DEAD						
Present (n=24 patches)	1	1	0	0	0	2
Max. Density (acre)	34	101	0	0	0	101
Ave. Density (acre)	1	4	0	0	0	6
Min. Density (acre)	0	0	0	0	0	0
ALL TREES						
Present (n=24 patches)	21	18	22	17	5	24
Max. Density (acre)	24687	9308	2833	1012	135	36828
Ave. Density (acre)	2578	942	694	248	20	4483
Min. Density (acre)	0	0	0	0	0	57

Table 6. Summary of information on the patches sampled or noted in each aspen stand.
Column headings are explained below the table.

Sampling Point Number (n = 18)	Size class of stand	Patch Number	Sampled? (n = 24)	% of Stand	<1" dbh Aspens/acre	<1" dbh Live Canopy Wtd Ave Min = 12.5 Max = 87.5	<1" dbh Browse Wtd Ave. Min = 0, Max = 75	1"-4" dbh Trees/Acre	1"-4" dbh Live Canopy Wtd Ave Min = 12.5, Max = 87.5	Wtd Ave of Sizes, Live Aspen / Dead Aspen / Log. Min = 0.5, Max = 9
RSA000001	0.1 - 1 ha	RSA000001.1	Yes	100	0			0.00		9 / 7.42 / 5.43
RSA000002	0.1 - 1 ha	RSA000002.1	Yes	100	0			67.45	62.50	4.83 / 2.89 / 3.67
RSA000003	0.1 - 1 ha	**RSA000003.1**	**Yes**	**95**	**832**	**68.48**	**36.72**	**13.49**	**62.50**	**1.04 / 4.89 / 5.36**
		RSA000003.2	No	5	-	-	-	-	-	
RSA000004	0.1 - 1 ha	**RSA000004.1**	**Yes**	**10**	**3238**	**65.63**	**9.09**	**0.00**		**0.92 / 0.83 / 3.17**
		RSA000004.2	Yes	80	231	50.00	25.00	115.63	62.50	3.91 / 2.6 / 3.49
		RSA000004.3	No	10	-	-	-	-	-	
RSA000005	≤ 0.1 ha	**RSA000005.1**	**Yes**	**90**	**1065**	**76.67**	**22.41**	**35.50**	**12.50**	**0.73 / 2.44 / 2.25**
		RSA000005.2	No	5	-	-	-	-	-	
		RSA000005.3	No	5	-	-	-	-	-	
RSA000006	1 - 5 ha	RSA000006.1	Yes	40	364	79.17		40.47	87.50	0.7 / 0.5 / 2.89
		RSA000006.2	**Yes**	**30**	**2509**	**70.00**	**3.33**	**0.00**		**0.5 / 1 / 2.93**
		RSA000006.3	Yes	30	253	72.50	5.00	0.00		0.5 / 1.25 / 2.83
RSA000007	0.1 - 1 ha	RSA000007.1	Yes	98	0			50.59	87.50	4.25 / 2.58 / 3.74
		RSA000007.2	No	2	-	-	-	-	-	-
RSA101103	1 - 5 ha	RSA101103.1	No	15	-	-	-	-	-	-
		RSA101103.2	**Yes**	**55**	**688**	**22.50**	**60.00**	**0.00**		**3.25 / 4.1 / 2.82**
		RSA101103.3	**Yes**	**30**	**21854**	**57.87**	**4.69**	**809.40**	**12.50**	**0.57 / 0.5 / 1.11**
RSA101108	0.1 - 1 ha	RSA101108.1	Yes	33	0			121.41	62.50	5.06 / 6.5 / 4.76
		RSA101108.2	No	33	-	-	-	-	-	-
		RSA101108.3	Yes	33	243	37.50		404.70	57.50	2.22 / 1.59 / 3.61
RSA101119	1 - 5 ha	RSA101119.1	**Yes**	**100**	**573**	**25.00**	**61.11**	**775.68**	**61.41**	**2.94 / 1.53 / 3.99**

Table 6 (continued).

Sampling Point Number (n = 18)	Size class of stand	Patch Number	Sampled? (n = 24)	% of Stand	<1 " dbh Aspens/acre	<1" dbh Live Canopy Wtd Ave Min = 12.5 Max = 87.5	<1" dbh Browse Wtd Ave. Min = 0, Max = 75	1"-4" dbh Trees/Acre	1"-4" dbh Live Canopy Wtd Ave Min = 12.5, Max = 87.5	Wtd Ave of Sizes, Live Aspen / Dead Aspen / Log. Min = 0.5, Max = 9
RSA101120	1 - 5 ha	RSA101120.1	**Yes**	**100**	**2833**	**73.86**	**4.31**	**0.00**		**0.5 / 0.5 / 3.06**
RSA101217	1 - 5 ha	RSA101217.1	Yes	100	0			121.41	37.50	2.5 / 3.73 / 2.91
RSA101218	1 - 5 ha	RSA101218.1	Yes	99	243	45.83	75.00	242.82	87.50	2.14 / 1.82 / 5.5
		RSA101218.2	No	1	-	-	-	-	-	-
RSA101314	0.1 - 1 ha	RSA101314.1	Yes	100	162	62.50	25.00	0.00		0.5 / 0 / 1.2
RSA102114	1 - 5 ha	RSA102114.1	**Yes**	**100**	**30353**	**72.43**	**0.00**	**1618.80**	**31.25**	**0.6 / 1 / 2**
RSA102120	0.1 - 1 ha	RSA102120.1	Yes	40	34	87.50		101.18	45.83	4.77 / 3.46 / 2.9
		RSA102120.2	**Yes**	**40**	**911**	**17.50**	**65.00**	**0.00**		**1.88 / 2.23 / 3.67**
		RSA102120.3	No	20	-	-	-	-	-	-
RSA102203	0.1 - 1 ha	RSA102203.1	**Yes**	**60**	**1619**	**82.50**	**5.36**	**161.88**	**75.00**	**1.67 / 4.5 / 3.08**
		RSA102203.2	No	15	-	-	-	-	-	-
		RSA102203.3	No	25	-	-	-	-	-	-
RSA102226	1 - 5 ha	RSA102226.1	Yes	95	324			0.00		0.5 / 2.05 / 1.17
		RSA102226.2	No	5	-	-	-	-	-	-

Explanations of column headings: **<1" dbh Aspens/acre** shows the density of trees in the 2 smallest size classes (<4.5 ft. tall, and 4.5-6.6 ft. tall and < 1 in. dbh); rows in bold typeface indicate density $\geq$ 500 stems/acre. **<1" dbh Live Canopy Wtd Ave Min = 12.5 Max = 87.5** is the weighted average of the live canopy percent classes for the live aspens in the smallest two size classes, with a minimum possible value of 12.5 (where all the trees have <25% live canopy) and maximum possible value of 87.5 (where all the trees have > 75% live canopy). **<1" dbh Browse Wtd Ave. Min = 0, Max = 75** is the weighted average of the percent of terminal buds browsed on live aspens <4.5 ft. tall, with a minimum possible value of 0 (all trees with no buds browsed) and maximum possible value of 75 (all trees with > 75% of buds browsed). **1"-4" dbh Trees/Acre** is the density (trees/acre) of live aspens 1 in. - 4 in. dbh. **1"-4" dbh Live Canopy Wtd Ave Min = 12.5, Max = 87.5** is the weighted average of the live canopy percent classes for the live aspens 1 in. - 4 in. dbh, with a minimum possible value of 12.5 (where all the trees have <25% live canopy) and maximum possible value of 87.5 (where all the trees have > 75% live canopy). **Wtd Ave of Sizes, Live Aspen / Dead Aspen / Log. Min = 0.5, Max = 9** shows the weighted average size of live trees, dead trees, and fallen logs, with a minimum possible value of 0.5 for each (where all trees or logs are < 1 in. diameter) and maximum possible value for each of 9 (where all trees or logs are in the > 8 in. dia. class).

Table 7. Vegetation types found at the 49 known points predicted to have aspen and at which the vegetation was sampled or noted.

These 49 known points consist of 44 points where the vegetation was described (11 with aspen, 33 without aspen) and 5 points where aspen was simply noted as present.

	OBSERVED TYPE											
	With Aspen			**Without Aspen**								**Total**
PREDICTED TYPE	Aspen woodland	Aspen-limber pine woodland	**Points With Aspen**	Pinus flexilis woodland	Juniperus osteosperma woodland	A. tridentata shrubland, subspp. unknown	A. tridentata tridentata shrubland	A. tridentata vaseyana shrubland	A. tridentata wyomingensis shrubland	Sarcobatus vermiculatus shrubland	**Points Without Aspen**	**Total**
BLM aspen	*5*	*2*	***7***	*1*	*2*		*1*	*2*		*1*	***7***	***14***
BLM aspen-conifer	*6*		***6***	*1*	*2*	*2*	*4*	*8*	*6*	*2*	***25***	***31***
BLM, both	11	2	**13**	2	4	2	5	10	6	3	**32**	**45**
WLCD deciduous	3		**3**					1			**1**	**4**
Grand Total	14	2	**16**	2	4	2	5	11	6	3	**33**	**49**

APPENDIX 1. SAMPLING FORMS USED IN THE 2008 FIELD SEASON

Rock Springs FO Aspen Survey, 2008. **FORM 1: SAMPLING POINT DESCRIPTION**

Sampling point number ___________________________________

Surveyor____ Date______________________

A. LOCATION

Geographic coordinates (UTM Zone 12N, NAD83):

northing 4_________________________mN, easting_____________________________mE

Was sampling point moved in field from its original coordinates? No_____ Yes_____

Explain:____

____

1:100,000 Map Name___________________________________.

1:24,000 Map Name (optional____________________________________

Township_____N, Range_____W, Section_______

B. PHOTOGRAPHS (OPTIONAL)

Taken? No_____ Yes_____ Photographer_____________________ Camera_____________________

Photo # (e.g., 08CW0812.01)	Focal length	Description
_______________	F______	____
_______________	F______	____
_______________	F______	____

C. WERE SAMPLES TAKEN?

No_____ Why not? ____

____

Yes_____ What samples?

Plot number	Patch number	Description
______________	___________	____
______________	___________	____
______________	___________	____
______________	___________	____

STOP HERE IF NO SAMPLES WERE TAKEN.

CONTINUE ON BACK IF SAMPLES WERE TAKEN.

Rock Springs FO Aspen Survey, 2008. **FORM 2: STAND AND SAMPLING AREA DESCRIPTION**

A. STAND DESCRIPTION

Size of stand (circle): ≤ 0.1 ha 0.1-1 ha 1-5 ha >5 ha

Patches present

Number	Sampled?	% of stand	Describe
_______	Y N	_________	______________________________
_______	Y N	_________	______________________________
_______	Y N	_________	______________________________

Notes:

B. SAMPLING AREA DESCRIPTION

Aspect (degrees)_____ Slope: steepness (deg)_____. Slope shape (circle) flat convex concave

Surface deposit (circle): Residual Colluvial Landslide Aeolian Alluvial Glacial

Topo Position (circle) Interfluve, Shoulder, Backslope, Footslope, Toeslope, Step in slope, Valley Floor

Disturbance Signs:____

____

____

____

List the noxious weeds present:____

____

Percentage of sampling area within aspen stand (to nearest 10%):__________

Rock Springs FO Aspen Survey, 2008 **FORM 3: PATCH VEGETATION DESCRIPTION**

Sampling Point Number____ Patch Number_______________________________

Surveyors____ Date _______________________________________

GROWTH-FORMS: TBD=Tree, Broadleaf, Deciduous; TN=Tree, Needleleaf; SBD=Shrub, Broadleaf, Deciduous; SBE=Shrub, Broadleaf, Evergreen; SM=Shrub, Dwarf; HF=Herb, Forb; HG=Herb, Graminoid; NV=Non-vascular

CANOPY COVER CATEGORIES								
	Percent Canopy Cover	<1	1-5	5-15	15-25	25-50	50-75	75-100
	Code for recording	1	2	3	4	5	6	7

Layer (Live / Dead)		Growth-form (Live / Dead)	Common Plant Species (Height; Live Cover / Dead Cover)
TREE	**Overstory:** Height ____ m Cover ___/___	TBD Cover ____/____	
		TN Cover ____/____	
		Epiphyte: Cover ____/____	
		Vine: Cover ____/____	
	Understory: Height ____ m Cover ___/___	TBD Cover ____/____	
		TN Cover ____/____	
		Epiphyte: Cover ____/____	
		Vine: Cover ____/____	
	Regeneration: Height ____ m Cover ___/___	TBD Cover ____/____	
		TN Cover ____/____	
		Epiphyte: Cover ____/____	
		Vine: Cover ____/____	
SHRUB Height_______m Cover ____/____		TBD Cover ____/____	
		TN Cover ____/____	
		SBD Cover____/____	
		SBE Cover____/____	
		SM Cover____/____	
		Epiphyte: Cover ____/____	
		Vine: Cover ____/____	
FIELD Herbs & sub-shrubs Height_______m Cover ____/____		TBD Cover ____/____	
		TN Cover ____/____	
		SBD Ht _____ cm Cover ____/____	
		SBE Ht _____ cm Cover ____/____	
		SM Ht _____ cm Cover ____/____	
		HG: Ht _____ cm Cover ____/____	
		HF: Ht _____ cm Cover ____/____	
NON_VASCULAR Cover____/____		Moss Cover_____	
		Lichen Cover_____	
		Club-moss Cover_____	
Total Canopy Cover Estimate cover of all vegetation. This is NOT simply the sum of values for separate layers ____/____			

Rock Springs FO Aspen Survey, 2008 **FORM 4: LINE TRANSECT**

Sampling Point Number____________________________ Patch Number___________

Surveyor______________________________________ Date________ ___________

Transect Length _________ meters

Orientation of Transect____

____

Enter information for one fallen log per line.

No.	Species	Dia. Class	Check if DBH	No.	Species	Dia. Class	Check if DBH

Diameter Classes

Category No.	Height	Diameter at 4.5 ' off ground
1	< 4.5 feet (1.4 meter)	
2	4.5 - 6.6 feet (1.4 - 2 meters)	By 2 inch (5 cm) size class
3	> 6.6 feet (2 meters)	1 inch - 4 inches (2.5 - 10 cm)
4	> 6.6 feet (2 meters)	4 - 8 inches (10 - 20 cm)
5	> 6.6 feet (2 meters)	> 8" (20 cm)

Rock Springs FO Aspen Survey, 2008 **FORM 5: BELT TRANSECT**

Transect Length _________ meters Width of Belt (circle): 1 meter 2 meters

Orientation of Transect____

Enter Information for One Stem Per Line

No.	Species	Alive or Dead	Size class	Wounds & Conks	Live Canopy Category	SPROUTS: Terminals Browsed Category

Size classes		
Cat. No	**Ht. (ft)**	**DBH**
1	< 4..5’ < 1.4 m	
2	4.5’ - 6.6’ 1.4-2 m	By 2” cat. By 5 cm
3	> 6.6’ > 2 m	1” - 4” 2.5-10 cm
4	> 6.6’ > 2 m	4” - 8” 10-20 cm
5	> 6.6’ > 2 m	> 8” > 20 cm

% Live Canopy Categories	
Cat. No.	**% Vol. Occupied**
1	≤ 25%
2	25% - 50%
3	50% - 75%
4	> 75%

SPROUTS: % Terminal Buds Browsed Categories	
Cat. No.	**% Buds Browsed**
0	None
1	< 50%
2	> 50%

APPENDIX 2. DETAILED INFORMATION ABOUT EACH SAMPLING POINT

This appendix is included with printed copies of the report. The information contained in this appendix is stored in the Microsoft Access database, "RSAspen2008_FinalDatabase.accdb". The appendix can be viewed (and additional copies printed) with the report, "SumPtStandFromQuery_ MasterREPORT", in that database.

The "Description of Vegetation" tables in this appendix shows single-integer codes for live canopy cover and dead canopy cover of vegetation strata, plant growth-forms and individual species. Those codes represent the following ranges in percent canopy cover:

Cover Code in Tables and Data Sheets	Range in Percent Canopy Cover
1	< 1% cover
2	1% - 5% cover
3	5% - 15% cover
4	15% - 25% cover
5	25% - 50% cover
6	50% - 75% cover
7	75% - 100% cover