

STEWARDSHIP INCENTIVES PLAN
(SIP)

For:

Merlin Williams
6387 Niwot Road
Longmont, CO 80503
(303) 530-3513

Parts of the
E1/2, Sec 23, T1N, R73W, S.P.M.
and the
W1/2, Sec 24, T1N, R73W, S.P.M.

Prepared By:

Douglas J. Stevenson
Colorado State Forest Service
936 Lefthand Canyon
Boulder, CO 80302
(303) 442-0428

April 16, 1997

This management plan has been prepared at my request to guide my Stewardship management activities which I voluntarily apply on my property. I believe that activities recommended in this plan are appropriate to meet my objectives and will benefit the natural resources on my property. I intend to apply the recommended practices and to maintain them for a period of at least ten years, thus helping me to be a good steward of the forest and associated resources entrusted to me on my property.

Merlin Williams

Date

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OBJECTIVES: The forestry objectives for this property are:

1. Consistent with requirements of the Stewardship Incentives Program, to improve the health and vigor of the forest and enhance its productivity.
2. Follow principles of sustained yield forestry and multiple use management, giving particular attention to production of forest products and enhancement of wildlife habitat.
3. Preserve the aesthetic qualities of the property.
4. Protect the soil and water resources of the property.

AREA: The property contains 32.8 acres, all of it forested:

Forest	0.4 acres	Northwest Corner Lodgepole
	8.1 acres	Klondike Lodgepole Pine
	18.7 acres	Friend Lodgepole Pine
	3.1 acres	Aspen
	<u>3.3</u> acres	Mixed Conifer
	33.6 acres	Stewardship Incentives

PROPERTY LOCATION: The property is located west of Highway 72, about $\frac{1}{4}$ -mile north of the road to the Mountain Research Station.

BOUNDARY MONUMENTS: Some corners are marked with plastic caps on $\frac{1}{2}$ -inch rebar. Most are not marked.

ACCESS: Access is by driveway from Colorado 72. The ridge top is relatively flat and easily accessed for fire-fighting or wood harvesting. On the north face of the ridge wood would have to be brought uphill to the drive. Most of the south face can be accessed from the driveway; in most cases, wood can be hauled downhill to the drive. There is a USFS trail immediately west of the property.

TOPOGRAPHY: The property stands on a ridge on the south side of Fourmile Creek. Elevation ranges from about 9000 feet above sea level east of the highway to about 9480 feet above sea level on the ridge at the west end of the property. Aspects are mostly

south on the south side of the ridge, north on the north side and flat on top. Slopes reaching 70% on the south face of the ridge.

GEOLOGY: Bedrock throughout the property is part of an unnamed Precambrian metamorphic unit about 1.8 billion years old.

North-northwest trending faults of Precambrian Age pass near the property but do not cross it. The nearest two provided weaknesses in the rock along which Ninety-seven Gulch and Winiger Gulch formed. These and other similar faults in the area, have occasionally been reactivated.

Lower Paleozoic rocks (Cambrian through Mississippian) are missing in this area. It is thought these rocks once existed, but were eroded away during Early Pennsylvanian times when the Boulder area was uplifted on the northeast flank of the Ancestral Front Range uplift, one of several northwest-trending mountain ranges that comprised the late Paleozoic Ancestral Rocky Mountains. These mountains (Ouachita Orogeny) resulted from the reactivation of Precambrian structures when Africa collided with South America and the southern edge of North America. Gravel and sediments washing off the Ancestral Front Range were deposited as the Fountain Formation which was later uplifted to form the Flatirons. By the late Paleozoic, the Ancestral Front Range was eroded to a set of low hills.

In the Early Cretaceous, the area began to subside and was eventually buried under almost 10,000 feet of marine sediment.

In the Late Cretaceous-Early Tertiary (about 67.5 million years ago), the Laramide Orogeny uplifted a mountain range with much the same configuration as the present day Front Range. Erosion about balanced uplift so that the relief was never great, much less than at present. By the Late Eocene, the uplift ceased, leaving a low-profile range of hills. Most of the faulting and eastward tilting that raised the Flatirons into position occurred during the Laramide Orogeny.

Intrusive volcanic activity occurred to the east during the Paleocene, but apparently did not involve this property.

During the Oligocene, this region was reduced to a plain, similar to eastern Colorado today with an elevation of about 3000 feet. In the Miocene, thermal uplift and east-west expansion formed the Rio Grande Rift and began the rise of the modern Front Range, which continues to rise today.

Though this property was never glaciated, it came close (The Arapaho Moraine is a little over a mile to the west.). Sediment features in the Boulder area have been tied to recent glacial

episodes. Apparently, there is a connection between glacial advances and the creation of the piedmont gravel fans.

SOILS: Soil maps for western Boulder County have not been published; Natural Resource Conservation Agency agronomists are in the process of doing this at this time. I believe the soils on your property to be similar to the Juget Series.

Juget Soil Series¹

The Juget series is made up of shallow, somewhat excessively drained soils. These soils formed on mountain slopes and ridges in sandy residuum weathered from granite. Slopes are 9 to 55 percent. Elevations are 6,300 to 8,200 feet. At lower elevations the native vegetation is mainly ponderosa pine, and at higher elevations it is Engelmann spruce and Douglas-fir with an understory of grass. Annual precipitation is 18 to 24 inches. Mean annual air temperature is 43° to 46° F., and the frost-free season is about 80 to 120 days.

In a representative profile the surface layer, about 6 inches thick, is dark-gray very gravelly sandy loam. The underlying material, about 5 inches thick, is brown very gravelly loamy sand. Underlying this layer is granite. Soil reaction is slightly acid.

Juget soils have rapid permeability. Available water capacity for the profile is low. Roots can penetrate to a depth of less than 20 inches.

These soils are used mainly for grazing, although some areas with scattered trees are used for recreation, forestry and homesites. The grass cover must be maintained to help prevent erosion.

Representative profile of Juget very gravelly sandy loam, in Jug-et-Rock outcrop complex, 9 to 55 percent slopes, located 2,540 feet north and 650 feet east of the southwest corner of sec. 11, T. 1 N., R. 71 W.:

A1 - 0 to 6 inches, dark-gray (10YR 4/1) very gravelly sandy loam, black (10YR 2/1) when moist; weak, very fine, granular structure; soft, very friable; 60 percent gravel and stone; slightly acid; clear, smooth boundary.

C - 6 to 11 inches, brown (10YR 5/3) very gravelly loamy

¹Moreland, Donald E. and Moreland, Ronald C., Soil Survey of Boulder County Area, Colorado, USDA - Soil Conservation Service, Denver, 1975.

sand, dark grayish brown (10YR 4/2) when moist; massive; hard, friable; about 80 percent fine gravel; slightly acid; clear, wavy boundary.

R - 11 inches, hard granite bedrock.

The A1 horizon ranges from 4 to 8 inches in thickness and very gravelly sandy loam to very gravelly loamy sand in texture. Depth to bedrock ranges from 10 to 20 inches. The average rock fragment content of the soil ranges from 50 to 70 percent and is dominantly fine gravel.

Juget-Rock Outcrop Complex, 9 to 55 percent slopes (JrF). - This complex is made up of about 50 percent Juget very gravelly sandy loam and about 30 percent rock outcrop. The profile of the Juget soil in this complex is the one described as representative of the Juget series.

Included with this complex in mapping are small areas of Peyton soils near drainageways and a few small areas of Allens Park soils. These included soils make up about 20 percent of each mapped area.

Runoff is rapid on this complex. The erosion hazard is high. Juget soils take in water rapidly, but they retain only limited amounts for plant use because of their shallow depth to bedrock.

None of this complex is suitable for cultivation. It is in grass and scattered trees and shrubs. In the past, it was used for grazing livestock and for forestry, but now many areas are used for homesites, recreational purposes, and wildlife habitat. (Capability unit viis-1, nonirrigated; tree suitability group 2)

HISTORICAL LAND USE: The section line running through your property was surveyed in October, 1874 by J. P. Maxwell. Survey records indicate a trail going up the ridge across what is now your property. The old Sunnyside townsite is located in the northeast quarter of Section 23, apparently in the low saddle where the highway cut on the north side of Fourmile Creek is now.

A study of fire scars on nearby property indicates a history of fire in this area. A number of residual trees survive from this time. Fire scars indicate a fire about 1853. According to local legend, Arapahos angered at being cheated by whites, burned most of Boulder County. (A more likely explanation is that settlers were extremely careless with fire and dozens of small fires left burning would coalesce during dry weather to go rolling off as a vast sea of flame.). The Boulder Canyon Fire of 1889 apparently burned this area, as well. The property was logged about this time, also. The lodgepole stands were established after the fire. The area has not been cut or burned since.

The property has been mined, but apparently nothing very profitable was found as the mines are no longer active.

DESIRED CONDITION: Healthy, vigorous, fully-stocked stands of trees are the objective of the Stewardship Incentives Program. This condition need not be achieved immediately, or even during the ten-year span of this plan, but progress must be made in this direction.

IMPACT ON NEIGHBORS & NEARBY COMMUNITIES: Dwarf-mistletoe control efforts on the north side of the hill will be readily visible from CO-72, except for limited screening by U. S. Forest Service trees. The lodgepoles along the highway at the south end of the property are not infected; at most, some light thinning is anticipated here. Cutting activities on the south side of the ridge will not be easy to see from the highway. Any cutting that might occur on the ridgetop will be screened from all directions by U. S. Forest Service trees; although the existing hiking trail is close enough that cutting will be visible through the trees.

A limited amount of firewood and poles will be made available to the Boulder firewood market. This should run between 7 and 10 cords per year until dwarf-mistletoe control is achieved. After that, the stand has the ability to continue producing at the same rate, but there is no immediate need to do so.

LOCAL MARKETS: Sawtimber markets in Boulder and vicinity are severely limited. Firewood markets are weaker than they were ten years ago, but still capable of handling 1200 to 1500 cords per year, possibly as much as 2000 cords. As long as firewood markets remain up to the task, cutting projects can be handled through commercial firewood sales, excepting timberstand improvement work on steep slopes.

WETLAND AREAS: There are no Federal wetlands on this property.

WILDLIFE: There were numerous red squirrel pine cone caches. Tracks of a male coyote, a fox and an elk were observed. There are numerous reports of a mountain-lion in the area. Several woodpecker nesting holes were observed.

Threatened and Endangered

The U. S. Fish and Wildlife Service lists the following species for Boulder County:

American peregrine falcon, Falco peregrinus, Endangered
Bald eagle, Haliaeetus leucocephalus, Endangered
Whooping crane, Grus americana, Endangered
Eskimo curlew, Numenius borealis, Endangered
White-faced ibis, Plegadis chihi, Category 2
Mountain plover, Charadrius montanus, Category 1
Northern goshawk, Accipiter gentilis, Category 2
Black tern, Chlidonias niger, Category 2
Mexican spotted owl, Strix occidentalis lucida, Threatened
Loggerhead shrike, Lanius ludovicianus, Category 2
Boreal toad, Bufo boreas boreas, Category 2
Black-footed ferret, Mustela nigripes, Endangered
Preble's meadow jumping mouse, Zapus hudsonius preblei,
Category 2
Fringed-tailed myotis, Myotis thysanodes pahasapensis,
Category 2
North American wolverine, Gulo gulo luscus, Category 2
Swift fox, Vulpes velox, Category 2
Greenback cutthroat trout, Oncorhynchus clarki stomias,
Threatened
Plains topminnow, Fundulus sciadicus, Category 2
Rocky Mountain capshell, Acroloxus coloradensis, Category 2
Regal fritillary butterfly, Speyeria idalia, Category 2
Lost ethmiid moth, Ethmia monachella, Category 2

The following plants are also listed:

Bell's twinpod, Physaria bellii, Category 2
Larimer aletes, Aletes humilis, Category 2
Ute ladies'-tresses orchid, Spiranthes diluvialis,
Threatened
Colorado butterflyweed, Gaura neomexicana coloradensis,
Category 1
Showy prairie gentian, Eustoma graniflorum, Category 2
Pale moonwort, Botrichium pallidum, Category 2
Purple lady's slipper orchid, Cypripedium fasciculatum,
Category 2

The peregrine falcon and bald eagle have been observed in Boulder County numerous times since 1987. The white-faced ibis has been observed just across the county line at Continental Pond in Weld County in the fall of 1994.

The purple lady's slipper has been observed several times since 1987.

The Mexican spotted owl occurred in Boulder County historically, but has not been seen here since the Threatened and Endangered Species Act was passed in 1973. The nearest known nest is located south of Denver in Douglas County. A detailed search of Coal Creek, Boulder and Lefthand canyons and their tributaries last summer failed to turn up anything.

The northern goshawk is favored by the many age classes of trees created by rotational cutting. As long as buffer zones are left around nests (30 acres) and cutting activities avoid a fledging area (400 acres) during the fledging season, there should be no problems. Though this bird may occur in Boulder County, I am not aware of it.

To the best of my knowledge, the black-footed ferret is listed only because its prey (prairie-dogs) is found here. I do not know of any sightings. The ferret is a creature of the plains and would not pose a problem for most mountain projects.

The whooping crane was included on the list because it might come here during migration. Again, I am not aware of any sightings. The same applies to the Eskimo curlew.

The Ute ladies'-tresses only occurs below 7000 feet; there is no need to worry about it at higher elevations.

The black tern is a shorebird and is a concern around creeks and reservoirs, but not in the mountains, away from water.

The black-footed ferret, preble's meadow jumping mouse, fringed-tailed myotis, Colorado butterflyweed and showy prairie gentian occur only in the plains. The mountain plover, northern goshawk, Mexican spotted owl and purple lady's slipper occur only in the mountains (except for a single spotted owl sighting in Adams County).

Other listed species could occur in either mountains or plains, especially areas where forest and prairie intermix.

Wildlife Habitat Opportunities:

There are a number of practices that could be implemented to enhance the property's usefulness to various species of wildlife. Several ideas are:

1. Create woodpecker and cavity-nesting bird habitat by killing selected trees and letting them stand. As these trees die, they are attacked by woodborers and other insects which provide food for woodpeckers. As the trees decay, woodpeckers build nests in them, providing housing for themselves and other cavity-nesting birds, such as flycatchers (Woodpeckers

are perfectionists; it takes them five or six tries before they get the hole just right; the extra holes are available for other animals to use.). Snags at least 10.0 inches in diameter are needed at a rate of 2.3 per acre in areas more than 300 feet from the meadows, this should be increased to at least 3.0 per acre (maximum of 7.0 snags per acre) near meadows.

2. There is little that can be done to benefit deer on a property this small. Forest management practices encourage deer, which encourage mountain-lions, which take deer, dogs, cats, an occasional jogger and have even been known to attack children. The following practices will benefit deer, as much as is possible, on a 33-acre property:
 - A. When the dwarf-mistletoe cuts are made, care must be taken not to produce openings larger than 300 feet across, and to leave cover strips at least 300 feet in width connecting sapling and pole stands.
 - B. Cutting should be done as quickly as possible to minimize animal disturbance. This restricts the choice of cutters to those capable of completing the project quickly and requires short-term cutting Agreements.
 - C. After all dwarf-mistletoe is removed from a portion of a stand, the cut patches should be allowed to restock themselves before harvest cutting of the adjacent stand begins so that adequate deer cover strips can be maintained (A patch is adequately stocked when a deer is 90% hidden at a distance of 200 feet.).
3. Meadows (both natural and artificial) can be used by western blue birds if there is adequate nesting cover nearby. Thinning work eliminates nesting trees, unless special efforts are made to preserve useable trees. These are snags located at 100-yard intervals around the perimeter of the cut. They are created by girdling selected trees: these trees must be at least ten inches in diameter; trunks must be sheltered by foliage from other trees; and there can be no tall grass or forbs around the stump.

It takes several years for a girdled tree to die and decay enough that woodpeckers will build nesting sites in it. In the mean-time nesting boxes should be put up. These should meet the same requirements for spacing and location as nesting trees.

4. Slash left over from timber cutting could be piled to create shelter for small animals ("bunny houses"). A few larger pieces will be needed to hold slash off the ground and permit access, so some three-to-six diameter material will need to

be preserved during cutting. These are constructed shelter piles and not just a haphazard pile designed more to make the site look nice than to provide animal cover.

In order to meet Stewardship requirements, at least one wildlife practice must be implemented (The practices listed are only suggestions; there are many others that could be chosen.). Cost-sharing will probably be available (The practices are not required if cost-sharing is not available.).

NOTE: The word "required" is misleading. SIP is a voluntary program; if you elect not to participate, nothing is required. If you elect to participate, the forester can handle the requirements by simply making sure that practices are cost-shared in order of program priority. The only requirement that may be a problem is the one to maintain the practice for a period of ten years. For further information, ask your forester.

INVENTORY: The entire property is in the transition zone between the ponderosa pine/Douglas-fir/Arizona fescue, and Engelmann spruce/subalpine fir ecotypes. Lodgepole pine is a seral stage within this type.

Stand A (0.4 acres) is a lodgepole pine stand in the northwest corner of the Klondike Mineral Claim, isolated by the intervening Dewey Mineral Claim. It consists exclusively of small-pole lodgepole pines. Because of uncertain boundaries, I could not tell the degree of dwarf-mistletoe infection. The need to cross the Dewey to access this area may be a problem. Stocking is about 8 cords. Basal area exceeds 130 square feet per acre.

Stand B (8.1 acres) is a lodgepole pine small pole stand consisting of the Lost Friend Extension and the balance of the Klondike. The site is relatively level and easily worked. It is proposed as a future house site. Defensible Space practices will be required by Boulder County Land Use as a condition of approving the occupancy permit (This Defensible Space practice, being required by law, is not eligible for cost-sharing.). Stocking is about 150 cords with basal area running about 130 square feet per acre.

The lodgepole pines are infected with lodgepole pine dwarf-mistletoe which infects about one-quarter of the stand. With the lodgepoles both stagnant and infected with dwarf-mistletoe, they are, in effect, at financial maturity now. The standard prescription is to remove the infected patches of lodgepole. This, however, cannot be done all at once without undesirable consequences to the aesthetic qualities of the stand. Also, lodgepole

pine does not regenerate well in openings more than 100 feet wide.

The solution to the problem is to cut small patches (0.3 acres per year), none of which is more than 100 feet wide. The cut area should then be completely freed of dwarf-mistletoe either by removing all host trees, or by reduction (pruning the stand free of dwarf-mistletoe infections in at least three consecutive years). Adjacent stands should not be cut until new seedlings are established in the cutover area (at least five years, probably seven or eight). This will require cutting blocks in at least three non-contiguous areas.

Stand C (18.7 acres) is a lodgepole pine stand. It is the same stand as A & B, but is isolated from them by intervening U. S. Forest Service land. Stocking levels, dwarf-mistletoe and management considerations are the same as Stands A & B.

Stand D (3.1 acres) is an immature aspen stand. It is about thirty years old and should not be cut until it is at least eighty. Stocking is about eight cords per acre, due to small size.

Note: Aspen stands are harvested by clearcutting. This is due to (1) aspen's prolific sprouting capability which is most active in direct sunlight, but is considerably reduced by the presence of residual trees, making the stand easier to regenerate when it is clearcut, and (2) aspen's thin bark which is easily wounded in felling and skidding operations. The wounds are infected by stem cankers (fungus diseases) which then kill and/or deform the stem, rendering the tree useless (Fifty percent mortality usually occurs at about 12 years following cutting.).

Stand E (3.3 acres), though listed as a mixed conifer stand, is better described as a lodgepole pine/aspen stand. It is located on the east side of CO-72. Dwarf-mistletoe is present, but because of the property's long, narrow shape, reinfection from adjoining USFS land would occur and control would be difficult to achieve. Stocking is about 30 cords and 110 square feet of basal area.

SILVICULTURAL OBJECTIVES: Over a forty-year time span, the lodgepole stands will be freed of dwarf-mistletoe and regenerated. This will result in much of the stands becoming over-mature, but this is deemed an acceptable trade-off.

To prevent pure lodgepole stands developing following cutting, ponderosa pine (90 per acre) and Douglas-fir or white fir (30 per acre) will be planted in the openings created.

Dead aspen stems may be removed by bucking into firewood-sized pieces and hauling them out of the stand by hand. This will reduce injuries from cutting work and resulting canker infections. This is labor-intensive and will cost more than the wood is worth. Because of the cost of hand work and the damage that will result from commercial cutting, I recommend against any activities in the aspen stand.

IMPLEMENTATION SCHEDULE:

- 1997: Remove dwarf-mistletoe-infected trees from one-acre area (Block 1997) to be determined by owner (I suggest the northwest corner if access can be obtained.). This should be done commercially through a firewood sale, if possible.
- 1998: Complete cutting activities for Block 1997. This includes the first dwarf-mistletoe cleaning of infected trees. (An initial dwarf-mistletoe cleaning can be cost-shared [65% of actual cost up to \$200 per acre] through SIP. Also, there are a number of ways to obtain both Federal and State income tax advantages for forestry work. We need to discuss this in more detail.
- 1999: 1. Plant 90 ponderosa pines and 30 white firs in Block 1997. Use weed barrier to enhance survival and growth. (Planting is also eligible for cost-sharing and special tax treatment of expenses.)
2. Conduct second dwarf-mistletoe cleaning of Block 1997. (Second third and fourth cleanings are eligible for 65% of cost, up to \$47 per acre.).
- 2000: 1. Conduct third dwarf-mistletoe cleaning of Block 1997.
2. Remove dwarf-mistletoe-infected trees from one-acre area (Block 2000) to be determined by owner (I suggest the southeast corner; Block 2000 follows the same treatment regime as Block 1997, but three years behind Block 1997.).
- 2001: 1. Conduct fourth dwarf-mistletoe cleaning of Block 1997. If the first three cleanings were thorough, this will be only an inspection. Dwarf-mistletoe inspections/cleanings should continue until three consecutive years have passed with no dwarf-mistletoe found.
2. Conduct first dwarf-mistletoe cleaning of Block 2000.
- 2002: 1. Conduct fifth dwarf-mistletoe cleaning of Block 1997, if needed.

2. Plant Block 2000.
 3. Conduct second dwarf-mistletoe cleaning of Block 2000.
 4. Update this plan. "The best-laid plans of mice and men...." Things often get off track; cutters go broke and can't finish the job; land is added to the original tract, etc. This is mostly just a discussion between landowner and forester about what direction management should take, with the results documented.
- 2003:
1. Conduct sixth dwarf-mistletoe cleaning of Block 1997, if needed.
 2. Conduct third dwarf-mistletoe cleaning of Block 2000.
 3. Remove dwarf-mistletoe-infected trees from one-acre area (Block 2000) to be determined by owner (I suggest the Klondike and/or Friend.).
- 2004:
1. Conduct seventh dwarf-mistletoe cleaning of Block 1997, if needed.
 2. Conduct fourth dwarf-mistletoe cleaning of Block 2000, if needed.
 3. Conduct second dwarf-mistletoe cleaning of Block 2003.
- Note: all-lodgepole pine blocks will be regenerated naturally, so as to avoid the expense of planting.
- 2005: Conduct dwarf-mistletoe cleanings in each block, each year, if needed.
- 2006:
1. Conduct dwarf-mistletoe cleanings in each block, each year, if needed.
 2. Prepare a new SIP plan. This is a requirement of SIP, but only if it has been less than ten years since the last cost-shared practice. With the Congressional budget ax falling hither and yon, SIP may not last ten years.

Forester's Note:

This plan assumes at least eleven acres of dwarf-mistletoe-infected lodgepole pines. If, in fact, there are fewer infected acres, the cutting rate should be reduced, as soon as the infected areas have been treated.

Should major portions of the property be infected, this cutting and cleaning rate will free the stands of dwarf-mistletoe over a 40-year time span (Long enough for new seedlings

to become established and reach heights exceeding thirty feet; a visitor in 2033 will not readily be able to tell there has been an ongoing cutting and replanting program in operation for 40 years.).

Most of these practices are eligible for tax benefits under the Internal Revenue Code, as well as cost-sharing money under the Stewardship and/or Forestry Incentives Programs. For example, reforestation is currently eligible for both the 10% investment credit and a deduction from income (7-year term, half-year convention, straight-line amortization). The forester can provide some information at the time; see your tax preparer for details.

SUMMARY:

Although profits will be small (Most "profits" will be reinvested in tree planting projects.), with the help of cost-sharing programs, and tax benefits, this property can produce forest products and recreation and serve as a house site.

For many years to come, you can enjoy your forest and at the same time, obtain a modest return on it. With people like you taking care of our forests, their well-being is assured.

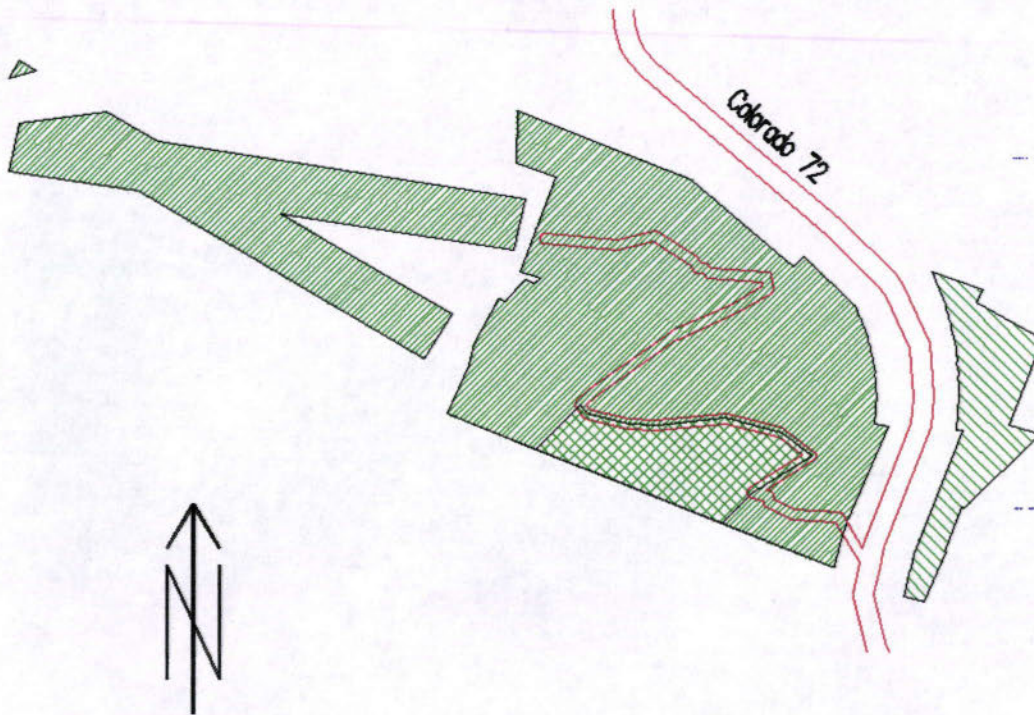
Thank you.

Respectfully submitted by,



Douglas J. Stevenson
Assistant District Forester

Scale: 1:6749; 1 Inch = 562 Feet



Merlin Williams

E1/2, Section 23, T1N, R73W, S.P.M.

W1/2, Section 24, T1N, R73W, S.P.M.

— Property Line
== Road

▨ Lodgepole Pine
▧ Mixed Conifer
▩ Aspen

Drawn By: Douglas J. Stevenson

April 14, 1997

QUAKING ASPEN (Populus tremuloides Michx.)²

BOTANICAL FEATURES

Leaves 1½" to 3" in diameter; shape suborbicular to broadly ovate; margin finely crenate-serrate; apex acute to acuminate; surfaces somewhat lustrous, green and glabrous above, duller and glabrous below; petioles laterally flattened³, ½" to 3" long; especially in the var. aurea, the leaves turn a bright yellow in the autumn.

Fruit about ¼" long, narrowly conical, curved; seeds about 3,600,000 to the pound.

Twigs slender, lustrous, reddish brown; terminal buds conical, sharp-pointed, sometimes very slightly resinous, covered by 6 to 7 visible, reddish-brown, imbricated scales; lateral buds incurved, similar to the terminal buds but smaller.

Bark smooth, greenish to white to cream-colored, at length furrowed, dark brown or gray, often roughened by numerous wartlike excrescences.

GENERAL DESCRIPTION

Quaking aspen is the most widely distributed tree of North America. It is fast growing, relatively shortlived, and commonly attains heights of 50 to 60 ft and diameters of 1 to 2 ft (max. 120 by 4½ ft⁴). This tree is very intolerant and under competition develops a long, clear bole and small rounded crown. The root system is widespreading, and sometimes surface roots may extend as far as 80 ft from the base of the tree. Depending upon soil depth, other roots may go down 3 to 5 ft or more. Over its vast range, quaking aspen is found on many types of soil from moist loamy sands to shallow rocky soils and clay.

In old-growth forests, this species occurred as a scattered dominant tree, or along the edges of openings or water courses where there was sufficient light. Logging and subsequent fires usually destroyed the organic litter over wide areas and exposed mineral soil. Such sites are favorable to aspen, a prolific seeder, and

²Harlow, William M. and Harrar, Ellwood S. Textbook of Dendrology, Fifth Edition, McGraw-Hill, New York, 1968.

³On young sprouts the petioles are often nearly terete, and the leaf shape is like that in balsam poplar.

⁴P. E. Packer reported a tree of this size growing in the Manti National Forest, 28 miles west of Castle Dale, Utah.

extensive pure stands of this species spring up and serve as a cover for the more tolerant northern conifers and hardwoods which develop slowly beneath this semi-open canopy. After 30 years or more, competition becomes excessive, much of the aspen dies, and the relatively few trees which are left maintain a position of dominance over the dense growth of other species below. In the Lake States, these include the northern pines, spruces, and balsam fir, which in turn are finally replaced by hemlocks and maples. Other aspen associates are many, including bigtooth aspen, paper birch, and balsam poplar, and in the west Douglas-fir, lodgepole pine and white fir.

Unless managed, the pioneer stand of aspen is transient, and although some individual trees may reach an age of 150 years (200 in the west⁵, most Lake States aspen over 60 years old is not worth harvesting because of its rapid deterioration⁶. At least 500 organisms from deer and beaver to insects, fungi, and viruses feed upon aspen.

When aspen stands are cut, innumerable root suckers grow quickly from the shallow roots and form dense new forest. In Michigan, Minnesota and Wisconsin, there are extensive areas of aspen forests which are especially valuable for pulpwood production.

RANGE

Transcontinental through Canada, northern United States, and western mountains.

BLUE SPRUCE, SILVER SPRUCE (Picea pungens var. argentea Engelm.)⁷

Those who are familiar with the shapely and beautiful silvery-blue ornamental varieties of this species would scarcely recognize the blue spruce in its central Rocky Mountain domain. Found on the middle and upper slopes, and sculptured by gale-force winds and heavy snows, the trees often bear little resemblance to the carefully nurtured specimens of park and dooryards. Even the foliage, except for a brief time in early spring when the needles are coated with a powdery waxy bloom, is dull dark green to blue-green with only an occasional tree silvery. The blue spruce of-

⁵Boyd R. Strain reported an aspen from California's White Mountains that reached an age of 226 years, but a height of only 39 feet; this seems to be the record age for an individual tree.

⁶In Colorado, aspen reaches financial maturity at 80 years.

⁷Harlow, William M. and Harrar, Ellwood S. Textbook of Dendrology, Fifth Edition, McGraw-Hill, New York, 1968.

ten resembles the Engelmann spruce, with which it is sometimes associated at the lower elevations. Since both species may be seen as ornamentals outside their natural range, the following comparisons may be useful.

TABLE OF COMPARISON

Feature	Blue spruce	Engelmann spruce
Needles	Sharp, extending at angles to the twig; when chewed, have a sharp, acid, pungent taste	More or less blunt, usually pointing forward; lacking a sharp acid taste
Twigs	Essentially glabrous	More or less pubescent
Bud scales	Reflexed	Usually appressed
Cones	About 3" long, scales often narrow	1" to 2½" long, scales relatively broad
Form	Branch arrangement gives crown a layered appearance	Crown not layered

This species and several of its varieties, because of their habit, beautiful foliage, and ability to withstand drought and extremes of temperatures, are highly prized ornamentals in many parts of the United States.

RANGE

Yellowstone National Park near the Montana state line and northwestern Wyoming, south along the mountains to south-central New Mexico; in the West, south through extreme eastern Idaho, central Utah, and central Arizona to southeastern Arizona. Altitudinal distribution: 6,000 to 9,000 ft in the North, 8,000 to 11,000 ft in the South.

DOUGLAS-FIR (Pseudotsuga menziesii (Mirb.) Franco⁸)

BOTANICAL FEATURES

Leaves $\frac{3}{4}$ " to $1\frac{1}{4}$ " long, yellow-green or blue-green, more or less flattened, standing out from all sides of the twig or with a tendency to be somewhat 2-ranked; apex rounded-obtuse or rarely acute, stomatiferous below, persistent for 8 or more years.

Cones 3" to 4" long, pendent, ovoid-cylindric, with exserted, 3-lobed, forklike, appressed or strongly reflexed bracts; seeds triangular, terminally winged; about 42,000 seeds to the pound, dewinged.

Buds fusiform, sharp-pointed, lustrous brown.

Bark on young stems smooth except for resin blisters; at length becoming 6" to 24" thick on old trees, and then divided into thick reddish-brown ridges separated by deep irregular fissures. In a few instances the bark is "tight" (fine-textured) on old trees and corky on others, particularly those of the mountain form.

GENERAL DESCRIPTION

Douglas-fir, monarch of Pacific Northwest forests, was first observed by Menzies on Vancouver Island when he accompanied the British naval captain Vancouver on an expedition to the Pacific Coast in the early 1790s. For more than a quarter of a century this tree was variously classified as a spruce, hemlock, true fir, and even as a pine; in fact logs exported by the Hudson's Bay outpost near the mouth of the Columbia River were listed in European ports as "Oregon pine," a name which has persisted in the trade to this day, especially in Australia. It remained for David Douglas, a Scottish botanist sent out by the Royal Horticultural Society in 1825, to study this tree, to show that it was sufficiently different to be considered as separate from other previously described conifers; later Carrière coined the new generic name Pseudotsuga. This name was a rather unfortunate choice, since it literally means "false hemlock." The common name, Douglas-fir (The names red fir and yellow fir have been used by loggers and lumbermen to differentiate locally certain specimens on the basis of ring width, color and softness.), commemorates Douglas, and in addition serves to distinguish this species from the true fir (Abies).

Douglas-fir is a dimorphic species with two more or less distinct forms (Several European workers have claimed that there are three species of Douglas-fir; this is based largely upon needle struc-

⁸Harlow, William M. and Harrar, Ellwood S. Textbook of Dendrology, Fifth Edition, McGraw-Hill, 1968.

ture. Studies by W. E. Kilgore at the New York State College of Forestry have failed to substantiate this viewpoint.). One of these is restricted to the forests of the Pacific slope, and the other to those of the Rocky Mountain region.

The Rocky Mountain form of Douglas-fir is considered distinct from the coast form by some taxonomists, who accordingly classify it as Pseudotsuga glauca Mayr. or Pseudotsuga menziesii var. glauca (Beissn.) Franco. However, in certain sections, the two types intergrade. Usually the foliage of the Rocky Mountain tree is blue-green, but sometimes trees with blue-green foliage and others with yellow-green leaves are found standing together. Similarly, although yellow-green crowns are typical of the coast form, some trees show a blue-green coloration. The principal botanical difference between these two forms lies in the structure of their cones. Rocky Mountain trees have small cones rarely 3 inches in length, with much-exserted and strongly reflexed bracts. By contrast, the cones of the coast form are often 4 in. long and have straight, more or less appressed bracts.

Douglas-fir comprises about 50 percent of the standing timber of our western forests. It produces more timber than any other American species and at the present time furnishes about one-fifth of the total annual cut.

ROCKY MOUNTAIN FORM

The Rocky Mountain form of Douglas-fir rarely exceeds a height of more than 130 ft or a diameter of 3 ft. It occurs in both pure and mixed stands with ponderosa pine, western larch, and grand fir. Other associates include western hemlock, western white and lodgepole pines, Engelmann spruce, white fir and aspen. Douglas-fir is more tolerant than these except the hemlock and spruce.

Although most abundant on moist sites, Rocky Mountain Douglas-fir is quite drought resistant and is often found on arid areas with ponderosa pine. It is frost-resistant and hardy in the East and is a common ornamental of that region. The trees are grown for timber in Europe and have been planted successfully in many parts of the world.

RANGE

Western United States and British Columbia. Altitudinal distribution: sea level to 5,000 ft along the coast; 4,000 to 6,000 ft inland; 10,000 ft in the southern Rocky Mountains.

ENGELMANN SPRUCE (Picea engelmannii Parry)⁹

BOTANICAL FEATURES

Leaves 1" to 1½" long, linear, 4-sided, blue-green, flexible, apex often blunt; exhaling a rank odor when crushed; often somewhat appressed and tending to point toward the tip of the twig.

Cones 1" to 2½" long, ovoid-oblong; scales thin and somewhat papery, wedgeshaped, and commonly erose at the apex; seeds ⅛" long, nearly black; wings about ½" long, oblique; about 135,000 (69,000-200,000) seeds to the pound, dewinged.

Twigs more or less pubescent, light brown to gray; bud scales more often appressed than in blue spruce.

Bark very thin, broken into large purplish brown to russet-red, thin, loosely attached scales.

GENERAL DESCRIPTION

The name of this spruce commemorates Dr. George Engelmann, noted German-American physician and botanist of the middle nineteenth century.

Engelmann spruce is typically a mountain species and under favorable conditions for growth attains a height of from 100 to 120 ft and a d.b.h. of 18 to 30 in., although somewhat larger trees (max. 165 by 6 ft) occur on the best sites. Its general habit is quite similar to that of Sitka spruce, and like that species, it reaches its maximum size on deep, rich, loamy soils of high moisture content.

Besides occurring in extensive pure stands, Engelmann spruce is found with other species comprising some 14 recognized forest types. The most common associate is subalpine fir. Through the central Rocky Mountains, lodgepole, limber, and whitebark pines, Douglas-fir and quaking aspen may also be included. Where the ranges of Engelmann and white spruce overlap, a confusing array of natural hybrids is to be found. Both Colorado blue and Sitka spruce also produce hybrids with this species.

Engelmann spruce produces large crops of seed every 3 to 6 years. Germination is particularly high (up to 97 percent) in beds of moist mineral soil, although seedling development is also good in moist duff soils covering the floor of virgin forests. A few trees are also traceable to layering, but individuals produced in this way never attain commercial proportions.

⁹Harlow, William M. and Harrar, Ellwood S., Textbook of Dendrology, Fifth Edition, McGraw-Hill, New York, 1968.

This spruce is tolerant, and among its common associates is exceeded only by subalpine fir and the hemlocks. Trees of all ages are often found under the canopy of old trees, and individuals often suppressed for 50 to 100 years quickly recover upon being released. Growth is restricted by a short summer season; and trees 16 to 22 in. in diameter are often 350 to 450 years of age. The average maximum age for Engelmann spruce appears to be in the neighborhood of 400 years. Occasional trees over 500 years of age have been reported, and Bates (Colorado Forester, 1926) observed one stem with 660 growth rings.

Periodic outbreaks of the Engelmann spruce bark beetle have been extremely damaging to mature stands in the central Rocky Mountain region. The bark is thin even on old trunks, and fires cause extensive damage.

RANGE

Rocky Mountains, Cascade Mountains, and northeastern California. Altitudinal distribution: 1,500 to 12,000 ft in British Columbia, the Cascades, and northern Rockies; 9,000 to 11,000 ft through the central Rockies; and 10,000 to 12,000 in the southern Rockies.

LIMBER PINE (Pinus flexilis James)¹⁰

DISTINGUISHING CHARACTERISTICS

Needles in 5's about 2½" long, clustered near the branch ends, dark green, stout, rigid, stomatiferous on all surfaces; resin canals dorsal. **Cones** 3 to 10 in. long, cylindrical, the scales thickened, and slightly reflexed at the apex; seeds large, with rudimentary wings or wingless. **Bark** on young stems smooth, silvery white to light gray or greenish gray; that on old trunks dark brown to nearly black, separated by deep fissures into rectangular to nearly square, superficially scaly plates or blocks.

GENERAL DESCRIPTION

Limber pine was first observed near Pike's Peak by Dr. Edwin James, an army surgeon attached to Long's Mountain Expedition of 1820. Like other relatively inaccessible trees of high altitudes, limber pine is primarily of importance in protection of valuable watersheds. Ordinarily the tree attains but small proportions, varying from 30 to 50 ft in height and from 15 to 24

¹⁰Harlow, William M. and Harrar, Ellwood S., Textbook of Dendrology, Fifth Edition, McGraw-Hill, New York, 1968.

in. d.b.h. (max. 85 by 7 ft). The bole is stout, noticeably tapered, and supports a number of large plumelike often drooping branches. The result is an extensive crown which not infrequently reaches to within a few feet of the ground. Young trees develop a long, sparsely branched taproot which is later supplemented by several laterals.

RANGE

East slopes of the Rocky Mountains in southern British Columbia and southern Alberta, south along the mountains to Arizona and New Mexico; west to the mountains of southern California, and north along the Sierra Nevada to northern California; east through Nevada and Idaho (one outpost is found in the Black Hills of South Dakota). Altitudinal distribution: 4,000- to 10,000-ft elevation in Montana, Wyoming, and Idaho; 4,500 to 11,500 ft in Colorado; 8,000 to 11,800 ft in southern California.

LODGEPOLE PINE¹¹ (Pinus contorta Dougl.)¹²

BOTANICAL FEATURES

Needles 1" to 3" long, in 2's or rarely solitary, dark green to yellow-green, often twisted, persistent until the 4th to 6th seasons; resin canals 2, medial; epidermal cells somewhat square in cross section.

Cones ¾" to 2" long, subcylindric to ovoid, asymmetrical at the base, occasionally opening at maturity but often remaining closed for many years; apophysis tawny to dark brown, flattened, or those toward the base knoblike; umbo dorsal, terminating in a long, recurved, often deciduous prickle; seeds about 1/6" long, ovoid, reddish brown, often mottled with black; wings ½" long; about 135,000 (111,000-165,000) seeds to the pound, dewinged.

Twigs moderately stout, dark red-brown to nearly black; buds ovoid, slightly resinous.

Bark of coastal trees ¾" to 1" thick, deeply furrowed and transversely fissured, reddish brown to black and superficially scaly;

¹¹So called because of its use for poles by the Plains Indians. The lodge or tipi with its movable smoke flaps and symbolic decorations is perhaps the most functional and beautiful dwelling ever designed by nomadic man.

¹²Harlow, William M. and Harrar, Ellwood S., Textbook of Dendrology, Fifth Edition, McGraw-Hill, 1968.

that on mountain trees about $\frac{1}{4}$ " thick, orange-brown to gray, covered by thin, loosely appressed scales.

GENERAL DESCRIPTION

Lodgepole pine is a cosmopolitan tree of wide distribution through western North America. Two distinct forms of the species are recognized.

Shore pine. This is a small tree ordinarily 25 to 30 ft high and 12 to 18 in. in diameter. It is characterized by a short, often contorted bole and a dense, irregular crown of twisted branches, many of which extend nearly to the ground; the root system is deep, wide-spreading, and includes a persistent taproot, even when growing in bogs or muskegs. The tree is one of the first to invade the peat bogs of Alaska and British Columbia, as well as those of the Puget Sound basin in western Washington where it may form pure stands. Farther south it is found most abundantly on dry sandy and gravelly sites near the Pacific Ocean to northern California. Here it sometimes mingles with Sitka spruce and occasionally with grand fir. Because of their small size and poorly formed boles, the trees of the coastal form contribute little or nothing to the nation's timber supply. Large stands occasionally retard the migration of sand dunes, but smaller ones have been completely buried by shifting sands.

Lodgepole pine. This form, by contrast, is a medium-sized tree 70 to 80 ft high and 15 to 30 in. in diameter (max. 150 by 6 ft), with a long, clear, slender, cylindrical bole and short, narrow, open crown. Best development is attained on a moist but well-drained sandy or gravelly loam, although trees reach commercial proportions on a variety of soil types. Unlike the shore pine, which is seldom found far from tide water, the lodgepole pine occurs from 1,500 to 11,500 ft of elevation in either pure dense even-aged stands or in mixture with several other conifers. At the lower limits of its altitudinal range its associates are ponderosa and other western pines, Douglas-fir and western larch. At higher levels it is found chiefly with Engelmann spruce, subalpine fir, and limber pine in the Rockies; and with limber pine, Jeffrey pine, and California red fir in the Sierra.

This form is one of the most aggressive and hardy of western forest trees and under favorable conditions is capable of fully restocking cutover lands in a remarkably short time. Following fire it quickly forms dense stands and occasionally usurps areas formerly occupied by Douglas-fir, or at higher levels by Engelmann spruce.

The gregarious habit of this species is traceable to a number of factors. The trees are prolific seeders and often produce fertile seed before they are ten years of age. Heavy seed crops occur at intervals of two or three years, but instead of releasing all of the seed at maturity, many of the cones remain closed

and attached to the branches for as long as 15 to 20 or more years. When the cones remain closed, large quantities of seed are gradually accumulated. The heat of a forest fire sweeping through the stands starts the opening of the cones. After the fire has passed, the scales open fully and release their seeds upon the freshly exposed mineral soil.¹³ The subsequent reproduction is often so dense that it quickly stagnates. Under normal conditions, growth is rather slow but persistent, and maturity is attained in about 200 years with a maximum of 500 to 600 years. According to Hanzlik, trees 100 years of age in the Blue Mountains of southern Oregon average 70 to 80 ft in height and 12 in. in diameter, while trees of the same age in the Sierra are 90 to 100 ft high and 15 to 18 in. in diameter. Lodgepole pine is rated as intolerant.

RANGE

Western North America. Altitudinal distribution: sea level to 2,000 ft in Alaska and British Columbia, sea level to 6,000 ft in Washington and Oregon, sea level to 11,500 ft in California, 6,000 to 11,000 ft in the Rocky Mountains.

PONDEROSA PINE (Pinus ponderosa Laws.)¹⁴

BOTANICAL FEATURES

Needles in 3's, or 2's on the same tree, 5" to 11" long, dark gray-green to yellow-green, flexible, persistent until the 3rd season. Crushed needles have a turpentine odor similar to that of most other pines.

Cones 3" to 6" long, ovoid to ellipsoidal, sessile, solitary or clustered; usually leaving a few basal scales attached to the twig, when shed; apophysis dark reddish brown to dull brownish yellow, transversely ridges and more or less diamond-shaped; umbo dorsal, with a slender, often deciduous prickle; seeds ¼" long, ovoid, slightly compressed toward the apex, brownish purple; wings moderately wide, about 1" long; about 12,000 (6,900-23,000) seeds to the pound.

¹³According to Enos Mills, a camping party once built a fire against a solitary lodgepole pine. The tree was killed, as shown by the subsequent loss of its needles. Four years later, a long tattered green pennant, formed by thousands of lodgepole pine seedlings, showed on the mountainside. This pennant, varying in width from 10 to 50 ft., began at the tree and streamed out for more than 700 ft. from its base.

¹⁴Harlow, William M. and Harrar, Ellwood S., Textbook of Dendrology, Fifth Edition, McGraw-Hill, 1968.

Twigs stout, exhaling a turpentine odor when bruised; buds usually covered with droplets of resin.

Bark brown to black and deeply furrowed on vigorous or young trees (bull pines); yellowish brown to cinnamon-red and broken into large flat, superficially scaly plates separated by deep irregular fissures on slow-growing and old trunks.

GENERAL DESCRIPTION

This is the most important pine in western North America, and in the United States is found in commercial quantities in every state west of the Great Plains. At present it furnishes more timber than any other American pine and in terms of total annual production of lumber by species is second only to Douglas-fir.

Ponderosa pine is a large tree 150 to 180 feet high and 3 to 4 ft in diameter (On the best sites, 300-year-old dominant trees average about 175 ft high and 48 in. d.b.h.) (max. 262 by 8.6 ft). Even though this species commonly forms open parklike forests, the boles are ordinarily symmetrical and clear for one-half or more of their length; short conical or flat-topped crowns are characteristic of old trees. Four-year-old trees may have tap-roots four to five feet long. Moderately deep wide-spreading laterals develop as the trees get older. Ponderosa pine is not exacting in its soil requirements, but trees on thin, dry soils are usually dwarfed. Its occurrence on dry sites with the nut pines and certain of the junipers is indicative of its great resistance to drought. This species attains its greatest development, however, on the relatively moist but well-drained western slopes of the Siskiyou and Sierra Nevada Mountains of southern Oregon and California, respectively.

Ponderosa pine occurs in pure and mixed coniferous stands. Excellent pure forests are found in the Black Hills of South Dakota, the Blue Mountains of Oregon, the Columbian Plateau northeast of the Sierra Nevada, and in northern Arizona and New Mexico. It is also commonly the most abundant tree in mixed coniferous stands; east of the summit of the Cascade Range in Washington and Oregon it occurs with western larch, Douglas-fir, and occasionally lodgepole pine; in the central Rocky Mountains with Douglas-fir; and in California with Jeffrey and sugar pines, incense-cedar, Douglas-fir, and white fir. On the Fort Lewis plains in western Washington, near Puget Sound, ponderosa pine is occasionally found in association with Douglas-fir and Oregon white oak.

Small quantities of seed are produced annually, but large crops are released only at intervals of three to five years. Under forest conditions germination as high as 50 percent may be anticipated, but in the nursery this figure can be increased to 80 percent. Seedlings can exist under the canopy of the parent

trees, even though they grow quite slowly, and in such conditions often attain a height of only 3 to 4 ft during the first 15 to 20 years. Reproduction is best in clearings made by fire or logging. The seedlings will grow on sterile sites and have been planted extensively in the Nebraska sand hills and elsewhere. Ponderosa pine is classed as intolerant.

The rapidity of growth has a marked effect on the general appearance of the trees of this species. Young, vigorous specimens commonly develop dense crowns of dark foliage, and bark which is dark brown to nearly black, more or less corky, and deeply furrowed. In contrast, the foliage of old-growth or slow-growing trees is yellow-green, and the bark yellow-brown to cinnamon-red and plated. Those of the first type are generally called "bull" or "blackjack pines," and to some woodsmen ponderosa pine and bull pine are different trees. Fast-growth bull pines 150 years of age found near Cle Elum, Washington, measured 30 to 40 in. in diameter, while more typical ponderosa pines occurring in the same vicinity were only 10 to 14 inches in diameter at the same age. The growth of this species varies considerably with locality. In California, trees 120 years of age averaged 23 in. d.b.h., while in Arizona trees of the same age were only 16 in., and in the black hills 10½ in. Trees over 500 years of age are seldom encountered (Keen considers that this pine may reach an age of 800 years, while Mills reported a tree in southwestern Colorado with 1047 rings.). Severe damage is caused by bark beetles, and ponderosa pine is also attacked by more than 100 other kinds of insects. Fires kill seedlings and cause considerable damage even to large trees. Severe fires in the past have completely destroyed hundreds of thousands of acres of ponderosa pine forest. Other destructive agents include mistletoe and fungi.

The common name ponderosa pine is identical with the species name. Previously called western yellow pine, logs of this tree were also sold under such names as Arizona white pine, California white pine, and western soft pine, since the wood resembles that of the white pines rather than that of the hard, moderately heavy wood of the southern yellow pines. Finally, the name ponderosa pine was adopted by the U. S. Forest Service, and it is now accepted by the industry.

RANGE

Western North America. Altitudinal distribution: 5,000 to 8,000 ft in Arizona, 3,300 to 6,000 ft in Montana and South Dakota, 2,000 to 7,000 ft in northern Idaho, sea level to 6,200 ft in British Columbia and Washington, sea level (Columbia River Valley) to 7,000 ft in Oregon, 300 to 7,000 ft in northern California, 4,000 to 9,000 ft in southern California; for the most part a tree of relatively low elevations.

DWARF-MISTLETOE¹⁵**Quick Facts**

Dwarf mistletoe causes a serious forest problem in many parts of Colorado.

Hosts for mistletoe include most members of the pine family.

The seeds of mistletoe are dispersed in August and early September.

The ultimate effect of dwarf mistletoe is premature death of the affected tree.

Dwarf mistletoes (Arceuthobium spp.) are a major problem in Colorado forests on ponderosa and lodgepole pine. Other members of the pine family, Douglas-fir, pinyon and limber pine are damaged occasionally. Nursery and ornamental plantings seldom are attacked; however, this parasite can be introduced into an area by the planting of collected stock infected with dwarf mistletoe.

Dwarf mistletoes are small, leafless, parasitic flowering plants. The seeds, explosively discharged from the fruit, are very sticky and adhere to any surface they strike. Seeds that adhere to young branches of susceptible trees germinate and the mistletoe plant penetrates the bark. These seeds generally are dispersed in August and September.

This parasite is easily identified by the yellow to green or brownish-green segmented shoots that protrude from the infected part of the tree. These perennial shoots are 2 to 6 inches (5-15 centimeters) long and $\frac{1}{8}$ - to $\frac{1}{4}$ -inch (.3-.6-cm) in diameter.

The "roots" of the dwarf mistletoe are imbedded in the bark and phloem of the tree. The parasite produces secondary root-like structures called "sinkers" that become imbedded deeper in the wood as the twig adds its annual growth rings. These "roots" provide the parasite with nutrients obtained from the living tissues of its host.

Symptoms

The first symptom of dwarf mistletoe infection is a slight swelling of the bark at the site of infection. As the "roots" of the parasite become more extensive in the host, a distorted branching habit or witches' broom may form. The witches' broom diverts food from uninfected parts of the tree, subsequently reducing vigor and causing premature death of the tree. Infected trees that do not develop witches' brooms usually have visible

¹⁵Swift, C. E. and Dickens, L. E. Dwarf-Mistletoe, Colorado State University Extension Service, Service in Action Leaflet No. 2.925.

mistle-toe shoots protruding from the infected area; however, shoots are not formed until two to three years after infection.

Control

Pruning is the best control measure available for reducing or eliminating dwarf mistletoe infections in ornamental trees or urban forests. Trees severely infected in the upper branches or those with only a few live branches should be cut. Trees with high, unreachable mistletoe infections will continue to rain seeds on nearby trees if not cut down.

Lightly infected trees can be freed from the parasite by pruning off all infected branches. All branches to be pruned should be cut off flush with the trunk. The entire branch should be removed. The trees should be examined every two or three years and any infected branches pruned off. The mistletoe shoots die as soon as the branch is cut, consequently burning pruned-off branches is not necessary.

If the mistletoe on a branch is close to the trunk the infection may have already entered the trunk. Shoots will form on the trunk even if the branch is removed. When pruning infected limbs, the following guidelines should be used to insure the trunk is free from infection. Trees with infections closer than indicated should be cut down to remove a future source of infection.

Branch diameter (outside bark)	Distance of infection on branch from trunk
Under 1.0 inch (2.5 centimeters)	6 inches (15.2 cm)
1.1 - 2.0 inches (2.8 - 5.1 cm)	8 inches (20.3 cm)
2.1 - 3.0 inches (5.3 - 7.6 cm)	10 inches (25.4 cm)
3.1 - 4.0 inches (7.9 - 10.2 cm)	12 inches (30.5 cm)

In some cases a highly desirable tree with a trunk infection cannot be removed for aesthetic or other reasons. In these instances, the mistletoe shoots must be knocked off periodically as they appear to prevent further spread.

In heavily infested areas, nonsusceptible trees can be planted to replace cut trees. Ponderosa pine areas can be planted to:

Douglas-fir	Pinyon pine	White fir
Limber pine (sic)	Blue spruce	Rocky Mountain juniper

In lodgepole pine areas, the following trees can be substituted:

Engelmann spruce	Subalpine fir	Douglas-fir
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Hardwoods such as ash, birch and aspen, also can be planted in affected areas because dwarf mistletoes do not attack hardwood trees.

DWARF-MISTLETOE ADDENDUM¹⁶

Three species of dwarf-mistletoe occur in Boulder County. They are ponderosa pine dwarf-mistletoe (Arceuthobium vaginatum), lodgepole pine dwarf-mistletoe (A. americanum) and limber pine dwarf-mistletoe (A. cyanocarpum), each named for its primary host.

Besides its primary host, each dwarf-mistletoe species attacks the other two pine species as a secondary host (Limber pine is attacked by ponderosa pine dwarf-mistletoe as a secondary host and should not have been listed on the Service in Action leaflet as suitable for planting on ponderosa pine sites.). Only in rare circumstances are other species of trees affected.

Dwarf-mistletoe infects and eventually kills its primary host. Secondary hosts are much more resistant to attack. There are numerous examples of secondary host trees standing in the middle of heavy dwarf-mistletoe infections without becoming infected.

Dwarf-mistletoe control is achieved in forest situations by clear-cutting the infected patch, allowing the stand to regenerate from natural seeds from adjacent stands. If the patch is a large one, the clearcut may have to be completed in several stages so that a seed source remain nearby until the stand regenerates.

In urban settings, or with ponderosa pine dwarf-mistletoe, which is large enough to see easily, it is often feasible to prune dwarf-mistletoe out of infected trees. Due to dwarf-mistletoe's incipient stage, this process must be repeated for at least three consecutive years.

Planting with susceptible tree species before the overstory stand is free of dwarf-mistletoe will result in reinfection. Seedlings are small and not usually infected during the first few years, so if control efforts are continued until all dwarf-mistletoe is gone, an extra two or three years' growth can be obtained by planting after the first year's cleaning.

¹⁶Stevenson, Douglas J. Dwarf-mistletoe Addendum, Colorado State Forest Service, Boulder, 1994.