Managing for Old-Growth in Boulder Mountain Parks: Ponderosa Pine and Enchanted Mesa

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Introduction

The conservation and restoration of biological and ecosystem diversity is increasingly a critical management concern for land management agencies in the United States. The conservation and restoration of old-growth forests is of particular importance: old-growth forests are rare and declining, are of enormous biological and ecological value, and can take hundreds of years or more to recover, if they recover at all, once destroyed or degraded. Boulder Mountain Parks is an unusual municipal land management agency in that the management of its lands for old-growth forest is an explicit objective. However, our understanding of what constitutes old-growth forest and how to manage for its recovery and restoration, especially in Boulder Mountain Parks, is in need of attention.

It is to this end that we have prepared this report. Boulder Mountain Parks can manage to protect and restore remaining old growth, but we need to know what old growth remains and where it is. Boulder Mountain Parks can also manage its lands to produce additional old growth, but it must be able to select which lands to manage in this manner, and it must know how to manage these lands so as to maximize the likelihood that an adequate range of old growth characteristics will eventually develop.

We will do four things in this paper. In the first section, we will discuss and review basic approaches to defining old-growth forests generally and ponderosa pine old-growth specifically. Second, we will recommend a definition for use by Boulder Mountain Parks in management of ponderosa pine forests. Third, we will characterize the existing forest stand data, in terms of this ponderosa pine old-growth definition, for several selected stands in the Enchanted Mesa area of Boulder Mountain Parks. We have selected this area because of the availability of data, because it is the subject of ongoing management efforts, and because some old-growth conditions exist. Finally, based on this analysis, we will offer management recommendations aimed at future research efforts and future management.

PART I
DEFINITIONS OF OLD-GROWTH FOREST

The scientific literature on old growth forest characteristics provides no shortage of old

The age of the oldest trees in a stand is an obvious starting point for characterizing the structural attributes of old-growth forest. As Moir (1992) writes, "[i]n a word, old-growth forests are 'old' forests, as determined by the oldest surviving trees from the earliest cohort established after a stand-replacing disturbance" (18). The structural importance of age can be elucidated by considering stand characteristics like the stability of the species composition and what the age of the stand's dominant trees is relative to the average life expectancy for that species on that type of site (Hunter 1990).[2]

Tree Size

Obviously one would expect old-growth forest to consist of trees that are large as well as old. For instance, a reverse-J shape diameter distribution is often understood as a characteristic of old-growth (Oliver and Larson 1996 citing Meyer and Stevenson 1943, Minckler 1971, and Leak 1973). As Oliver and Larson (1996) point out, this diameter distribution is often assumed to reflect a reverse-J age distribution as well.

Vertical Structure

Many structural definitions of old-growth include some measure of vertical structure. For instance, Oliver and Larson (1996, citing Lutz 1930, Hough 1936, Morey 1936, and Franklin et al. 1986) point to the importance of a "relatively continuous vertical distribution of foliage" (280). It is important to realize that vertical structure can be a difficult characteristic to isolate, and its relationship to other structural characteristics should be taken into account. For instance, variation in vertical structure can produce or at least influence horizontal patchiness (Brokaw and Lent 1999).

Spatial Heterogeneity

Structural definitions of old-growth often consider the patchiness of trees and other vegetation across the stand as well as the number and variety of species (Oliver and Larson 1996 citing Nichols 1913, Franklin et al. 1981, Franklin et al. 1986, and Alaback 1984a). For instance, one would often expect to find widely-spaced trees that are both large and old (id.). Of course, there is often a natural spatial heterogeneity that exists independently of a stand's seral status. This is due to soils, topography, microclimatic variation, and disturbance patterns (Hunter 1990). But the heterogeneity expected of old-growth differs somewhat from this "intrinsic" heterogeneity: "[A]ll authors agree that this last stage [old-growth] is characterized by a shifting

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[2] Moir (1992:18) points out, however, that "[o]ld-growth forest is a *stand* condition that is attained through time, not a count of how many old trees are present."

the process of identifying specific minimum values for each of these characteristics. A strict reliance on a list such as this or on specific minimum values is problematic because "it is clear that certain features of old-growth stands vary depending on site productivity and geographic location" (Kaufman et al. 1992:5).

A Forest Service workshop on old-growth forests in the southwest and Rocky Mountains produced a revised, regionally-sensitive, and more sophisticated revision of this definition:

> Structural features that characterize old growth in the central and southern Rocky Mountains and Southwest vary widely according to forest type, climate, site conditions, and disturbance regime. Old growth is characteristically distinguished from younger growth by some *but not necessarily all* of the following attributes:
>
> - Large trees for species and site.
> - Wide variation in tree sizes and spacing between trees.
> - Relative to earlier stages, high accumulations of large, dead standing and fallen trees.
> - Decay in the form of broken and deformed tops of bole and root rot.
> - Multiple canopy layers.
> - Canopy gaps and understory patchiness.
>
> (Kaufman et al. 1992:4-5)

Although each of these definitions gets us closer to being able to usefully distinguish old-growth ponderosa pine from younger seral stages, even this definition is limited. For instance, presettlement old-growth ponderosa pine stands were generally characterized by widely-spaced large trees, few snags and little woody debris, and often only a single canopy layer. In other words, this general old-growth definition may be misleading when the concern is specifically ponderosa pine (not to mention ponderosa pine in Boulder County).

The Forest Service attempted to address concerns of old-growth variations among species and regions by developing the following definition specific to ponderosa pine in the Rocky Mountain Region:[3]

[3] Those characteristics with a numerical value or an "X" are required. Those with a "Q" are "quality" criteria, which means they are not required but indicate a higher quality old-growth when present. (Mehl 1992). Also note that "age" in this table is the minimum mean age of the trees in the upper canopy meeting or exceeding the DBH.

Finally, perhaps of greatest utility in attempting to articulate a definition for Boulder Mountain Parks, Lowry (1992) describes an old-growth ponderosa pine definition adopted by the Arapaho and Roosevelt National Forests within the Rocky Mountain Region:

- presence of live trees (18"+ dbh), including 15 or more trees per acre 12"+ dbh
- presence of large snags (14"+ dbh) including 2 or more snags per acre 12"+ dbh
- presence of large fallen trees (14"+ diameter) including 3 or more per acre 12"+ diameter
- presence of multi-storied canopy
- overhead canopy closure >20%
- presence of large, old, declining live trees
- presence of more than one tree species
- presence of small openings with grasses, forbs, or shrubs
- presence of seedlings, saplings, or poles
- little or no evidence of logging
- little or no evidence of fire, insect, or wind disturbance

Even a site- and species-specific definition such as this requires some qualitative guidance in its application. For example, Shinneman and Baker (1997) point out that, at least in the Black Hills, old-growth ponderosa pine could occur in both an open-canopy form and a closed-canopy form. Similarly, they suggest that stand replacing events probably occurred in at least parts of the Black Hills ponderosa pine forest, maybe large parts, and warn against adopting a management regime that is too rigid in its understanding of what constitutes old-growth. When considering old-growth ponderosa pine in Boulder County, a sensitivity to major differences even among genuine old-growth stands may be critical.

Process Definitions

Some efforts to define old-growth forest emphasize particular ecosystem processes emblematic of older forests. Such efforts tend to be more concerned with the developmental pathway by which a stand has reached its seral stage than the structural characteristics it exhibits. For instance, some definitions of old-growth forest focus on population processes (Spies and Turner 1999). Others point to the importance of ecophysiological processes (Kaufmann 1992). We will discuss several of the most important processes and old-growth qualities in turn.

Vigor / Senescence

There are numerous characteristics of forest stands relating to the age of trees in the stand, the age of the stand itself, and the demographic dynamics that characterize its recruitment and mortality patterns. Structural definitions tend to utilize the age of the oldest trees in a stand temporarily unavailable for growth" (Kaufman 1992:42).[4] The complexity and diversity of accumulations may increase as well, as Kaufman et al. (1992, also citing Moir 1992) suggest for chemical energy accumulations in wood and litter. Moir (1992) makes the same suggestion about ecological relationships more broadly, and points to the complexity, for instance, of detrital food webs.

Wildlife

The presence or absence of key old-growth species may also be important. Reynolds and Linkhard (1992), for example, describe the relationship between old growth ponderosa pine and flammulated owls. This is not strictly a process concern, of course. For some species, the presence of the appropriate structural habitat conditions may be adequate to result in a sustained presence. However, many species, especially those that are more specialist in their habitat and life history needs, may require habitat conditions that are only offered by old-growth forest that is old-growth in development and not merely in terms of some selected structural habitat characteristics. This may mean that the presence of certain species may be better proxies for developmental old-growth conditions than the conventional structural characteristics described earlier in this paper.

It is important to realize, however, that the absence of certain species may not necessarily mean that the stand lacks old-growth conditions. Other factors besides habitat could affect the presence of a species. For example, many species require different habitat types and conditions for different life history needs (e.g., foraging and denning). The absence of such a species in the old-growth habitat may indicate that other, non-old-growth needs are not being met. The same is true for the presence of such a species; the mere presence does not necessarily mean that the habitat is actually old-growth. For instance, if adequate nearby habitat is being degraded or destroyed, individuals may be displaced into marginal or even inadequate habitat. This may result in the presence of such species in a given stand but no long-term persistence (i.e., inadequate reproductive success).

Disturbance Regime

Finally, some definitions include consideration of the disturbance regime that resulted in the stand in question. For instance, Hunter (1990) is concerned about whether the forest has ever been extensively or intensively logged, or if it has ever been converted by humans to another ecosystem type. In fact, some definitions are specifically concerned about evidence of prior anthropogenic disturbance. Anthropogenic disturbance is sometimes a condition precluding status as old-growth. For instance, Spies and Turner (1999:113) note that "[o]ld growth is

[4] Kaufman suggests that this may at least partially explain the importance of low intensity fire in such ecosystems; low intensity fire may be critical for the release of these nutrients.

The use of dead trees and woody debris, as noted above, may provide a good example of these concerns. The use of these structural attributes, for instance, may result in significantly misdirected management efforts. For instance, managers might treat a stand to produce the desired woody debris distribution, but if the processes by which such a distribution is normally created did not occur, the actual ecosystem qualities comprising genuine old-growth may not exist despite the existence of the debris.

Process-based definitions may avoid many of these problems. Definitions based on ecosystem processes and development pathways focus on the processes by which a stand came to look as it does instead of simply how it appears. Spies (1997:25) offers a succinct explanation of the value of process-based definitions:

> Process-based definitions have the appeal of focusing on the way forests develop rather than the way they appear at particular stages. This perspective is valuable in cases where old forest conditions do not currently exist and the objective is to have them in the future. It is also valuable in situations in which management is directed toward maintaining old growth across a landscape as a whole, including maintaining processes within current old-growth stands and insuring that future ones will develop. Process-based definitions also provide a stronger conceptual link with the idea that vegetation is a dynamic entity.

The major disadvantage of process-based definitions, of course, is that they are difficult to articulate, and even more difficult to use in a field inventory or management context. And, in the case of Boulder Mountain Parks, process-based definitions may be particularly problematic because of a lack of the necessary data.

PART II
APPLICATION: BOULDER MOUNTAIN PARKS AND ENCHANTED MESA

Physical Elements of Enchanted Mesa

LOCATION: Enchanted Mesa extends from the 3rd, 4th, and 5th Flatirons area down to the plains. It extends in-between Bluebell Canyon and Coyote Canyon. Please see the attached orthophoto map showing the stand location and boundaries.

TOPOGRAPHY:

Elevation: Ranges from 5,800 to 6,800 feet.

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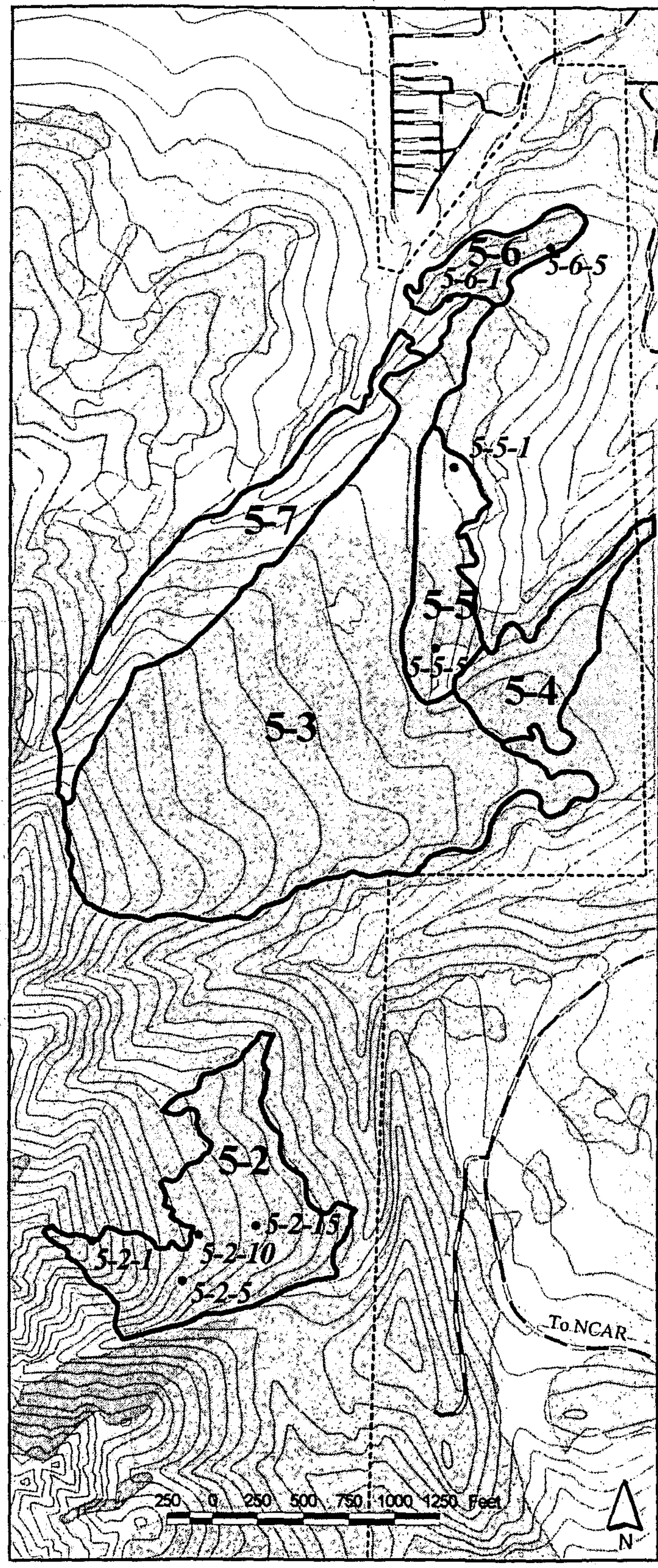
relic trees died or do they persist in the stand?), is very much about the developmental process of a stand toward an old-growth condition.



Enchanted Mesa Project Area

- Stand Boundaries
- Cruise Points
- Park Boundary
- Ponderosa Pine/Douglas Fir
- Ponderosa Pine
- Douglas Fir

forested area and stand densities appear to be significantly lower than today. They do not reveal the proportion of old vs. young trees.

We found a historical University of Colorado study (truly a gem) written in 1908 (edited by Frances Ramaley), which describes in some detail the mesa and foothill vegetation on Enchanted Mesa and adjacent Kohler Mesa (which were then called Horse Mesa and Long Mesa). Bluebell Canyon had the same name as today, but Coyote Canyon and Skunk Canyon had different names (Cemetery Gulch and Pole Canyon). Some of the more important ideas in this historical document include:

- The overall pattern of tree distribution was similar to, but different than, what it is today. There was a very dense concentration of Ponderosa Pine (referred to as Rock Pine) on the upper half of the mesa, but there were very few trees on the southern half of the mesa. [The overall density and distribution of trees today is greater].
- The highest concentration of trees was on the north crests of the mesa (north-facing slopes), while the south-facing slopes were almost devoid of trees--clearly a response to the moisture gradient. [Similar to today.]
- The trees extended out farther on the north slopes than the south slopes. [Similar to today.]
- The very end of the mesa, which has much finer-textured soil and wide solar exposure, had only a scattered few trees, which were young trees invading the grassland. [Similar to today, but the extent trees are bigger.]
- Young trees were also growing all over the mesa among the older trees. [Today, widespread canopy closure and associated stem exclusion do not allow the widespread distribution of young trees.]
- The older trees were more common on the upper part of the mesa top and along the north crests out to a point about half-way to the end of the mesa. [Probably true today.]
- On the north slopes the pines were found on the drier parts where the soil is rockier and consequently more devoid of grass (which enables the pine seeds to reach the bare soil easily). [Probably true today.]
- Douglas-fir (referred to as Douglas Spruce) grew only in the deeper and moister parts of Bluebell Canyon on the north exposure. [Forest treatments the last two years have removed most of the numerous understory Douglas-firs growing in the shade of the Ponderosa Pine canopy--clearly more shaded conditions today foster Douglas-fir in-growth.]
- There were three well-marked and noticeably different sizes of trees (besides seedlings). Trees intermediate between these three sizes were few and scattered. The three groups included:
  1) Oldest and largest--150-200 years old, relatively few in number and widely space, distributed on the higher parts of the mesa top [Only a very small remnant number of these oldest trees are still surviving.]
  2) Medium sized--80-100 years old, more numerous than the biggest trees,

Meadow, its relatively flat and accessible terrain, and its portal to the Flatirons, the Enchanted Mesa has long been a very popular and heavily used hiking area. The very popular Mesa Trail leads through Enchanted Mesa south to NCAR. There are several designated trails and many social trails that dissect the Enchanted Mesa area. This area is well known for its diversity of bird species, its use by black bears and coyotes, and as a bastion for Abert's squirrels.

Like most of the Ponderosa Pine / Douglas-fir forest lands in Mountain Parks, the Enchanted Mesa area was affected by a severe outbreak of Mountain Pine Beetle (MPB) during the 1970s. At that time, a large percentage of Enchanted Mesa land had become overgrown, and these extremely dense stand conditions (including some doghair stands) were largely the result of fire suppression over the previous 75 or more years. These overcrowded conditions created additional stress on the trees and probably made them more susceptible to the MPB epidemic. In addition, a significant amount of in-growth of shade-tolerant Douglas-fir had established under the Ponderosa Pine overstory. Project Greenslope, begun in 1979, involved aggressive thinning of 80 acres on Enchanted Mesa in 1982. The objectives were to reduce unnaturally high tree stand densities, remove trees successfully attacked by MPB to prevent the beetles further spread, improve overall forest health and wildlife habitat, and reduce wildfire hazards.

The Enchanted Mesa stands, on a relative basis, were substantially opened up compared to the overcrowded conditions existing in the late 1970s. Substantial release of surviving trees and some limited seed tree regeneration resulted. A mix of smaller trees and larger trees were logged and removed in the forest treatments. Most of the thinning involved cutting suppressed understory trees (thinning from below), including both Ponderosa Pine and Douglas-fir. Many of the larger trees were left, but some larger trees were logged, in order to open up the canopy and probably to make the logging operation commercially feasible. Trees killed or infested by MPB and Dwarf Mistletoe (DMT) were targeted for cutting. Several dense tree patches were kept for Abert's squirrel habitat. Severely disturbed areas were raked and seeded (with non-native grasses). Water bars were constructed where necessary on skid trails. Logged trees were removed by contractors, city crews, and the general public. Slash not taken by the public was scattered to a shallow depth.

As result of the thinning, the forest density was substantially reduced and the canopy was opened up. The trees left were mostly medium sized and were relatively uniformly spaced (fairly homogenous stand conditions). Effects of the thinning project were positive in improving overall tree vigor, stimulating patch regeneration of ground-level grasses and forbs, and improving wildlife habitat values. Some seed regeneration resulted, but we feel that the remnant stand densities were still too high to generate much seed regeneration. Some negative effects of the treatments were the perpetuation of some of the logging roads and skid trails as social trails, invasion of many non-native weedy plant species and, by some accounts, a reduction of bird species density and diversity. Follow-up treatments on Enchanted Mesa were scheduled for 1994 and 1997, involving patch cuts and prescribed thinning, and were outlined in the 1982 Forest Management Plan for Boulder Park and Open Space Lands.

new ones were created. A small but significant number of snags was created. In many drier areas opened up to sunlight, a new layer of lush grass regeneration was evident the following Spring. Prairie dropseed, an important native grass, responded particularly well. Arnica was released, and it spread in extent. Mountain Parks staff will be able to gauge the extent of the treatment's effects by comparing the results in the treated areas vs. control areas. There was also some observed negative effects of the treatments. The invasive plant mullein was spread from the ground disturbance caused by smoke suppression activities. The spread of other weed species has not yet been determined.

The results of this burn were quite successful in spite of less than optimal conditions present in the narrow window of time to carry out the prescribed burn on Enchanted Mesa. There was a lot of moisture in the bottom layer of vegetation, which inhibited the desired burn behavior and created considerable smoke. The goal was to combust much of the ground litter, seedlings, and saplings, but the combustion was not as complete as desired and required heavy use of drip torches. However, it was not just the moist ground conditions that hampered the combustion. It was necessary to prematurely suppress the low-intensity, creeping fire because of intense smoke that occurred around 5:00 p.m., which was due to both an unanticipated temperature inversion and down valley drainage of smoke into the city. Instead of letting the smoldering underground burning continue for two or three days, it was necessary to attempt full fire suppression to stop the intense smoke from adversely affecting the city. It still took approximately two days to substantially stop the continuing smoke.

Besides the prescribed burn in 1998, Enchanted Mesa experienced another significant natural disturbance. During the following February (1999), a relatively large-scale windbreak event occurred in the treated stand and two adjacent stands (a total of 60 relatively large-sized trees). In stand 5-3, the treated stand, there were 29 treebreaks, while 5-4 had 22 and 5-5 had 9. The importance of this windbreak event is that the severe deficit of large tree snags in Enchanted Mesa (~1 snag per acre before the windbreak event and most of those snags are small sized) was partially alleviated. This windbreak event raised the snag density for the whole of Enchanted Mesa from about 1 to 2 snags per acre, and most of the new snags created are large sized. This stand development event means that snag-dependent wildlife received an immense benefit and the scope of prescribed mechanical creation of snags, which is very time consuming and expensive, has been lessened.

Analysis of Old Growth Structural Characteristics for Enchanted Mesa Forest Stands

Selecting an appropriate old growth definition for Boulder Mountains Parks is a tricky affair. Kaufman et al. (1992) suggest that there are problems with strictly relying on structural stand characteristics in defining old growth. One such problem is that some stands with very large trees and high levels of structural diversity and woody debris may not, in fact, contain any *old* trees. Conversely, a stand with very old trees may lack many of the other, important stand characteristics. Structural definitions may have difficulty with these conditions.

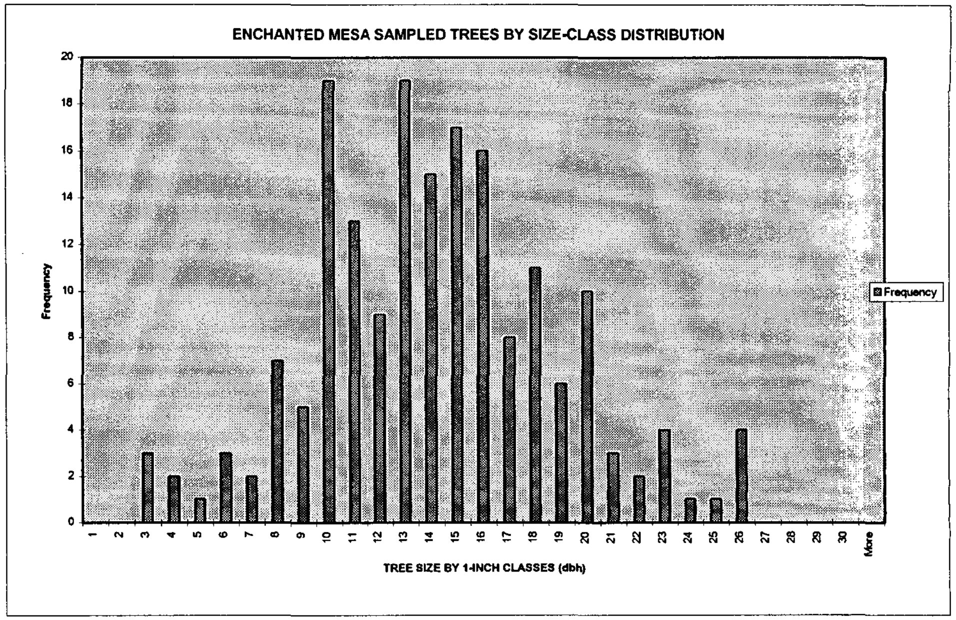
Another concern is that structural definitions may not always capture critical ecosystem qualities with confusing relationships to structural qualities. Kaufman et al.'s (1992) discussion

TABLE 1

KEY OLD-GROWTH STRUCTURAL CHARACTERISTICS FOR PONDEROSA PINE / DOUGLAS-FIR FORESTS			
PRIMARY PARAMETERS	**SECONDARY PARAMETERS**	**INVENTORY VARIABLES**	**SUMMARY OF ANALYSIS OF MOUNTAIN PARKS STANDS**
Presence of live trees over 200 years old measured at breast height (bh) (We assumed at least 20 years of growth has to be added to the raw data when measured at bh; RM-Stand assumes 15 years.)		**Tree age measured at bh**	**Very little presence of trees over 200 years old. There is a relative paucity of really old trees. Out of 86 age-sampled trees, there were only 2 trees older than 200 years, with the oldest being 205 years old. The upper age limit for Ponderosa Pine in the Front Range is around 400 years old, so the oldest recorded surviving tree on Enchanted Mesa is about half of that. The average age of all trees sampled is 103 years old (with the 20 years added on).**

SIZE- AND AGE-CLASS DISTRIBUTIONS AND HISTOGRAMS FOR ENCHANTED MESA FOREST STANDS

Size (dbh")	Frequency
1	0
2	0
3	3
4	2
5	1
6	3
7	2
8	7
9	5
10	19
11	13
12	9
13	19
14	15
15	17
16	16
17	8
18	11
19	6
20	10
21	3
22	2
23	4
24	1
25	1
26	4
27	0
28	0
29	0
30	0
More	0



Age	Frequency
10	0
20	1
30	1
40	3
50	4
60	11
70	8
80	15
90	12
100	19
110	4
120	0
130	2
140	1
150	1
160	1
170	1
180	0
190	1
200	0
210	1
220	0
230	0
240	0
250	0
260	0
More	0

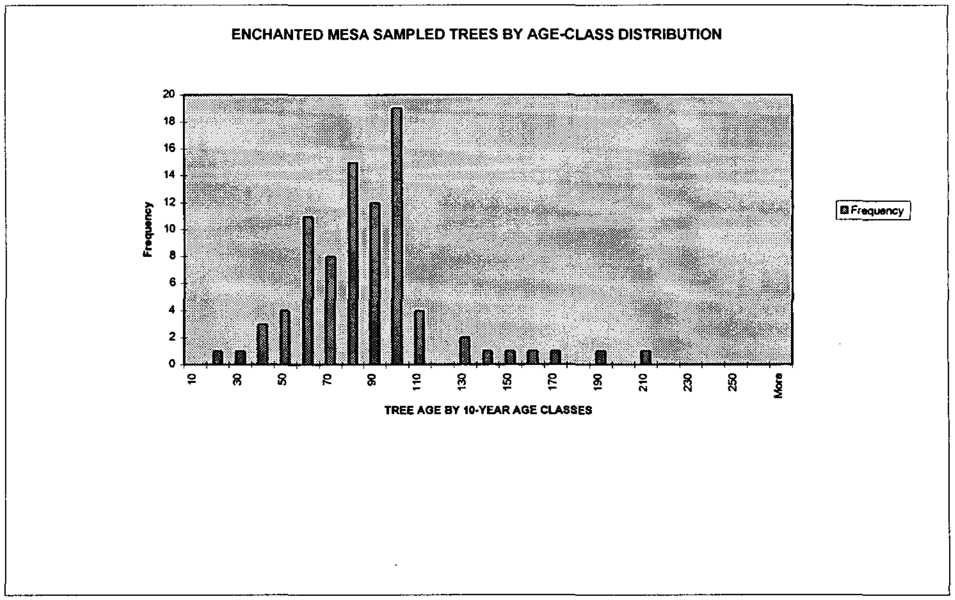


FIGURE 1

Size-class distribution with a negative exponential, reverse-J shape (live trees)		**Histogram of all tree sizes**	**Size distribution indicates a big middle-to-large-sized tree cohort. The histogram in <u>Figure 1</u> shows the distribution of sampled trees in size classes conforms closely to a bell-shaped curve (presumably reflecting a broad, even-aged structure), which indicates that a large canopy disturbance from fire or logging occurred between 120 and 140 years ago (between the 1860s and 1880s when settlement and mining became significant). We believe that the lack of trees shown in the smallest size classes is probably due to several factors: stem exclusion from the closed canopy conditions in much of the Enchanted Mesa area; Greenslope thinning almost 20 years ago that reduced the smaller size classes; and the lack of inclusion of seedling and small sapling data in this histogram (the 1/100 acre regeneration plot data could possibly be added at a later time).**
Presence of large standing dead trees 14"+ dbh (snags)	**2 or more snags / acre 12"+ dbh**	**Snag size measured at bh**	**With the addition of newly created large snags from the February 1999 windbreak event, a standard of at least 2 snags per acre has been achieved in the Enchanted Mesa area. However, this condition is somewhat hypothetical, since the snag density is extrapolated from only four snags sampled prior to the windbreak event. It is quite possible that this snag density is either overestimated or underestimated. Further, three of the four snags inventoried were small-sized snags, which may suggest that there is still a paucity of large-sized snags; in that case, the secondary snag criterion would not be met. The average dbh for the windbreak snags, however, was about 16".**

OTHER COMMON OLD-GROWTH CHARACTERISTICS FOR PONDEROSA PINE / DOUGLAS-FIR FORESTS			
PRIMARY PARAMETERS	**SECONDARY PARAMETERS**	**INVENTORY VARIABLES**	**SUMMARY OF ANALYSIS OF MOUNTAIN PARKS STANDS**
Presence of more than one tree species		**Tree inventory by species**	**There really is not a significant presence of multiple tree species. Ponderosa Pine predominates about 98% of the Ponderosa Pine / Douglas-fir total tree presence. Also, previous stand management has emphasized removal of understory Douglas-fir.**
Presence of small canopy openings with grasses, forbs, shrubs		**Forest openings > 1/4 acre in size**	**The Enchanted Mesa forest is predominantly closed canopy; there are very few forest openings of any size. There is no overall inventory of forest openings, but the orthophotos show only four forest openings > 1/4 acre. It is possible that shadows on the orthophotos could underestimate the number or small forest openings, but not on any order of magnitude. Two of the identified forest openings barely make up 1/4 acre, and the other two are somewhat less than an acre. One of them Mystic Meadow is caused mainly by periodic high ground water, not treefall gaps.**

Current Ecological Status of Enchanted Mesa

We can draw several key conclusions about the ecological status of Enchanted Mesa from this analysis.

1. Stand conditions in Enchanted Mesa do not exhibit many of the structural conditions characteristic of old growth

The structural old-growth criteria substantially met currently by stands on Enchanted Mesa include:

- Presence of large live trees and large tree density
- Presence of large dead standing trees (due to the February 1999 windbreak event); however, large tree snag density does not meet the criterion.
- Presence of multi-story canopy
- Presence of > 20% canopy cover
- Presence of seedlings, saplings, and poles

The structural old-growth criteria not currently met by stands on Enchanted Mesa include:

- Significant presence of live trees over 200 years
- Size-class and age-class distribution of live trees forming a negative exponential J-shaped curve characteristic of old-growth stands
- Sufficiently high density of large-sized snags
- Significant presence of large dead fallen trees
- Significant presence of old, declining trees (showing the wear-and-tear of advanced age)

These criteria that are not currently met tend to be more important in defining the primary characteristics of old growth than those are met.

The history of Enchanted Mesa, with significant human disturbance during settlement and mining times, effective fire suppression over the last 80 years, and the forest management thinning activities in 1982, has produced the current stand conditions. The forest management prescriptions for Enchanted Mesa aim to restore many of the now missing more natural characteristics to Enchanted Mesa. However, sustained management over many years will be needed to restore key forest structural conditions, disturbance processes which nurture them, and the rightful presence of a significant cohort of old-growth trees and other characteristics.

2. Existing structural stand conditions do present the opportunity to nurture the small number of oldest-surviving trees to old-growth conditions

The good news is that there are many relatively large-sized trees on Enchanted Mesa, and

3. Assess the Adequacy of Sample Size

Two issues should be addressed:

1. Is the number of samples or sampling acreage large enough to achieve the desired overall confidence level? In Enchanted Mesa, a total of 30 plots comprising 3 acres was sampled in the variable plots--out of the total acreage of approximately 136 acres (2%). The key issue is getting enough data for a "sufficient" sample, within the context that efficient use of scarce staff inventory resources does not permit the highest level of accuracy (an efficiency vs. accuracy trade-off).

2. Are the right kinds of locations being selected for sampling plots to give a reasonable representative sample of conditions in the entire stands? We are not suggesting that there is a problem, but we are suggesting that an assessment procedure be developed that can serve as a mechanism to ensure quality control. The sampling plot procedure in place involves laying out the cruise line to be inside the stand edge by two chains (132 feet) and to pass through those observed parts of the stand that are most characteristic of the overall density of the stand. The issue we are raising is making sure that this subjective procedure does, in fact, achieve the desired representativeness.

Modification of Existing Forest Management Prescriptions

1. Set Goals for Old Growth Development Based on A Larger Picture

From a management perspective, decisions on the desired amount of old growth in any given stand within Mountain Parks should be related to the historical, current, and desired future conditions--within both a park-wide context and a larger regional context. In other words, decisions on how much old growth is desirable within Mountain Parks should be based, in part, on how much old growth is available or likely to be available in private and public forests located in proximity to Mountain Parks. In addition, how much old growth is desirable within any given forest stand within Mountain Parks should be decided based on the desired spatial distribution, level of spatial heterogeneity, and the desired mix of habitats within Mountain Parks. While Mountain Parks does not have any legal obligation to be a dominant caretaker for the region's old growth, Mountain Parks still is a refuge for many wildlife species, including some old-growth and forest-interior dependent species. Setting ambitious targets for growing and nurturing old growth forests in Mountain Parks will serve the overall goal of conserving and restoring the integrity and diversity of BMP's ecosystems.

Targets for the amount and distribution of old growth in Mountain Parks may or may not be similar to the hypothetical mix of conditions that occurred within an historical range of variability (HRV). Essentially HRV is a way to characterize the range in upper and lower the historical range of variability present in these types of site conditions, would grow trees more densely, include a larger component of Douglas-fir, and have larger patches of continuous forest. Other low-elevation Ponderosa Pine / Douglas-fir stands may have environmental site conditions that would tend to grow trees at lower densities, more patchiness, and more clumpy patterns (the Southwestern model).

4. Put More Emphasis on Opening Up the Forest Canopy

In order to stimulate multiple pulses of tree establishment over time necessary for Ponderosa Pines regeneration and creation of multiple age and size cohorts, Mountain Parks should incrementally create many more canopy openings. These canopy openings should be various sizes but should include more of the larger-sized openings, which are more likely to provide enough light for tree seedlings to become established. Also, creation of these openings must be phased in over time so that one big new cohort is not established in favor of a mix of cohorts. It appears from the prescribed fire experience on Enchanted Mesa that low-intensity ground fires can be designed to successfully increase the size of existing forest canopy openings. Basically, if these periodic low-intensity ground fires are selectively allowed to burn hotter at the edge of existing canopy openings, they can incrementally enlarged the openings. The 1998 Enchanted Mesa burn was successful in killing a large number of seedlings, saplings, and some larger trees with the effect of increasing the size of Mystic Meadow.

5. Put More Emphasis on Creating Large Snags

Consistent with the literature, the optimal minimum large snag density is an average of 2-5 snags per acre. Further, management-created snags should be located in strategic places where: 1) canopy tree openings would likely create either release of existing understory Ponderosa Pine trees or cause new Ponderosa Pine tree seedling establishment; 2) snag locations would be most beneficial to snag dependent birds and mammals (probably in interior forest areas). Mountain Parks should build on the 1999 windbreak event that created 60 large tree snags and prior small-scale mechanical snag creation to increase large snag densities to within upper bounds of this range.

6. Devise Longer-Term Forest Management Prescriptions

In order to convert the existing predominance of single age and size cohorts to a sustainable mix of multiple cohorts, restore a significant amount of spatial heterogeneity at the patch, stand, and multi-stand levels, and create a significant component of old growth, Mountain Parks should implement a long-term series of incremental stand treatments. The intensity and patch characteristics of incremental stand treatments can be varied at a finer-grain level than is currently done. Further, accessibility is very good for Enchanted Mesa, which means that serial actions in achieving desired future conditions. Well-designed, adequate, and timely monitoring is essential to the adaptive management approach committed to in the City of Boulder's Forest Ecosystem Management Plan and the Mountain Parks Resource Protection and Visitor Use Plan.

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- Predominance of relatively dense, shady stands (those stands that would normally tend to be dense and those normally open, as influenced by natural physical environment factors and natural and human disturbance history).
- A significant amount of dense stands have low-vigor, dog-hair trees.
- Mostly middle-aged trees; little tree regeneration; few late-successional (old-growth) stands.
- Mostly middle-sized (pole-sized) trees; relatively few seedlings, saplings, and large-sized trees.
- In most dense, shady ponderosa pine stands, a significant amount of Douglas-fir in-growth has occurred.
- The areal extent of mistletoe infestation is widespread.
- The areal extent of pine bark beetle, while not widespread yet, is rapidly increasing.
- Relatively few snags and dead-and-down limbs and trees.

Natural Reference Conditions: (conditions existing in pre-Euro-American settlement times or similar conditions in current times)

- High degree of stand diversity, including a heterogenous mix of high, medium, and low-density stands and canopy cover conditions; gaps in forest canopy and forest meadows are common.
- Mesic (relatively wet) stands tend to be denser and more continuous (fewer forest openings) than xeric (relatively dry) stands.
- High degree of forest vigor, with relatively few occurrences of overly-dense, dog-hair stands and of forest insects and disease.
- A heterogenous mix of tree ages, with significant early- and late-successional age cohorts.
- Little in-growth of Douglas-fir into predominate ponderosa pine stands.
- Mistletoe, pine bark beetle, and other forest pathogens play an important but spatially limited ecological role with rare occurrence of large-scale epidemics.
- Overall abundance of snags and dead-and-down limbs and trees is high.

<u>UNDERSTORY VEGETATION CONDITIONS</u> (Grasses and Forbs)

Existing Conditions:

- In many areas, patches of native plant communities have been replaced or reduced in areal extent by non-natives, resulting in less native biodiversity.
- In many dense tree stands, intense shade and build-up of needles and duff have suppressed understory plant communities and diminished their diversity and vigor.
- Historic grazing and introduction of non-native grasses for forage have displaced native grasses in many areas; some recovery of native grasses may be occurring with removal of domestic grazing.

Natural Reference Conditions: (conditions existing in pre-Euro-American settlement times or similar conditions in current times)

- The full complement of native understory plant associations occur across the landscape, with relatively high biodiversity.