2410

CRYSTAL LAKES GREENBELT MANAGEMENT PLAN

PHASE I

Bear Gulch Park and Mummy View Park

Parcel #
4002406005
4002406006
4001205200

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CRYSTAL LAKES GREENBELT MANAGEMENT PLAN

PHASE I

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CRYSTAL LAKES GREENBELT MANAGEMENT PLAN -PHASE I

Bear Gulch and Mummy View

1993

The Crystal Lakes Road & Recreation Association has charged a committee with the direction and management of the greenbelts at Crystal Lakes. The Greenbelt Management Committee has responded to this charge by first requesting an inventory of both the Bear Gulch and Mummy View connecting parks. The inventory of vegetation and wildfire hazards was conducted by the Colorado State Forest Service in June 1993. The agreement also provides for the State Forest Service to make management recommendations for vegetation management and wildfire hazard reduction.

Background

In 1975, through an agreement with Don Weixelman, the Colorado State Forest Service completed a demonstration thinning on 3.8 acres in the 8th Filing. This was on Lots 96 and 97 owned by the developer. The purpose was to show lot owners that reducing wildfire hazard and increasing the health of residual trees was aesthetically acceptable, provided wood products, and significantly reduced wildfire hazard. Shortly after the thinning, both lots were sold to persons who appreciated the increased value of the properties.

In summary, that project removed 200 tons or 53 tons per acre of fuel for wildfire, increased the average tree diameter by one-half inch and tree height by 4 feet, left 364 superior trees per acre, and harvested 1600 trees per acre that were utilized for fenceposts, corral poles, and fuelwood. In addition, the tops, limbs, and needles were ran through a chipper and the resulting product used on the Crystal Lakes trail system to reduce erosion and provide an even walking/skiing surface.

New seedlings germinated and aspen sprouted within the project area. Now, nearly 20 years later, it is appropriate to re-enter these lots and complete a "maintenance" thinning. This is a necessary process to continue optimum tree growth, reduce the encroaching wildfire hazard, and reduce the susceptibility of the "leave" trees to insect epidemics such as the mountain pine and ips beetles.

The Beartrap Fire of 1981 substantiated the premise that wildfire travels more rapidly in unmanaged stands. It raged uncontrolled in dense, unthinned stands of trees. On the opposite side of Crystal Lake from the demonstration thinning, there were other thinned stands. This thinning was mandated along roads as part of the development process. The rapidly spreading crown fire dropped to the ground and was readily controlled when the fire

reached the fuelbreak created by the thinning and road clearing combination. Don Weixelman wrote a 8-page letter to the Colorado State Forest Service confirming the success of the thinned fuelbreaks.

Highly visible wildfires in Boulder County in recent years (Black Tiger, Sugarloaf, and Lefthand Canyon) continue to keep landowners with forested mountain land a little edgy. Creating and maintaining fuelbreaks in mountain communities has become a fact of reality in living in the native forests of Colorado.

These fuelbreaks, however, do NOT have to be clearings. It is totally possible to reduce wildfire hazard while improving both tree health and forest aesthetics. This is the concept in which the recommendations of this plan are written.

Area Description

Both parks are shown on the Crystal Lakes Map. Bear Gulch Park lies in the Bear Gulch drainage in Filing 13 between Osage Trail, Benaki Court, and Ottawa Way roads. Mummy View Park lies in Filing 6 between Jicarilla Trail and Pottawatomie Trail/Osage Trail roads. The parks are connected at and divided by Osage Trail. (See accompanying map)

Elevation ranges from 8700 to 9200 feet. Slopes face South on Mummy View, West on Bear Gulch, or are ridgetop in nature. There is a small area of valley bottom on Bear Gulch.

Mummy View Park is approximately 39 acres by rough calculation. Bear Gulch Park, by the same rough method, is approximately 47 acres. Information is on file in the Crystal Lakes Road & Recreation office that gives exact totals.

Vegetation

Bear Gulch - Lodgepole pine dominates the upper arm of this park. Aspen is present at the extreme north tip on the Bear Gulch riparian area. A patch of aspen is also present on the lower end of the stream bottom. Ponderosa pine occupies the remainder of the unit.

Mummy View - Ponderosa pine is the tree species that dominates this park. Douglas-fir is intermixed with the ponderosa pine on the higher elevations of this unit. A small stand of aspen is located midway through the lower section of Mummy View Park near the end of Flathead Court.

Process of Inventory

Five forest inventory plots were taken on Bear Gulch Park. Because of the uniformity, size, and shape, only 2 forest inventory plots were taken in Mummy View Park. A basal area factor of 10 was used. All trees within the variable plot were diameter measured and heights estimated. Slopes were measured in percent. Insect and disease presence was identified. Age was determined by core samples. Growing site was estimated based upon age and height of dominant and co-dominant trees. Ground cover species were also observed.

Fuels were inventoried on 3 plots in Bear Gulch and 1 plot in Mummy View. Fuel loadings were measured and calculated using "Handbook for Inventorying Downed Woody Material" by James K. Brown - 1974. This is a transect method.

Results of Inventory

Vegetation:

BEAR GULCH PARK

Plot	Slope	Species	Basal Area	Diam.	Ht.	Age	Stems/A.	cuVol/A
1	35%	LP*0	160	9.6	61'	114	317	4628
2	25%	LP*5	120	4.5	23'	103	1064	712
3	20%	LP*1	160	6.7	45'	107	662	3172
4	55%	PP*2	90	10.6	42'	177	147	1418
5	35%	PP*0	100	11.4	42'	114	140	1601

Site Indices = 65, 40, 50, 45, & 50 = Good

MUMMY VIEW PARK

1	30%	Df-PP*0	180	12.4	49'	147	216	3478
2	40%	PP*0	70	11.3	40'	113	101	1064

Site Indices = 50 & 50 = Good

Species * & No. = Species & dwarf-mistletoe rating

Other vegetation present: golden banner, common juniper, arnica, kinnikinnick, Oregon grape, sedges, wild rose, cliff bush, aspen, and limber pine.

Insects present: mountain pine beetle
Diseases present: western gall rust, commandra rust

Fuels:

BEAR GULCH

Fuel Size	Tons per Acre 0-0.25"	0.25-1.0"	1.0-3.0"	3+Snd	3+Rtn	Total
Plot						
1	0.13	1.15	0	0	2.0	3.28
2	0.65	0	5.30	1.78	0	7.73
3	0.47	1.90	13.50	0	0	15.80
MUMMY VIEW						
1	0.04	0.38	2.67	0.20	0	3.29
All	Aspen is considered fire resistant and fuel loadings were not taken within stands of this species.					

Other:

In addition to the plots summarized above, there is another area deserving of special attention. It is a sub-unit of Bear Gulch Park called Picnic Park. This sub-unit is located in an aspen flat. There are native grasses, wild rose, scatter lodgepole pine, squaw currant, willows, birch, water hemlock, skunk cabbage, and "woods" orchid here. An old road that probably was the original road up Bear Gulch provides access. This is a delightful area that should be developed as a location for day use.

Management Recommendations:

BEAR GULCH -

Vegetation - The sites present within this park are very well suited for the growth of trees. Damage to forest stands has occurred by two vectors, fire and insects. Fire damage was severe where it occurred. This was on the east side of the lodgepole pine stands in the upper neck of the park near Osage Trail. Insect damage was in the form of mountain pine beetle killed trees that were scattered throughout the ponderosa pine stands. A small current infestation was located on Lot 89 where the park crosses Osage Trail.

Specific recommendations -

1. Clean up the aspen stand on the north border. This includes removing those trees that have been heavily damaged and are dead or dying (and unsightly). Remove trees that have fungal infections (cankers. etc.). Cutting will stimulate sprouting of new aspen stems.

2. Thin the lodgepole pine near point #1 at the end of Flathead Drive to a density of 100 basal area. Select trees that are free of western gall rust and Commandra rust, have single-stemmed tops, do not have dwarf mistletoe, are a good green color, and do not have damage to the bark circumference.

   A basal area of 100 will leave 197 trees per acre that are spaced an average of 15 feet apart. Products from this thinning could be sold as posts, poles, small sawlogs, and fuelwood.

   These pines grew to 2 1/2 inches diameter in there first 10 years. They are currently growing at a rate of 3/8 inch in diameter in 10 years.

3. Thin the lodgepole pine near point #2 close to Osage Trail to a density of 60 basal area where possible. Remove all trees infested with dwarf-mistletoe. Thinning may not be possible due to the high incidence of d-m. If not, make patch clearcuts of up to 1 acre in size. The objective is to rid the stand of all dwarf-mistletoe and to cause new seedlings to germinate within the patch clearcut. The mistletoe is so heavy

here that it is stagnating growth and will eventually kill the trees. After the first patches regenerate and are successfully established, make new patch cuts of the same size until the entire infected stand has been gone over. This would be an entry every 4-5 years.

Products from this cleansing operation could be sold as poles and fuelwood.

These trees grew at the rate of 1 1/2 diameter inches the first 10 years. They area currently growing at the rate of 3/8 diameter inch per 10 years.

4. Cut all dwarf-mistletoe infected trees within the burned over area near Osage Trail. Leave seedlings that have reestablished and are not infected with the parasite.

   Plant lodgepole and ponderosa seedlings.

5. Thin the lodgepole pine near point #3 (which is south of the burned over area and east of Lot 43) to a density of 100 basal area similar to recommendation 2. Be very careful to remove those trees that are currently infected with dwarf-mistletoe. Western gall rust and commandra rust infected trees are present and must also be removed.

   Since the current trees average smaller diameters than point #1, more trees will remain. There will be approximately 350 trees per acre remaining that are spaced an average of 11 feet apart.

   These trees grew to 2 1/2 inches diameter the first 10 years. They are currently growing at the rate of 1/2 diameter inch per 10 years.

6. Selectively remove ponderosa pines near point #4 to a basal area of 65. Remove trees heavily infested with dwarf-mistletoe (4,5 &6 ratings). Infested trees that have a rating of 3 or less may be retained. Leave healthy lodgepole and limber pines for stand diversity. Protect all non-infected seedlings. Prune out dwarf-mistletoe infected branches within reach.

   Plant lodgepole pine where ponderosa pine is heavily infected with dwarf-mistletoe. Plant ponderosa pine where no dwarf-mistletoe in ponderosa exists.

   There will be approximately 100 large trees per acre remaining that are spaced an average of 20 feet apart.

These trees grew to 2 1/2 inches in diameter the first 10 years. They are currently growing at the rate of 1/4 diameter inch per 10 years.

7. Thin lodgepole pine south of point #4 to a basal area of 100. Refer to other lodgepole pine recommendations.

8. The aspen on the lower end of the park (Picnic Park) could be left in its current condition. It represents a typical native stand of aspen.

9. Selectively remove ponderosa pines in the area represented by point #5 to a basal area of 65. Remove trees that are extremely overmature with dying tops and any tree that has dwarf-mistletoe. There are very old fire scars on the north sides of most ponderosa pines. Do not remove a tree based upon the fire scar damage alone.

   There is some reproduction of ponderosa and limber pines so planting may not be necessary.

   There will be approximately 100 trees per acre remaining after thinning that are spaced an average of 21 feet apart.

   These trees grew at the rate of 2 3/8 inches in diameter the first 10 years. They are currently growing at the rate of 5/8 diameter inch per 10 years.

10. Periodically inspect for the presence of mountain pine beetle. If currently infested trees are found, remove and treat prior to July 15th of every year.

11. Tops, unmerchantable limbs, and needles of trees removed in thinning or sanitation operations should be treated by one of the methods indicated in the appendix to eliminate or significantly reduce the threat of buildups in detrimental insect populations. It is undesirable to leave large quantities of this "slash" lying in the greenbelt areas.

Fire- An important consideration in forest management is wildfire hazard reduction. The hazard was objectively measured using transects on selected plots that measured fuel loading in tons per acre. In addition, each transect was measured subjectively in terms of fuel continuity, fuel type, and slope. By considering both objective and subjective data, an area could have a very light fuel load but be a fire hazard because there are many continuous, small fuels that burn easily.

Specific Recommendations-

1. The total fuel loading on plot #1 (see map) was not high as shown on the chart on page 4. The ground fire hazard is relatively small due to the light fuel loads and lack of continuity of large fuels necessary to sustain ground fires. It is extremely important to treat any fuels created by the thinning activity recommended for forest health. The proposed thinning will reduce the crown fire hazard.

2. Fuel loading on plot #2 was the highest measured. This plot is located in an area burned by the Beartrap Fire. The fire at this location was not hot enough to completely consume available fuels. The bulk of the fuels remaining are in the 1-3 inch diameter category. A salvage fuelwood harvest should be conducted to reduce the fuel loading (wildfire hazard) and utilize the downed material before decay makes it unusable.

3. Fuel loading on plot #3 was low in woody fuels in all diameter classes. However, the grasses and forbs in the area are dense enough to cause concern. Management of the grasses could be accomplished through the use of grazing, prescribed fire, or fuelbreak establishment. All have advantages and disadvantages. These should be discussed by the Association, and a decision made following landowner input.

4. Either remove or make sure the television antennas located within the greenbelt are grounded. Lightning strikes do occur with regularity along the park ridges.

MUMMY VIEW -

Vegetation - The sites within this park are very well suited for the growth of trees. Damage to forest stands in this park has been mainly by insects. Mountain pine beetle, ips, Douglas-fir beetle, and western spruce budworm have caused problems in the past. Several trees have blown down as a result of high winds. There are more openings of grass and brush in this park than in Bear Gulch. They occur because of drier slopes created by the southern exposure.

Specific recommendations -

1. Thin this mixed stand of ponderosa pine and Douglas-fir near point #1 at the top of the park located west of the end of Mattapony Court to a density of 110 basal area. There are a few small patches of lodgepole pine within the ponderosa-Douglas fir stand. The higher density recommended is due to the wind exposure at this point. Remove Douglas-fir that have been severely damaged by budworm. Select leave trees that are free of insect or disease problems, have good green needle color, and are free of other damage.

   A basal area of 110 would leave approximately 140 trees per acre that are spaced an average of 18 feet apart.

   The pines grew to 2 3/8 inches in diameter their first 10 years. They are currently growing at a rate of 3/8 diameter inch in 10 years.

2. Do nothing but remove future beetle infestations in the ponderosa pine stand near point #2. Density is satisfactory at its present level of 90. There are a few tree groups where removal of suppressed individuals would benefit the remaining trees. This is not critical to the health of the trees and leaves a natural appearance to the park.

   Since there is some seedlings and saplings present, there is no need to plant any trees.

   Approximately 130 trees per acre at an average spacing of 18 feet is the optimum at a level 90.

   The pines grew to 2 1/4 inches in diameter in their first 10 years. They are currently growing at a rate of 1/2 diameter inch in 10 years.

3. There are aspen patches in the lower drainages close to Osage Trail. They should be left as is for the next ten years. A re-evaluation should be made at that time to determine if any action is needed then.

4. Trees should be harvested at designated locations along the Mummy View Trail to create view openings for the excellent distant views.

Fire - Comments on Bear Gulch would apply to Mummy View. There is one basic difference between the fire potential of the two parks. Mummy view is a drier site due to its southern exposure. Fuels will dry quicker in the summer. Wildfire danger will reach "high" earlier and last longer into Fall.

Specific recommendations-

1. The fuel transect measured in Mummy View indicated a total fuel loading of 15.8 tons per acre or moderate. It was the highest of any point taken. Most of the load is continuous, downed lodgepole pine in the one to three inch diameter class. This material could be removed and chipped, burned, or utilized as firewood to reduce the loading. All slash created in thinning should be treated to keep wildfire hazard at a minimum. The threat of crown fire spread will be reduced by the proposed thinning.

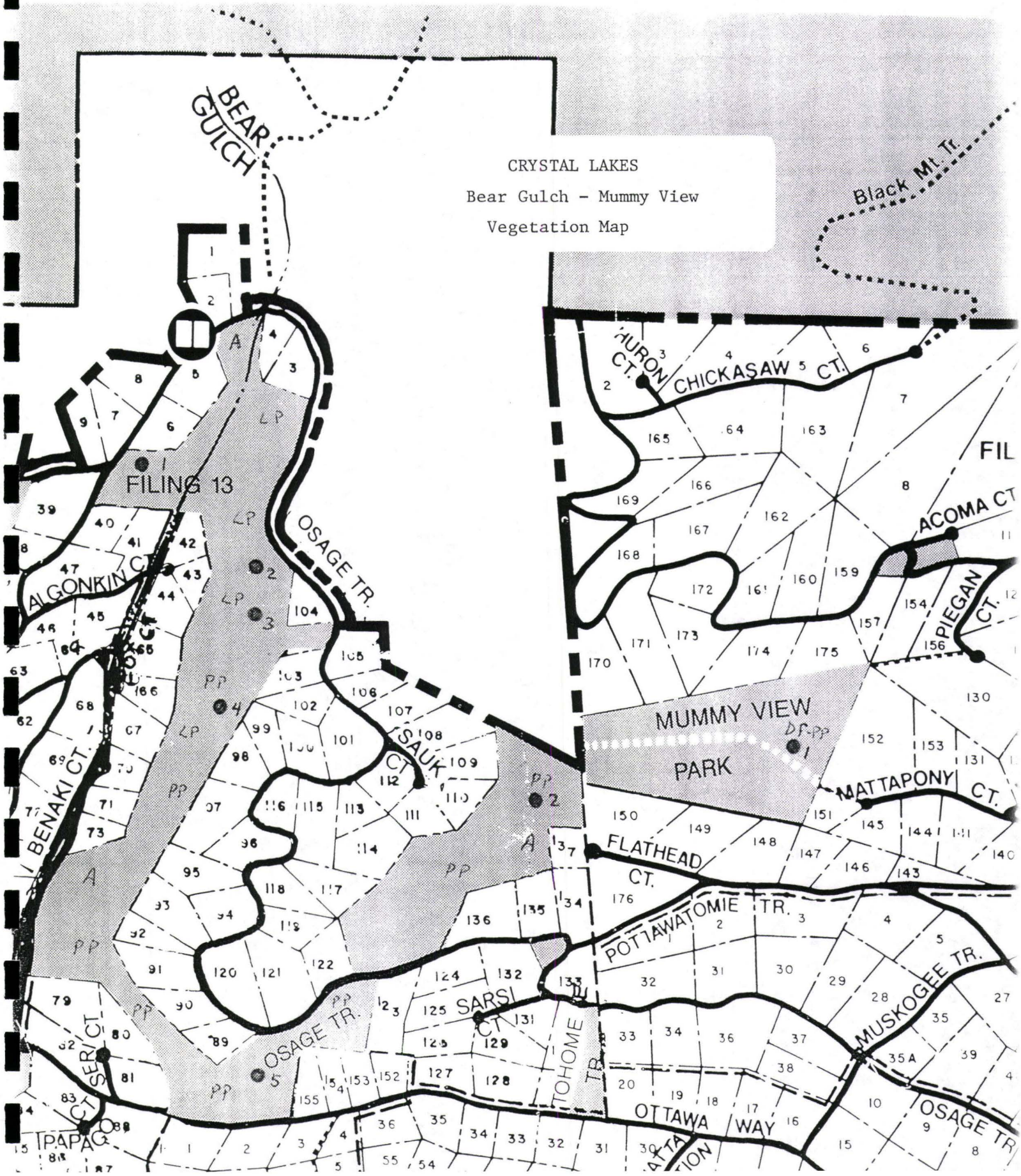
2. Removal of downed trees, including aspen, could be permitted at the discretion of the Greenbelt Management Committee. Removal should be accomplished without the use of vehicles to keep tracks out of the openings which encourage continued vehicle use.

3. Grasses and forbs could be managed through the use of grazing or prescribed fire. The decision for either method requires landowner input, cooperation, and understanding.

4. Clearing a limited width right-of-way along the Mummy View Trail would create a beneficial fuelbreak. Ground fires spread could be stopped at this fuelbreak.

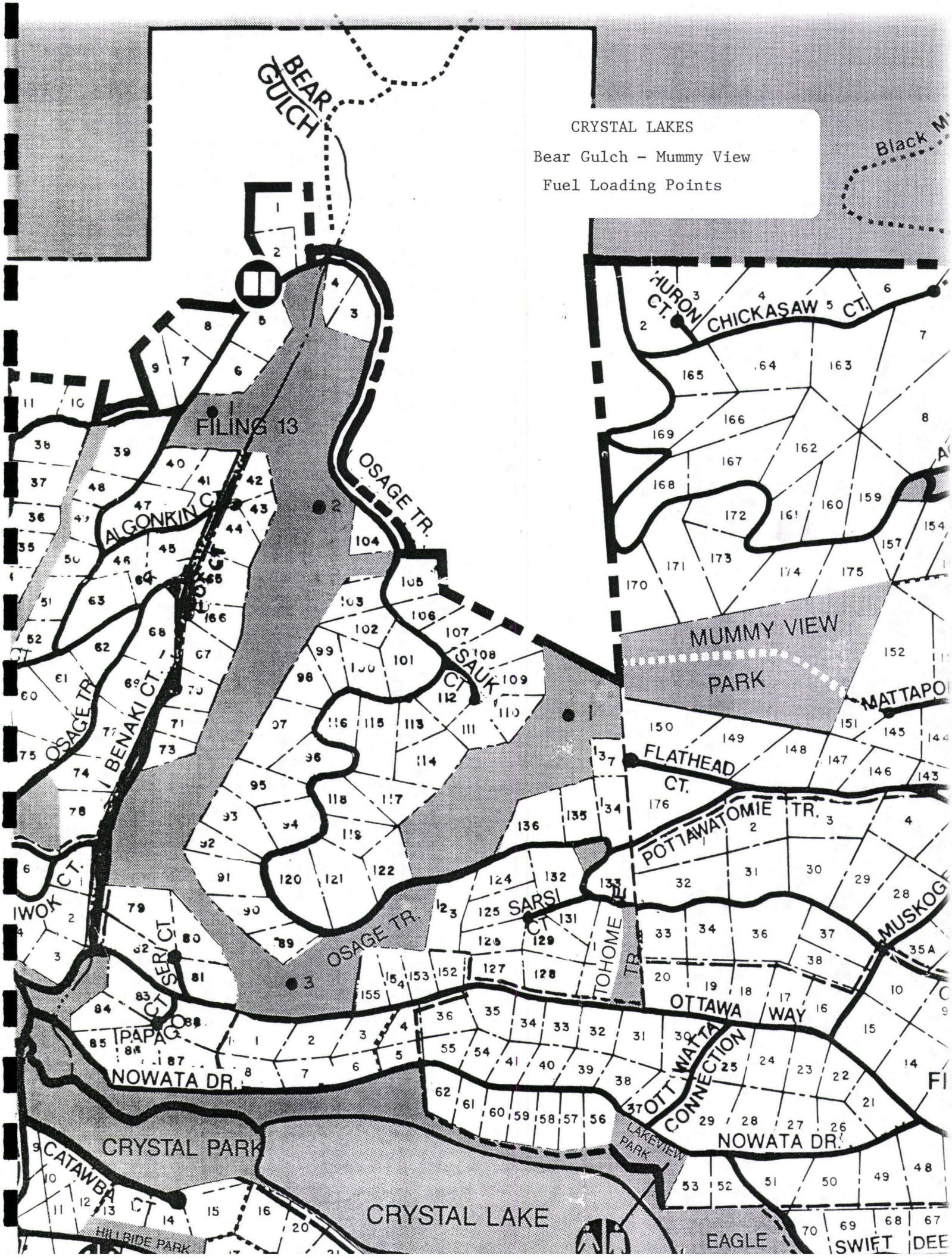
APPENDIX A

VEGETATION MAP


CRYSTAL LAKES
Bear Gulch - Mummy View
Vegetation Map
BEAR GULCH
Black Mt. Tr.
FILING 13
AURON CT.
CHICKASAW CT.
ACOMA CT
PIEGAN CT.
MUMMY VIEW PARK
MATTAPONY CT.
FLATHEAD CT.
POTTAWATOMIE TR.
MUSKOGEE TR.
OSAGE TR.
SAUK CT.
SARSI CT.
TOHOME TR.
OTTAWA WAY
ALGONKIN CT.
BENAKI CT.
PAPAGO
LP
PP
A
DF-PP

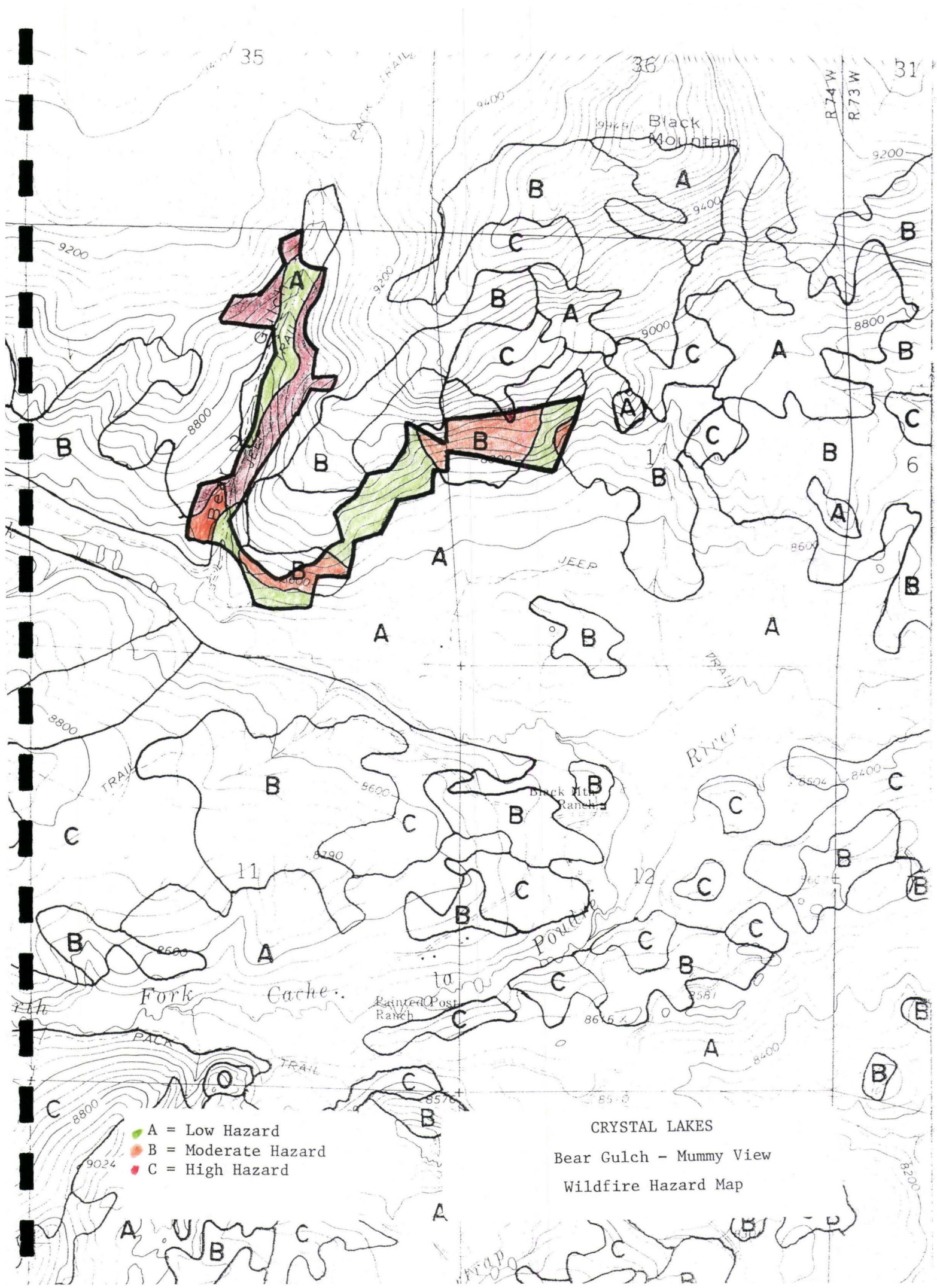
APPENDIX B

FUEL LOADING POINTS MAP


CRYSTAL LAKES
Bear Gulch - Mummy View
Fuel Loading Points
BEAR GULCH
FILING 13
OSAGE TR.
ALGONKIN CT.
BENAKI CT.
SAUK CT.
IWOK CT.
SERI CT.
PAPAGO
NOWATA DR.
CATAWBA CT.
CRYSTAL PARK
HILLRIDE PARK
CRYSTAL LAKE
AURON CT.
CHICKASAW CT.
MUMMY VIEW PARK
FLATHEAD CT.
POTTAWATOMIE TR.
SARSI CT.
TOHOME TR.
OTTAWA WAY
OTTAWA CONNECTION
LAKEVIEW PARK
NOWATA DR.
MUSKOG
MATTAPO
EAGLE
SWIFT
DEE

APPENDIX C

WILDFIRE HAZARD MAP


35
36
31
R.74 W
R.73 W
Black Mountain
9200
9400
9000
8800
8600
8400
PACK TRAIL
JEEP TRAIL
JEEP
TRAIL
RIVER
Fork
Cache.
Rainer Post Ranch
Black Mtn. Ranch
11
12
1
6
A = Low Hazard
B = Moderate Hazard
C = High Hazard
CRYSTAL LAKES
Bear Gulch - Mummy View
Wildfire Hazard Map

APPENDIX D

GLOSSARY

GLOSSARY OF TERMS

All Age - In a stand of trees where there are considerable difference in age of trees and in which three or more age classes are represented.

Artificial Regeneration - Where artificial means such as seeding or planting are used to establish a stand of trees.

Basal Area - A measure of density. It is the square footage of stump tops that would be exposed on an acre if all the trees were cut off at 4 1/2 feet above the ground. Often expressed as BA/Acre.

Board Foot - A board foot is 1" x 1" x 12".

Chipping - Refers to the chipping of logging slash, insect killed material, thinning residue, or potential wildfire fuels into small chips or flakes by a mechanical device. Chips make a good mulch if not piled too deep.

Cord - A unit of wood volume equal to a stack 4' x 4' x 8' solid. (128 cubic feet).

Cutting Cycle - The time interval between treatments.

DBH (Diameter Breast High) - The measurement of tree diameter at a point 4 1/2 feet above the uphill ground level. Usually expressed in inches.

Dog Hair - A stand of trees growing so closely together as to give the impression the trees are "as thick as hair on a dog's back."

DMR (Dwarf-Mistletoe Rating) - Refers to Hawksworth 's 6-point rating level for measurement of differing levels of dwarf-mistletoe infection.

Entry - Actual entering of stands for treatment purposes.

Even-Aged - A stand of trees in which the dominant trees originated at about the same time. Generally only one age class is represented.

Forage - Food available to grazing livestock or wildlife in the form of grasses, shrubs, and forbs.

Fuelwood - Dead woody material that has not begun to decay and that can be utilized for heating purposes.

Fuel Treatment - Practices used to reduce wildfire hazard by changing the composition of forest fuels.

Group Selection - Removal of a group of mature trees with intent to obtain natural regeneration from seeds produced adjacent to the area occupied by the group.

GSL (Growing Stock Level) - Stand density after treatment is expressed as a relationship between basal area and average stand diameter after cutting. A level is named by the basal area desired when average diameter is 10.0 inches. Basal areas increase with diameter until 10.0 inches diameter is reached, and remain constant thereafter. i.e., GSL 80 = basal area of 80.0 square feet when average stand diameter after cutting is 10.0 inches or larger.

Harvest - Removal of mature (commercial) trees.

Houselog - A portion of a tree which can be manufactured into a log that will be used in the construction of a log cabin. At least 8 feet long and 8 inches in diameter at the smallest end.

Lineal Foot - (Running foot) A unit of measure for houselogs, posts and poles. Only length is measured since diameter is not relevant.

Lop and Scatter - Tops and limbs of downed trees are lopped (cut) into small segments, scattered, and left to decompose. The closer to the ground pieces lie, the more rapid the decomposition.

Management Units - Areas or units with similar tree characteristics and management objectives. Can be a portion of one stand or several stands combined.

Marginal - Where commercial harvest becomes impractical for numerous reasons including: steep slope, transporation costs, tree density, tree quality, species, existing markets, etc.

Mature/Overmature - Trees that have reached their maximum growth potential and are falling victim to insects, diseases, and natural mortality.

Merchantable Material - Portions of a tree which can be processed and sold at a profit.

MBF (Thousand Lineal Feet) - 1,000 l.f., common unit of measure in sales of posts, poles, and houselogs.

Natural Regeneration - Tree seedlings which become established without added costs of seeding and/or planting. Seed source comes from existing or adjoining trees.

Patch - An area of trees of relatively uniform density, tree quality, and age structure that is too small to be treated as a stand.

Piling and Burning - Slash or other forest woody fuels is bunched into piles and burned to eliminate fire hazard. Piling can either be done by machine or by hand. Burning should be done under safe conditions by permit from local air quality agency.

Posts and Poles - Generally a product of thinning. Size range from 6 1/2 feet to 20 feet in length and 2 1/2 to 10 inches in diameter at the small end of the individual piece.

Pruning - Removal of branches to improve tree beauty, increase future lumber value, remove ladder fuels, and remove disease infested limbs.

Reproduction - Synonymous with regeneration. See artifical and natural.

Right-of-Way - Legal access for transporting forest products.

Sawlog - A portion of a tree which can be manufactured into lumber. At least 8 feet long and 6 inches in diameter at the small end of the cylinder.

Seed Cut - Reduction of the density of mature trees to encourage the establishment of natural regeneration over an area large enough to be treated as a stand.

Silvicultural Practices - Tree management techniques and procedures utilized to reach a given desirable stand condition.

Site Index - Relative measure of the potential productivity of an area. Generally it is the height of a tree at 100 years of age. On trees less than 100 years, graphs are used to extrapolate the normal base age.

Skidding - The process of moving felled (cut) trees to a central point for loading on a vehicle for transport to the manufacturing point. Can utilize crawler tractors, 4-wheel drive rubber-tired tractors, cable cranes, horses or mules.

Stand - A subdivision of a treatment area that is several acres in size, usually 5 acres or larger. Applicable to an area of even-aged or all-aged trees that can be regenerated by a single reproduction method.

Thinning - Removal of poorest formed, damaged, suppressed, and crowded trees in a stand to improve growth and form of remaining trees.

Two-Storied Stand - A stand composed of two definite age classes of trees with a significant or noticeable difference in tree heights giving a "layered" effect.

Uneven-Aged - Same as all-aged.

Wolf Tree - A slang term for a poor form, open grown tree which has numerous, large green branches. Another term often used is "apple-orchard" tree. Not a desirable, single-stem, self-pruning, upright tree.

Yarding - Same as skidding.

APPENDIX E

TREE SPECIES

LODGEPOLE PINE

(*Pinus contorta*)

Lodgepole pine is one of the most aggressive and hardy of western forest species. It reproduces quickly under many conditions, being more adaptable than many other species. Lodgepole pine is shade intolerant, meaning it cannot grow well or at all where other species are present and growing above it. However, when forested areas are burned or the area otherwise cleared, lodgepole pine will often regenerate and recover the area within a relatively few years provided a seed source is available and the young trees are not shaded out. Lodgepole pine is prevalent at elevations ranging from 8,000 to 11,500 feet. It is commonly associated with ponderosa pine, Douglas-fir, and other western pines. Growth averages 70-100 feet high and 12 to 18 inches in diameter. In the Rocky Mountain region, growth may be somewhat less due to competition and poor conditions.

Needles - 1 to 3 inches long, in groups of two; green to yellow-green.

Cones - 3/4 to 2 inches long, occasionally open at maturity but often closed for many years.

Bark - 1/2 inch thick, orange-brown to gray, covered by thin loose scales.

PONDEROSA PINE

(*Pinus ponderosa*)

Ponderosa pine is the most important pine in Western North America. It makes hard, strong, and fine-grained wood. High-grade ponderosa is used for doors, sashes, frames, and paneling; the low-grade wood for boxes, rafters, pallets, fencing, joists, and railroad ties. It also makes a handsome ornamental tree and hardy windbreak component. Ponderosa pine forests have also produced abundant forage and have long been grazed by domestic livestock. These forest areas produce much of the region's deer, elk, and other wildlife. Seventy species of birds were identified in the ponderosa ecosystem at Estes Park during the 1976 annual Audubon spring bird count. Recreational use has been expanding at a rapid rate.

Ponderosa pine in the Colorado Front Range occurs in the Montane Life Zone. This zone is the first timbered belt above the plains on the east side of the Colorado Rockies. Ponderosa pine is a climax species within its normal altitude zone of 5,500 to 8,800 feet in Larimer County. Annual precipitation is very low for tree growth, averaging from 15 to 20 inches. Approximately two-thirds of the annual precipitation falls during spring and summer when it is most useful for regeneration and growth. Soils are largely granitic in origin.

The first harvest cutting in ponderosa pine forests occurred in the Front Range of Colorado about 1860. During the gold rush years, tens of thousands of acres were virtually clearcut for fuel, mine timbers, and lumber. The tree has been cultivated in the U.S. since 1827 for ornamental purposes.

Needles - Growing in 2's and 3's up to 7" long. They remain through 3 growing seasons.

Cones - Up to 4" long. Deciduous. Made up of scales with small prickles. Male and female flowers on same tree.

Seeds - 1/4" long with 1" wing. Two on each scale. 12,000 seeds per pound.

Form - symmetrical single bole or trunk. Young trees conical while older trees are flat-topped.

Age - Reach maturity at 140-180 years.

Height - Tallest on record is 232 feet (California). Will reach 175 feet in best sites. Usually mature at less than 100 feet in Colorado.

Diameter - Up to 6 feet at 4 1/2 feet above ground in western forests. May reach 4 feet in Colorado. Normally less than 30 inches.

Root - Tap root.

Bark - Dark brown to black in young trees (furrowed) yellow-brown to cinnamon-red in old growth (smooth and plate-like).

Stand Characteristics

Dry Site species but gets best development on relatively moist, well-drained soils.

Light Demanding species which does not reproduce naturally under low light intensity.

Root Competition can not be tolerated.

Growth is slow but does respond well to thinning operations (release). Generally grows in pure stands. Douglas-fir can occur as scattered trees in pine stands as well as in pure patches and stands on north-facing slopes and along streams. Also pinyon pine, juniper, and limber pine may be found in pine stands.

Windfall is not a serious problem.

Fire Tolerance is low. Although old, mature, thick barked trees are highly resistant to light ground fires, old trees are killed or severely damaged by severe crown fires. Seedlings and small saplings are killed by light ground fires. Fire is not needed for seedbed preparation, but may be beneficial to reduce a heavy litter layer which would hamper seed germination.

Regeneration - Small quantities of seed are produced annually but large crops are released only at intervals of 3-5 years. Germination is as high as 50 percent in nature. Seedlings can exist under canopy of parent trees but grow quite slowly (only 3-4 feet during first 15-20 years). Reproduction is best in clearings made by fire or logging. There must be abundant seed supply and plenty of moisture for 2 or 3 years in a row to get reproduction. These conditions occur only once in every 20 years and then only in restricted localities.

Destructive Agent - Lightning, high winds, dwarf mistletoe, and mountain pine beetle have been the main causes of mortality. The oldest and least vigorous trees are the most susceptible. Other problem causing agents include ips beetles, pine needle miner, pine tip moth, pine budworm, western red rot, porcupines, deer, and small rodents. High rodent populations were found to be a major obstacle to establishment of natural regeneration.

Management - The principle forest values derived from the Montane zone relate to beauty of the landscape and to various forms of outdoor recreation. Mountain communities located here rely on these values for existence. Tree management normally is not a tool to obtain maximum production of wood products. Instead, it is a means of reducing the damage from mountain pine beetles, dwarf mistletoe, and other agent that can lower the attractiveness and usefulness of the zone. It can be utilized to increase and perpetuate the values of landscape, wildlife, livestock forage production, recreation, and employment.

APPENDIX F

INSECTS AND DISEASES

DWARF MISTLETOE

Dwarf mistletoe is a parasitic plant that severely weakens and sometimes kills its host trees, ponderosa pine and lodgepole pine. normally different species of mistletoe affect ponderosa pine and lodgepole pine. The parasite (*Arceuthobium americanum*), usually infecting ponderosa pine but occasionally attacking lodgepole pine, greatly reduces the growth of an infested tree. It also limits cone production and thus, reproduction. Dwarf mistletoe infestation also increases susceptibility to other forest pests, especially the Mountain pine beetle.

Life Cycle

Dwarf mistletoe has a six-year life cycle. It flowers in the spring. Seed mature in August and September, a year later. Upon maturing, the seeds are released explosively. Water pressure can expel them at velocities up to 50 feet per second and distances up to 66 feet. The average distance is closer to 20 feet. The seeds are covered with a sticky material and adhere to whatever they touch. If one lands on a pine needle, it will be washed to the base of the needles by rain, where it will sprout and send a shoot into a branch. Three to six years later, shoots appear on the branch of the tree. These shoots usually produce flowers two years after emergence.

Symptoms of Mistletoe Infection

The most conspicuous symptom of mistletoe infection is the presence of mistletoe shoots on the branches or trunk. Swellings on the branch can be caused by mistletoe shoots that are about to emerge. "Witches brooms," or bunches of contorted branches are often caused by dwarf mistletoe.

Control

Severely infested trees should be cut down and disposed of. Such trees will probably die anyway, and are hazardous because of the possibility of dead branches or tops falling down. By leaving them standing, they will only continue to infest other trees. Patch cuts are recommended in an entire stand that is infested.

Trees not severely infested can be pruned, and will regain some of their health and continue to live. If the shoots occur mostly in the lower parts of the tree, the branches that are infested can be pruned off. All pruned branches should be cut off up to and including the highest infected branch. If sufficient live branches remain (1/4 to 1/3 tree height), prune the tree to two feet above the highest infected branches and brush off shoots arising from the trunk. If replanting is done, a mixed forest should be the goal. Where the pines are intermixed with Douglas-fir, for example, the rate of mistletoe spread will be greatly reduced.

RUSTS

Rusts are fungi that invade pines and cause gall and canker formation. Western gall rust (*Peridermium larknesii*) and commandra blister rust (*Cronartium commandrae*) are two common diseases of western pines. The gall rusts cause the tree cambium to divide rapidly, much like a cancer, and form galls. These galls kill the parts of the tree which bear them. Both types of rusts may eventually kill the host tree. Cankers on the main trunk of the tree mechanically kill weaken the tree at that point. Heavy winds will break off the tree at the canker.

Rusts have complex life histories, going through several stages of development. Commandra rust requires a second host, the commandra plant, to complete its life cycle. In both cases, microscopic spores produced by the different lifestages are spread by wind, rain, and animals to the susceptible tissues of the host pines and alternative host plants.

WESTERN GALL RUST

Hosts: Ponderosa pine and lodgepole pine.

Symptoms: Galls (globose - shaped swellings) produced on branches and twigs cause death of individual branches. Galls on main stems enlarge causing "hip" cankers. Yellow-orange blisters develop on galls during the summer.

Importance: Trunk cankers affect the form, lumber content, and growth rate of their hosts and may kill individual trees, but is not known to wipe out entire stands. The rust infects pines of all ages.

Control Strategy: Removal of infected trees during thinning operations and during intermediate cuts is the only practical way to reduce damage.

COMMANDRA BLISTER RUST

Hosts: Lodgepole pine and ponderosa pine (Commandra or bastard toadflax [*Commandra umbellata*], are the alternative hosts).

Symptoms: Spindle-shaped cankers on branches and main stem; flagging (fading) of infected branches; top-kill and death of infected trees.

Importance: Commandra rust affects much of the lodgepole pine stands in the Rocky Mountain Region. It causes spiketops and whole-tree mortality, as well as reducing tree growth and lumber content.

Control Strategy: Control is generally aimed at reducing the disease incidence rather than preventing infections. Salvage harvests of heavily infected stands should be done while the trees are still usable. Trees with commandra rust and dwarf mistletoe should be removed first. Trees with multiple stem cankers, spike tops, and girdling stem cankers in the lower crown of the tree should be discriminated against during any timber stand improvement work.

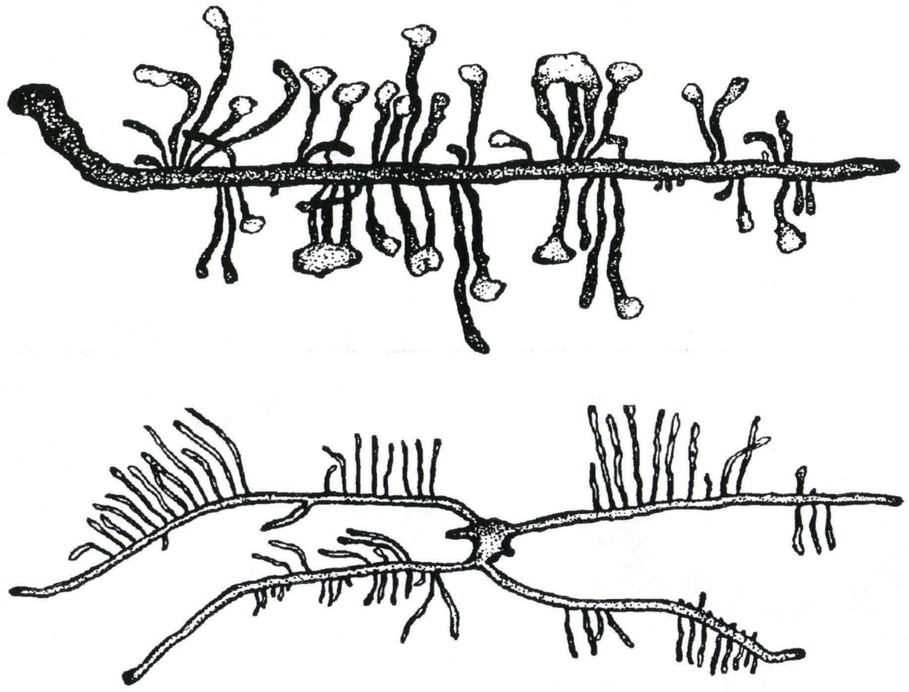


Figure 3: Typical egg and larval galleries produced by Dendorctonus (top) versus Ips (bottom).

MPB losses is to thin trees. Consult a professional forester to select the best cultural practices for your land.

Logs infested with MPB can be treated in various ways to kill developing beetles before they emerge as adults in summer. Logs may be burned to kill the larvae under bark. Intense solar radiation that dries out the cambium and raises temperatures to lethal levels (110F+) can kill MPB larvae. Beetles also die if the bark is removed by peeling or milling. Burying is another option to kill MPB in infested logs. In some cases, hauling infested logs to "safe sites" a mile or more from susceptible tree hosts also is practiced. Following beetle emergence, wood can be used without threat to other trees.

Chemical control options for MPB have been greatly limited in recent years. Former treatments that involve ethylene dibromide fumigation have been banned. Cacodylic acid (Silvisar products) and most formulations of lindane are unavailable or Restricted-Use. These treatments were primarily used to kill larvae in trees or adults as they emerge. (A few formulations of lindane, usually marketed as some brand of 'borer spray', remain available to treat infested logs.)

Certain formulations of carbaryl (Sevin, Sevimol, etc.) are registered for use to prevent attacks on individual trees. These sprays are applied to living green trees in early summer to kill attacking beetles. This preventive spray is quite effective through one MPB flight (one year) in ponderosa pine areas. In lodgepole pine areas, recent evidence indicates one spraying may provide satisfactory protection through two flights (two years).

Always carefully read and follow all label precautions before applying carbaryl for MPB prevention.

Research is ongoing with lures involving special attractants (pheromones) for beetle management. Primarily this has involved pheromones with attract beetles to 'trap` logs or trees where they can be more easily removed or treated. This approach has been effective in Colorado settings where there are trees available for sacrifice. Done correctly, combined with tree treatments, pheromones can be useful in reducing outbreaks in a small area.

Repellent pheromones to disperse beetles from high-value trees also are being developed. However, these have not yet provided consistently reliable protection in Colorado testing.

- Once MPB infest a tree, nothing practical can be done to save that particular tree.
- Under epidemic or outbreak conditions, enough beetles can emerge from an infested tree to kill about two same-sized trees the following year.
- Ips and related beetles that emerge early in summer often are mistaken for mountain pine beetle, leading to early reports that "MPB is flying". Be sure to properly identify the beetles you find associated with your trees.
- Trees from which MPB have already emerged (look for numerous, round, pitch-free exit holes in bark) do not need to be treated.
- The direction and spread rate of a beetle infestation is impossible to predict. However, attacked trees usually are adjacent or near previously killed trees.

Douglas-fir Beetle

A different species of bark beetle damages Douglas-fir in Colorado. The Douglas-fir beetle (*D. pseudotsugae*) also causes the rapid reddish-brown needle discoloration associated with MPB and other bark beetles. Douglas-fir beetle does not produce MPB-like pitch tubes, although clear sap may ooze from boring wounds.

Douglas-fir beetles have one generation per year. However, they overwinter as both large larvae and adults under the bark. Adults typically begin emerging in late April and May (earlier than MPB), but over 75 percent of the population emerges the last three weeks of June. Thus, the emergence period can extend from April through July.

Controls for Douglas-fir beetle generally are similar to MPB. However, since adults can emerge earlier, developing beetles must be destroyed and preventive sprays applied by late April.

Spruce Beetle

Engelmann and blue spruce can be attacked by the spruce beetle, *Dendroctonus rufipennis*. This beetle is considered to be less aggressive than MPB and usually limits attacks to wind-thrown trees, slash, and tree stumps. However, apparently healthy spruce trees can be attacked when beetle populations become epidemic. The largest single mass-killing of trees recorded in North America is attributed to spruce beetle, in the White River National Forest during the 1940's.

Spruce beetles generally take two years to complete a generation and attacks may take longer to kill a tree than occurs with other bark beetles. Pitch tubes usually are not formed and presence of brown sawdust from borings is often the best evidence of attack. Adult beetles emerge in late June and July.

Red Turpentine Beetle

Pines and, rarely, other conifer species sometimes are attacked by the red turpentine beetle, *Dendroctonus valens*. Trees scorched near the base by fire or injured during construction are particularly susceptible. Turpentine beetle attacks are characterized by large, pinkish-purple pitch tubes confined to the lower eight feet of the trunk. Beetles may be active throughout the warmer months, peaking in mid-summer.

Tunnels produced by red turpentine beetle do not have a regular egg gallery. Beetles make short, irregular tunnels and developing larvae feed as a group excavating a shallow cavity under the bark. Trees can survive attack, but weakening can make them more susceptible to other bark beetles.

Cultural practices that promote tree vigor can help avoid attacks by red turpentine beetle. Preventive insecticide sprays (carbaryl) applied before adult attacks, also are effective. Individual trees can be protected by screening the lower trunk.

Related Service in Action Sheets

5.506	Dutch elm disease
5.543	Western spruce budworms
5.558	Ips beetles — characteristics and control
5.567	Ponderosa pine budworms

service in ACTION

Colorado State University Cooperative Extension

no. 5.528

Mountain Pine Beetle

and related bark beetles

David A. Leatherman and Whitney S. Cranshaw[1]

Quick Facts

- Mountain pine beetle (MPB) is the most important insect pest of Colorado's pine forests. MPB often kill large numbers of trees annually during outbreaks.
- Trees that are not growing vigorously due to old age, crowding, poor growing conditions, drought, fire or mechanical damage, root disease and other causes are most likely to be attacked.
- For a long-term remedy, thin susceptible stands with emphasis on leaving well-spaced healthy trees.
- For short-term controls, spray, burn, and peel attacked trees to kill the beetles. Preventive insecticide sprays can protect green, unattacked trees.

Mountain pine beetle (MPB), *Dendroctonus ponderosae*, is an insect native to the forests of western North America. Previously called the Black Hills beetle or Rocky Mountain pine beetle, periodic outbreaks of the insect can result in losses of millions of trees. Outbreaks develop irrespective of property lines, being equally evident in wilderness areas, mountain subdivisions, and back yards. Even windbreak or landscape pines many miles from the mountains can succumb to beetles imported in infested firewood.

Mountain pine beetles develop in pines, particularly ponderosa, lodgepole, Scots (Scotch), and limber pine. Bristlecone and pinyon pine are less commonly attacked. During early stages of an outbreak, attacks are limited largely to trees under stress from injury, poor site conditions, fire damage, overcrowding, root disease, or old age. However, as

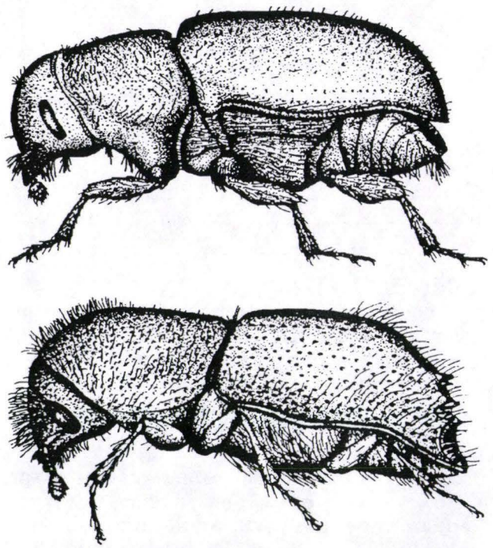


Figure 1: Adult Dendroctonus (top) versus Ips (bottom). Note gradually curved wing of Dendroctonus. Actual size of Dendroctonus from 3 to 8 mm; Ips 3 to 6.5mm.

beetle populations increase, MPB attacks may involve most trees in the outbreak area.

A related insect, the Douglas-fir beetle (*Dendroctonus pseudotsugae*), occasionally damages Douglas-fir. Most often, outbreaks are associated with previous injury by western spruce budworm (Service in Action sheet 5.543, *Western Spruce Budworm*). Spruce beetle, (*Dendroctonus rufipennis*) is a pest of Engelmann and blue spruce in Colorado. Injured pines also can be attacked by the red turpentine beetle, (*Dendroctonus valens*).

Mountain pine beetle, and other bark beetles in the genus Dendroctonus, can be separated from other bark beetles by the shape of the hind wing cover (Figure 1). In side view it is gradually curved. The wing cover of Ips or engraver beetles, another common group of bark beetles attacking conifers (Service in Action sheet 5.558, *Ips beetles — characteristics and controls*) is sharply spined; whereas Scolytus beetles, such as the shothole borers and European elm bark beetle, have the area under the wing cover (abdomen) indented.

This Service in Action sheet was produced in cooperation with the Colorado State Forest Service.

Colorado State FOREST SERVICE

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Signs and Symptoms of MPB Attack

- Popcorn-shaped masses of resin, called 'pitch-tubes' on the trunk where beetle tunnelling begins. Pitch tubes may be brown or white in color.
- Boring dust in bark crevices and on the ground immediatley adjacent to the tree base.
- Evidence of woodpecker feeding on trunk. Patches of bark are removed and bark flakes lie on ground or snow below tree.
- Foliage turning yellowish to reddish throughout the entire tree crown. Usually occurs eight to 10 months after a successful MPB attack.
- Presence of live MPB (eggs, larvae, pupae, and/or adults) as well as galleries under bark. This is the most certain indicator of infestation. A hatchet for removing bark is needed to check trees correctly.
- Bluestained sapwood (Figure 2). Check at more than one point around the tree's circumference.

Life History and Habits

Mountain pine beetle has a one-year life cycle in Colorado. In late summer adults leave the dead, yellow to red needled trees in which they developed. Females seek out living, green trees that they attack by tunneling under the bark. Coordinated mass attacks by many beetles are common. If successful, each beetle pair mates, forms a vertical tunnel (egg gallery) under the bark, and produces about 75 eggs. Following egg hatch, larvae (grubs) tunnel away from the egg gallery producing a characteristic feeding pattern (Figure 3).

MPB larvae spend the winter under the bark. They continue to feed in the spring and transform

Figure 2: Cross section of ponderosa pine log shows characteristic stain caused by fungus carried on beetle bodies.

into pupae in June and July. Emergence of new adults can begin in early July and continue through September. However, the great majority of beetles exit trees during late July (lodgepole pine) and mid-August (ponderosa pine).

A key part of this cycle is the ability of MPB (and other bark beetles) to transmit bluestain fungi (*Ceratocystis species*). Spores of these fungi contaminate the bodies of adult beetles and are introduced into the tree during attack. Fungi grow within the tree and, together with beetle feeding, weaken the tree. This mutual network of beetle galleries and bluestain fungi disrupt transport of water in the tree and rapidly kill it. The fungus gives a blue-gray appearance to the sapwood.

Control

Natural controls of mountain pine beetle include woodpeckers and insects such as clerid beetles that feed on mountain pine beetle adults and larvae under bark. Extreme cold temperatures also can reduce MPB populations. However, during outbreaks these natural controls often fail to prevent additional attacks.

Perhaps the most important natural control is tree vigor. Healthy trees are less attractive to beetles than trees under stress. Vigorously growing trees also have better defenses that allow them to 'pitch out' pine beetles.

Cultural controls that promote tree health and spacing are the primary means to prevent MPB outbreaks. The best long-term means to minimize

APPENDIX G

MANAGEMENT SPECIFICATIONS

CLEARCUT

Clearcut: Removal of all trees within a stand, providing an open area for natural or artificial regeneration of stand.

A. Age of Trees: Even-aged.
B. Rotation: Definite period, mature stand is cut at some given age.
C. Cutting:
   1. Size of cutting depends on economics, species characteristics (slope, exposure, wind, etc.), and aesthetic and wildlife considerations. Cuts in size of 1-10 acres are generally called "patch" cuts. Larger sizes are possible, and are called clearcuts,

   2. Select area of stand, or entire stand, to be cut. All trees, including non-commercial (unusable) trees, are cut. Commercial wood is removed, uncommercial wood is either removed or left on site. All trees are cut to eliminate competition to regeneration.

   3. Tops, limbs, and unusable wood, also called "slash", are treated. Treatment can occur as lopping and scattering slash throughout the stand, or by piling and burning slash. Burning can be done in smaller piles scattered throughout the area, or in larger piles or windrows. Burning is generally done with snow cover present.

      Lopping and scattering is done to increase decomposition rates, and to allow cones in the slash to distribute seed throughout the area for natural regeneration. Decomposing slash returns nutrients to the site very gradually, and helps protect the site. Piling and burning remove slash from the site immediately, but does not return as many nutrients to the site.

   4. Natural or artificial regeneration are used to replace the harvested stand. Natural regeneration can occur from seed distributed by slash, from adjacent stands. Artificial regeneration is accomplished by seeding or planting seedlings.

D. Results: Creates openings in forest cover. Size and area of cutting is determined by management objectives. The stand will be even-aged.

Advantages

A. No competition from other trees to reproduction.
B. Operations easiest to design and administer.
C. No damage to residual stand or reproduction.
D. Cost of logging lowest of any method.
E. Profit is maximized with this system.
F. Some species will not regenerate without this type of system, such as aspen.
G. May produce large amounts of regeneration in some species, i.e., lodgepole pine.

H. Can be used to develop wildlife habitat, by increasing browse and forage material in cut areas.

Disadvantages

A. Large amount of slash disposal.
B. Aesthetically displeasing, i.e., "messy-looking."
C. Not suitable for shade tolerant species.
D. Regeneration may be limited by harsher site conditions, or by slash in cut area.
E. Site disturbance greater at time of harvest than other systems.
F. Requires cutting of all trees in area, including unusable (noncommercial) trees.
G. Windthrow damage in adjoining stands possible, where cuts are poorly designed.

SELECTION METHOD (Single-Tree)

Selection Method (Single-Tree): Removal of single mature trees.

A. Age of Trees: All-age or even-age stands.

B. Rotation: Age at which mature timber is cut. Determined by size, i.e., diameter limit.

C. Cutting: Stand is cut every ten to twenty years back to a growing stock level of 80. The cut takes out the large, "ripe" trees including all defective, insect infested or diseased trees.

D. Results: Trees are all ages and sizes occupy the same acreage and furnish a great variety of sizes at any time.

Advantages

A. Keeps a forest cover.
B. Gives a variety of sizes on a small area of land.

Disadvantages

A. No acres are freed of root competition to provide enough space for reproduction -- this is peculiar to the Front Range of Colorado.
B. Costs more to log.
C. Much injury to young reproduction by logging.
D. Produces less timber.
E. Is irregular and difficult to control; therefore, apt to be overcut or undercut.
F. To be really successful, involves very intensive management.

SLASH DISPOSAL

Slash is a term used to describe the limbs, tops, and branches left from thinning and timber harvesting activities. Slash can add significant volume of fuel to the forest. These materials can accumulate and can serve as ladder fuels, or can become hot spots, increasing the difficulty of suppressing wildfire. Slash decomposes very slowly in Colorado and proper disposal is essential.

Three treatment methods commonly used are: (1) lopping and scattering; (2) piling and burning; (3) Chipping. Proper treatment reduces fire hazard, improves access for humans, wildlife, and livestock, encourages establishment of grasses and other vegetation (including seedling trees in some cases), and improves aesthetics. Size, amount, and location of slash dictates the method of disposal used.

Lopping and Scattering is the easiest and cheapest method of disposal, but must be done properly to be effective. Large branches are cut into small sections and scattered over the area. All pieces are cut small enough so all slash is within 12 inches of the ground. (Contact with the ground increases decomposition rates). This method leaves a "messy" appearance to the site for several years, especially if slash is not cut into small enough pieces. Advantages to this method are greater nutrient recovery to the site as slash decomposes, reduced surface erosion, and improved seedling establishment by some species (especially lodgepole pine).

Piling and Burning is a quick way to eliminate a large amount of slash at a moderate cost. Burning is done when sufficient snow cover exists to prevent fire spread. Piles are located far enough away from remaining trees to prevent scorching, and should be compact enough to burn easily. The county sheriff and local fire departments must be notified before any burning is done. In some counties, the Public Health Department requires a burning permit be completed before the burning season. A few scattered piles may be left for wildlife use without compromising wildfire danger.

Pile dimensions will depend upon site specific conditions and manpower, but should be at least 6 feet across by 5 feet high in size (when compacted) to facilitate burning during winter conditions. Piles should be burned during the first winter following cutting for best results. This method requires reentry to the stand, frequently during inaccessible periods, to complete treatment. Cost is slightly higher than lopping and scattering. Adverse weather conditions may delay burning for several years, reducing the effectiveness of this treatment. Advantages to this method are a "clean" site after treatment, improved accessibility within the area, and suitable seedbed for seedling establishment.

Chipping is the most expensive disposal method. Branches are fed through a machine equipped with metal blades that chop the slash into chips approximately 3/4 inch square by 1/3 inch thick. Chips decompose more rapidly than lopped and scattered slash, present little fire hazard, and act as a

mulch to hold soil moisture and prevent erosion on the site. Wood chips may prevent seedling establishment when spread too thick. Chipping is very expensive (1991 costs for CSFS were $40.00/hour), and requires the slash to be reachable by the equipment used. Chipping must be done within the first year of cutting to be done effectively, as the slash is more difficult to treat as it dries out.

WILDFIRE FUELBREAK SPECIFICATIONS

Definition:
A fuelbreak is defined as an easily accessible strip of land of varying width (depending upon fuel and terrain), in which fuel density is reduced, thus improving fire control opportunities. The stand is thinned, and remaining trees are pruned to remove ladder fuels. Brush, heavy ground fuels, snags, and dead trees are disposed of and an open, park-like appearance is established. A fuelbreak is not the same as a firebreak. A firebreak is an area, 20 to 30 feet wide (or more), in which all vegetation is removed down to mineral soil. It is reworked and maintained each year prior to fire season.

Purpose:
Fuelbreaks provide quick access for wildfire suppression. Control activities can be conducted safely due to low fuel volumes. Strategically placed, fuelbreaks break up large tracts of dense timber, thus limiting uncontrolled spread of wildfire. They can greatly aid firefighters by slowing fire spread during normal burning conditions. However, under extreme conditions, fuelbreaks stand little chance of stopping large fires. Large fires can drop firebrands 1/8 mile or more ahead of the fire. The fuelbreak is the line of defense. The area between it and the fire will be sacrificed. Despite this limitation, fuelbreaks have proven effective in Colorado. In 1980, crown fires associated with the Crystal Lakes Fire near Fort Collins were stopped in areas with fuelbreak thinnings, while adjacent areas of dense lodgepole pine burned completely.

Topography
Certain topographic features affect fire behavior. The rate of fire spread increases as the slope of the land increases. Fuels are preheated by the rising smoke column, and fire spreads to the crowns of adjoining timber. On a 30 percent slope, the rate of fire spread is double that of flat terrain. Chimneys are densely vegetated drainages on slopes greater than 30 percent. Wind tends to funnel up the drainage, rapidly spreading fire upslope. Saddles are low points along a main ridge or between two hills. Like chimneys, they also funnel winds to create a natural fire path during an uphill run and act as corridors - spreading fire into adjoining valleys or drainages. V-shaped valleys, such as deep canyons, can ignite easily due to heat radiating from one side to the other. A fire burning on one side of the valley can dry and preheat fuels on the other side until the fire "flashes" over. The slope effect then takes over and fire spreads rapidly uphill on both sides of the valley.

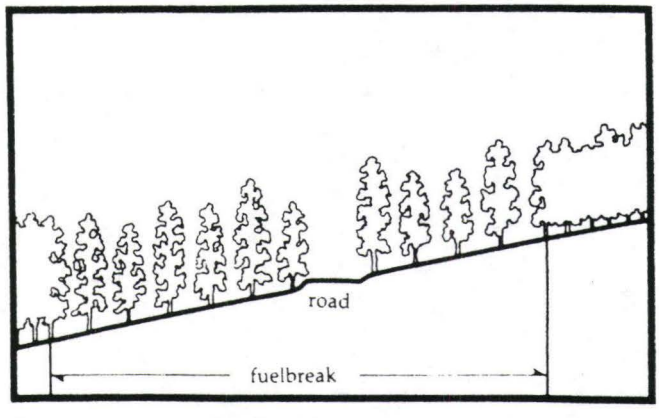
Location:
An effective fireline is connected or anchored to natural or artificial fire barriers. Some examples are rock outcrops, rivers, wet meadows, or a less flammable timber type. Since fuelbreaks provide quick, safe access to defensive positions,

CONSTRUCTING THE FUELBREAK

FUELBREAK WIDTH AND SLOPE ADJUSTMENTS

Note: Since road systems are so important to fuelbreak construction, the following measurements are from the toe of the fill for downslope distances and above the cut for uphill distances.

The **minimum** recommended fuelbreak width is approximately 200 feet. Since fire activity intensifies as slope increases, the overall fuelbreak width must also increase. However, to minimize aesthetic impacts, the majority of the increases should be taken from the bottom of the fuelbreak below the road cut.



Typical cross-section of fuelbreak built in conjunction with road.

Widths are also increased when severe topographic conditions are encountered. Guidelines for fuelbreak widths on slopes greater than 30 percent are given below.

FUELBREAK WIDTH PRESCRIPTION

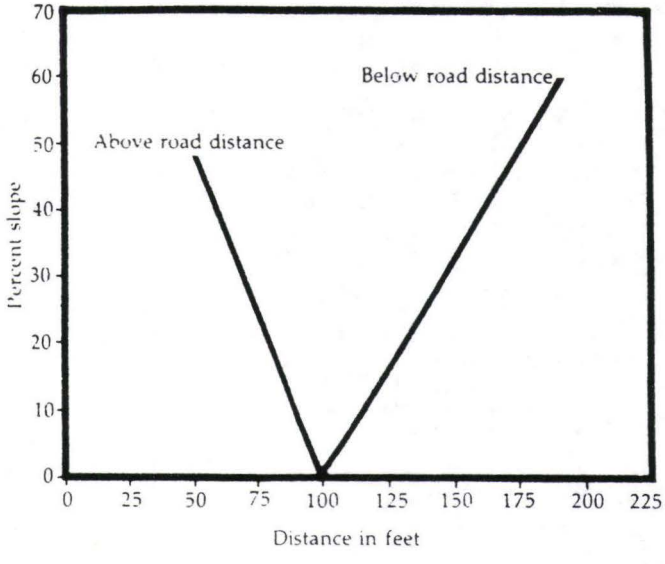
1) Below road distance:
Distance (ft.) = 100 + [(150%)(slope %)]

2) Above road distance:
Distance (ft.) = 100 - slope%

3) Fuelbreaks which pass through chimney or saddle areas should have distances increased by at least 50%.

4) Ridgetop fuelbreaks should be thinned on both sides of road based on below road distance prescription.

5) All distances are measured along slope.



FUELBREAK WIDTH/SLOPE

Percent Slope (%)	Uphill Distance (ft)	Downhill Distance (ft)	Total Width of Modified Fuels (ft)*
0	100	100	200
10	90	115	205
20	80	130	210
30	70	145	215
40	60	160	220
50	50	175	225
60	40	190	230

**As slope increases, total distance for cut-and-fill for road construction rapidly increases, improving fuelbreak effective width.*

they are necessarily linked to road systems. Cut and fill slopes of roads are an integral part of fuelbreaks, as they reduce the amount of fuel modification needed. Preferably, fuelbreaks are located along ridge tops to help arrest fires at the ends of their runs. However, they can be effective when established at the base of the slopes. Mid-slope fuelbreaks are least desirable. When located along ridge tops, continuous length as well as width is a critical feature. Extensive long-range planning is essential in positioning this type of fuelbreak. Improperly planned fuelbreaks adversely impact an area's aesthetic qualities. Careful construction is necessary when combining mid-slope fuelbreaks with roads with excessive amounts of cut and fill. Fuelbreaks should be done in conjunction with thinning and adjacent dense timber, both for aesthetics and effectiveness.

Fuelbreak Densities:

Crown separation is a more critical factor for fuelbreaks than a fixed tree density level. A minimum 10 foot spacing between they edges of tree crowns is desirable. Small, isolated groups of trees may be retained for visual diversity. A fuelbreak thinning is classified as a heavy "sanitation and improvement" cut from below. Trees which are suppressed, diseased, deformed, damaged, and of low vigor are removed along with all ladder fuels. Remaining trees are the largest, healthiest, most wind-firm trees from the dominant and co-dominant species of the stand. Because this type of thinning is quite heavy for an initial entry into a stand, windthrow hazard must be evaluated. It may be necessary to develop the fuelbreak over a number of years through several thinnings, to allow the stand to become windfirm.

Fuelbreak Maintenance:
Following thinning in the stand, trees continue to grow. Increased light on the forest floor encourages heavy grass and brush growth in the newly created openings. Site disturbance and exposed mineral soil is a perfect seed bed for new trees which, in turn, create new ladder fuels. Thus, fuelbreak effectiveness may decrease over time. Maintenance work should be planned for the fuelbreak to maintain its effectiveness. Grass and brush control needs to be conducted yearly, unless erosion hazard is high. Seedling trees should be removed as they may serve as ladder fuels. Some seedling trees may be allowed to grow within the area, serving as replacements for the fuelbreak trees.

Text and diagrams from Fuelbreak Guidelines for Forested Subdivisions, 1983, by Frank C. Dennis, Colorado State Forest Service, Colorado State University.