REPORT

ON THE

SILVICS OF THE WENAHA FOREST RESERVE

WASHINGTON AND OREGON

BY

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Topography

There are no mountains of great elevation in the Wenaha Forest Reserve, the highest being a little less than 7,000 feet absolute altitude; but there are great differences in elevation, the Tucannon Creek, for example, being but about 1,500 feet where it leaves the reserve, while the Oregon Buttes, which are the highest points, are nearly 7,000 feet high. The country is very rough. It may be safely said in general terms, that where a stream is found on the map of the reserve, there a deep canyon will be found; and since the entire area is well watered a series of ridges and canyons is presented with steep to precipitous slopes and a depth of some 2,000 feet. This is not always the case, for between many of the streams, each flowing in a canyon, is a broad plateau country with rolling hills. It is on these "flats" near the edges of the reserve that much of the best timber is found. This is especially true of the "Grouse Flats" and the "Hobo Country," just north of the Grande Ronde River, where the best stand of yellow pine is found.

Climatic Conditions of the Region

The length of the vegetative season is dependent upon the altitude and, of course, varies from year to year. On an average, however, the buds begin to open toward the end of April except in the higher interior mountains, and the leaves begin to fall at the time of the first fall frost which occurs about the middle of September.

The precipitation is well distributed thruout the year, with the exception of the months of July and August when very little rain falls. What rain falls during these months is usually local thunder showers of short duration.

The temperature occasionally falls as low as 20 degrees below zero, F., in the winter, thoughugh 8 degrees below zero is the usual annual minimum. A temperature of 85 degrees is the usual annual maximum althoughugh occasionally the temperature goes above 90 degrees for several days at a time during the summer months in the narrow canyons.

The first fall frosts appear about the middle of September and the last spring frosts in May or rarely even the middle of June. In the higher interior mountains, however, frosts are likely to occur almost any time.

The relative humidity is rather less than in the plains below. During the months of October and November, fogs often hang over the mountains at an altitude of from 1,500 to 3,000 feet. Above this elevation the sky is clear, while below the fogs the sky

appears overcast with low-lying, slowly drifting clouds which remain uncleared, but without precipitation, for days or weeks at a time.

The prevailing wind is the Chinook wind from the southwest. This is a dry wind of greatest velocity in the spring. The sheep trample out the humus on their bedding grounds on the high, exposed ridges and slopes where soil is shallow, and the late spring frosts loosen the soil, thereby weakening the hold of the trees upon the soil. The spring Chinook then blows the trees down on the edges of the bedding grounds. Sometimes on exposed places a whirlwind will take down a patch of trees, forming a windfall of considerable extent. This is most noticeable on southern slopes. Scrubby yellow pine and red fir on exposed ridges are particularly liable to windfall.

General Forest Conditions

The principal species of value on the reserve are, in the order of their importance, yellow pine, red fir, tamarack, lowland fir, and lodgepole pine. Engelmann spruce and sugar pine, though merchantable, do not occur in sufficient quantity to be important. Lodgepole pine does not grow to large dimensions and is never logged, although it is very largely used under free use permit for fuel.

The principal bodies of yellow pine are found on the Grouse Flats north of the Grande Ronde River, and in some of the canyons, notably the Tucannon, good stands of merchantable yellow pine, red fir, and tamarack are found. There is much mature yellow pine on the edges of the reserve which is beginning to deteriorate through decay and dying at the top. This material should be disposed of as rapidly as possible.

There is very little danger in logging operations of not obtaining an adequate restocking. Reproduction of all species is remarkably abundant, and the forest is extending its limits naturally. There is some danger in mixed stands that the yellow pine will not be able to compete with the other species owing to its less frequent seed years. But as a rule the species in reproduction bear about the same proportion as the mature stands.

Forest Types

Forest types conform to the general topography of the country, each topographic type having a different class of forest which varies in the nature of the species found on each, and in the condition of the timber and the forest floor. These types, then, form a convenient basis of description. The forest types may be divided into the summit type, the flat, and the canyon.

The Summit Type

Topography — The soil of the summit type is exceptionally thin, as shown when sheep have grazed off the glades leaving the bare, powdery soil which soon washing off leaves the lava rock exposed. It is well drained, but as a rule is rather dry in summer.

There are numerous springs on the summits and ridges but these, after flowing for a short distance, sink into the ground.

The characteristic species are:

Engelmann spruce	*Picea engelmanni* Englem.
Blue spruce	*Picea parryana* (Andre) Parry
Red fir	*Pseudotsuga taxifolia* (Lam.) Britton
White fir	*Abies concolor* (Gord.) Parry
Lowland fir	*Abies grandis* Lindl.
Lodgepole pine	*Pinus murryana* "Oreg. Com."
Tamarack	*Larix occidentalis* Nutt.

Occasionally along the ridges in open spaces groups of aspen are found, and around springs alder grows.

The principal species of shrubs are as follows:

Buck brush	*Pachystima mysinites* Raf.
Mountain mahogany	*Cercocarpus parvifolius* Nutt.
Huckleberry	*Vacinumi parvifolium* Smith and *Vacinumi ovalifolium* Smith

The spruces and firs form the major portion of the forest with groups of black pine and tamarack interspersed. Occasionally a pure stand of mature black pine or of tamarack occurs, though is more common in young stands after burns. On the edges of the exposed glades groups of silver fir or of blue spruce of small area are met with. These groups are characteristic of the edges of the mixed coniferous forests of this type. One or two mature trees 30 to 40 feet in height grow in the center of the group with a ring of trees of lesser height about these few. The lower branches, which extend to the ground, are closely appressed to the soil and extend for a distance of several feet from the center of the ring. The result is a cone-shaped mass of dense foliage, often as regular as pruned and trained by art.

The per cent of species in mixed forest is about as follows, though this is very variable:

White fir	20	per cent
Lowland fir	15	" "
Lodgepole pine	20	" "
Tamarack	15	" "
Red fir	15	" "
Engelmann spruce	10	" "
Blue Spruce	5	" "
	100	" "

The canopy is usually very broken, though in pure stands of lodgepole pine the canopy is dense.

The forest of this type is not merchantable, the trees being stunted, scrubby, and limby in exposed situations, and the soil not being deep enough to make a good merchantable forest.

Reproduction after burns is usually very prolific, the principal species which come in as second growth being lodgepole pine and tamarack, with a lesser proportion of white fir, lowland fir, and the spruces. On unburned areas, reproduction is rather backward, especially in thick stands of timber, but in blanks reproduction often is rather abundant and of the same proportion as the surrounding forest.

The Flat

Topography — The soil of the flat is variable, being in some localities deep, and in some shallow, according to location. Thus on the "Grouse Flats" near the Grande Ronde River the soil is deep and cultivable after clearing; while in Township 9 north, Range 42 east, for example, near the head of the Pataha and Charley Fork, the soil is rather shallow and rather approaches the summit type in this respect.

The soil moisture is on the whole satisfactory and the flats are well drained.

Since this type occurs at altitudes ranging from the lowest almost to the highest to be found in the reserve, the character of the forest is very variable. On the "Grouse Flats" the timber is almost exclusively a pure stand of mature yellow pine running as high as 20,000 feet B.M., per acre. The characteristic trees of this type are yellow pine, red fir, lodgepole pine, tamarack, lowland fir, and Engelmann spruce.

The yellow pine, lodgepole pine, and tamarack often occur in pure forest; lowland fir and spruce characteristically occur in groups of from 5 to 10 individuals, while red fir occurs more often singly in mixture with any or all of the other species.

In the yellow pine forests reproduction is by groups in blanks or openings in the forest. On burned areas the new growth is very apt to be either of tamarack or lodgepole pine and on such areas is abundant.

The most important commercial trees of this type are, first, yellow pine, then red fir, black pine, tamarack, and lastly white fir and Engelmann spruce. This is the most important type commercially and in the southeastern part of the reserve along the Grand Ronde, Grouse Creek, and Cabin Creek much good yellow pine stock is standing. This timber is largely overmature and shows the effects of deterioration in dying at the top, and very slow growth, and even in the attacks of fungi and insects. In other parts, as at the head of George Creek and Charlie Fork, black pine and tamarack are the principal commercial species, largely, however, because these species have supplanted the yellow pine after logging.

Canyon Type

There is no typical bottomland in the Wenaha Forest Reserve, but between the ridges and sectionizing the flats into plateaus lie deep, narrow canyons with steep, often precipitous slopes. In some cases, as on the Tucannon in Township 9 north, Range 41 east, the bottom of the canyon may be several rods wide, affording agricultural land when cleared; but even then there is no true bottomland, while more frequently the slopes of the canyon come down to the banks of the stream leaving but very little except steep slopes with a mountain stream flowing between them.

Since this is the case, it is impracticable as well as misleading to divide the canyons into a bottom and a slope type.

However, it should be borne in mind that in some instances the canyon type, though usually comprising a slope forest, includes a forest that approaches a bottomland type.

The slopes are thin-soiled and usually not well watered. If it were not for the forest growth upon them, the soil should soon wash off, exposing the bare rock. This has happened where the bunch grass has been overgrazed by sheep, and there are no trees to hold the soil. The bottom of the canyon is the bed of a stream. The streams flowing toward the west are usually perennial, while those of the east slopes such as George Creek and the forks of the Asotin are frequently dry, or all but dry, in summer.

The north and west slopes of the canyons are timbered and there is often considerable underbrush; while the south and east slopes are more sparsely covered with trees, the principal covering being bunch grass.

The species of the canyons are yellow pine, red fir, lowland fir, tamarack, and lodgepole pine, the commonest species being yellow pine, and after it, red fir. Along streams cottonwood and balm of Gilead is found with mountain maple, wild cherry, and other broadleaf species. The principal commercial species are yellow pine and red fir, and these often attain considerable size along the streams. Yellow pine forms perhaps one half of the total stand with other species in lesser proportion.

In logging, it would be necessary in some cases to subdivide the three general types enumerated above. For example on the flat type there are areas of pure yellow pine forest with open ground cover, pure, even-aged lodgepole pine stands, and pure tamarack stands, while on other areas several species of conifers are mixed and of all ages.

The flat type might be again subdivided into draws, which approach the canyon type and the hilltops, while the canyon type may be subdivided into slope and bottom.

Absolute altitude seems to affect the prevalence of a species more than the topography.

Yellow Pine

General Characteristics

Root system — Yellow pine has a deep taproot rendering the tree wind-firm in exposed situations.

Stem and crown — In early youth the last two years growth of the stem is covered by needles, the needles on the lower part of the stem falling off, leaving the stem roughened by the presence of the primary leaves. The crown in youth extends to the ground and is irregular in outline, but later in life it comes to occupy only the upper half or third, or even less of the tree, according to whether it is in forest or partially open stand. The crown of mature trees is cylindrical or of a lengthened conical outline, not broad, perhaps 20 feet broad, and long, with the leaves tufted at the ends of the branches. The bole tapers rather more than that of tamarack or black pine. At low elevations and where it comes up in old fields, yellow pine is short and scrubby.

Bark — The bark in youth is black becoming rough early. In older trees (60 to 80 years) it is yellow with deep longitudinal and diagonal fissures dividing the surface into polygonal plats, which are composed of thin lamellae which exfoliate in small particles with irregular outline. The bark is always relatively thick. A tree .5 inch in diameter at the ground has a bark .1 inch thick, while old trees over 100 years old and 32 to 38 inches in diameter on the stump, the bark is 1.5 to 2.5 inches in thickness, except at the furrows where it is much less. The bark is very variable in thickness being often not over 1 inch thick on large trees, while it may be nearly 3 inches thick on trees of the same size. The color also varies somewhat. Rather large trees may preserve the black, rough appearance that is a characteristic of early life, while sometimes a smaller tree may have the smooth, fissured, yellow bark. The fissures of the yellow barked trees are black like the younger trees and the bark does not exfoliate from them. In these younger black barked trees, the bark, being not so old, is thinner and has resin ducts running through it; while in older trees the outer bark has become dead and no resin flows thru it. It consequently is looser and peels off in scales more readily.

Self Pruning — In thick, even-aged, pure stands the lower branches persist and live till the trees attain an age of from 10 to 15 years with a height of about 7 feet. At this stage the lower branches die for a distance of about one third the total height from the ground, though the dead branches are not sloughed for a few years longer. They gradually disappear, however, and in forest grown trees it is not unusual for trees to be clear of branches for four-fifths of the total height. In close stand, however, the trees are tall and spindling.

TYPE	AVERAGE HEIGHT	MAXIMUM HEIGHT	AVERAGE DIAMETER	MAXIMUM DIAMETER B.H.	NUMBER OF TREES
Canyon bottom	103	155	30	65	10
Canyon slope	104	149	22	34	10

Site Requirements as Influencing Its Distribution and Development

Topographic situation — The yellow pine attains its best development in the canyon bottoms where the canyon has any "bottom," near water. It attains a good growth on flats, and is often the only tree growth on the canyon slopes at elevations between 2,000 and 3,000 feet. Above this altitude red fir and white fir take its place. On north and west slopes yellow pine grows fairly well, but on south and east slopes often nothing grows but bunch grass, while the draws that are offshoots of the main canyon are lined with yellow pine. On the slopes and draws, however, the tree does not reach the size that it does in the canyon bottom or the flat.

Soil — The species is not fastidious in regard to soil. It prefers a fresh but well drained soil of clay or clay loam, though it will grow on the rocky, thin soil of the slopes.

Exposure — Owing to its deep tap root it often stands firm on exposed situations. A lone yellow pine is often seen standing on a slope bare of everything but loose rocks and meagre bunch grass.

Altitude — Its altitudinal range is from the lowest altitudes of the reserve (about 1,500 feet), and even below this, to 4,000 feet, though it does best at from 2,000 to 3,000 feet altitude.

Gradient — It grows on steep slopes as well as on flats.

Effect of Tolerance and Rate of Growth upon Site Locations

Yellow pine is intolerant of shade but grows fairly fast, hence at altitudes between 2,000 to 3,000 feet it competes successfully with its neighbors red and white fir since these grow more slowly.

Tolerance

Yellow pine is intolerant of shade thruout life. It, however, will stand shading at the side in early youth provided its top is free. In later life it demands a certain amount of side light as well. On slopes the tree requires more light than it does in the deeper, moister soil of the flat or canyon bottom. When shaded by dominant trees the suppressed tree dies. It does not seem to be able to continue to live under shade, and when the dominant tree is removed by wind, fire, or logging, it is not often that the suppressed tree regains its vigor. A mature tree can live when shaded at the side, but it will grow in height in its endeavor to keep its top in the light, while diameter growth is retarded causing a long, spindling development.

Reproduction

Seed production and dissemination — Seed are not borne in large quantities every year, but the occurrence of a "seed year" or a year when seed are more abundantly borne is rendered less conspicuous than in the case of some other species because of the fact that different years do not present so very marked a contrast in this particular. Seed are borne first about the 40th or 50th year, though the most prolific yield is between the ages of 60 and 80. More seed are borne on trees that get full side light and that stand in deep, fertile, fresh soil than on trees in the interior of a forest or on shallow, dry soil. It takes two years for the cones to mature and the seed are scattered in the fall. The wind is the principal agent of dissemination, while on hill slopes gravity plays an important part in scattering the seed as the cones roll down for a considerable distance from the parent tree. Two seed trees would seem to be sufficient to seed an acre, if they are well separated.

Germination — The conditions most favorable to germination are a porous, well-drained, loamy, clay soil with but little humus. The principal deciding factor, however, is the abundance or lack of light. Partial shade from brakes or other underbrush, if not too heavy, seems to be an advantage to the seedlings for the first year or two, but unless the shade is very light the seed will not germinate; or if they do the seedlings will live but a short time. In openings in a broken stand of yellow pine, seedlings come in thickly, but under the shade of the parent trees, even though the shade be not heavy, no reproduction occurs.

Development of seedlings — Growth in diameter is rather slower in seedlings than in later life, but progresses evenly, and reaches a diameter of 2 inches in from 10 to 15 years. At this age the trees are 8 to 9 feet tall. The greatest mortality among seedlings is undoubtedly caused by fire. The seedlings before the heavy outer bark is added, are sensitive to fire, and because of the resin in the wood and leaves are easily killed. They need not necessarily be burned by actual contact with fire, the heat from a fire nearby being enough to kill them.

Seeding under present conditions is found only in blanks or openings in the forest. It is therefore advisable in future management to thin rather heavily. Clear cutting where the topography warrants will be quickly followed by natural reseeding provided a few seed trees are left. Where clear cutting is not practicable, a group system of management or a heavy thinning is indicated.

Relations with Other Species

The common associates of yellow pine are red fir, white fir, tamarack. Along streams it is found with cottonwood, balm of Gilead, and mountain maple. Red fir and white fir, since they cast a dense shade, make it impossible for such an intolerant species as yellow pine to grow where many of these two species are found, while since both these species are more tolerant of shade they easily get the better of yellow pine when there

is competition for growing space. If, however, yellow pine gets a start before the firs, they may help it by causing a side shade and prune itself of branches early, and since the yellow pine is faster of growth it can remain dominant.

Yellow pine is subject to attacks of bark borers, and the mixture with other species might tend to check their ravages if the insects (*Dendroctonus*) became numerous. At present, however, there is little danger of this.

It would seem to be inadvisable to log yellow pine alone where it occurs in mixture with other species, such as red fir and white fir. Wherever practicable these species should be taken with the pine, for otherwise there is danger that they will ultimately preclude the possibility of any further seeding of the more valuable species, yellow pine.

Maturity

Mature timber may remain sound as long as two hundred years of age. There is much mature and overmature timber on the reserve, with but little reproduction owing to the dense shade cast by the large trees. Stag-headed trees are not uncommon.

Fire

Fire often does great damage to young yellow pine. The fires on this reserve are almost entirely surface fires which run rapidly over the ground; and since the yellow pine forests on the flat type are open with long grass as a forest floor the young trees are scorched and die, being very susceptible to the heat. After attaining maturity, however, the trees are not damaged greatly unless covered with dry hanging moss.

In mixed forest, fires tend to bring in lodgepole pine which tends to supplant the more valuable yellow pine, thus injuring the commercial value of the forest.

Insects

Yellow pine is attacked by the yellow pine bark borer (*Dendroctonus*), the larvae of which channel the inner bark in all directions. The leaves become seared and the vitality of the tree is lessened or the tree may be killed. This injury, however, is not widespread.

Lodgepole Pine

General Characteristics

Lodgepole pine, locally known as black pine, has no tap root. The surface roots extend into the soil to a depth of about 2 feet in mature trees with a lateral extent of 5 or 6 feet.

Stem and crown — In youth the stem is clothed with branches from the ground upward, while the branchlets are covered with leaves. The foliage is a light green in

color, and loose. This stage exists until the tree is 4 or 5 inches in diameter near the ground. As the young trees crowd each other in their growth, the lower branches are pruned naturally and the crown comes to occupy only the upper half or third of the stem and the leaves darken in color. The leaves on the branchlets are now less noticeable and the foliage becomes more tufted in appearance. In maturity the crown is about 10 feet in lateral extent. The stem at all ages is cylindrical; even the young trees have a stout leader, while in mature forest grown trees there is often almost no difference in diameter at a height of 10, 20, and 30 feet above the stump.

Bark — The bark is smooth and light in color in youth, turning black and exfoliating in small scales in old age. It is always thin, being 0.1 to 0.01 inch thick in old trees (130 years) according to whether it is on the base or near the top of the tree, being thicker near the ground.

Self pruning — The young trees stand in close pure stand until 20 feet tall with very little or no "natural pruning." In maturity pruning has advanced until the canopy occupies only the top third of the bole, but frequently dead branches remain to within a short distance of the ground. The knots thus caused do not injure the timber especially since the tree is used almost entirely for fuel.

The following figures are based on measurements of 13 trees on the flat type.

AVERAGE HEIGHT	MAXIMUM HEIGHT	AVERAGE DIAMETER BREASTHIGH	MAXIMUM DIAMETER BREASTHIGH
Feet	Feet	Inches	Inches
89	104	8	18

On the Flats the average size of existing second-growth timber is 16 feet high with a diameter of about 1.5 inches. The maximum size of second-growth timber on the Flats is 25 feet tall, diameter 3 inches.

Lodgepole pine does not occur commercially in the canyons, while on the summit type there has been no logging so there is no second growth here excepting what comes in after burns.

Site Requirements as Influencing Its Distribution and Development

Topographic situation — The type on which lodgepole pine occurs characteristically is the Flat. As has been explained, the Flat is not absolutely flat but may present a series of low rolling hills, or be intersected by shallow ravines or "draws." It is in these draws that lodgepole pine attains its greatest size and age, but here it is slow of growth even in youth and does not reproduce well owing to the lack of sunlight. On the rolling hills and slopes it grows faster since it has more sunlight, but when the soil is thin and dry it does not grow to as large a size. On the summit type the soil is too shallow and dry for good development but on a broad, flat-topped mountain summit black pine often occurs in

pure stand, rarely, however, growing beyond the pole stage. Black pine is not common in canyons, though it is occasionally found here.

Soil — It grows in a dry or clay loam and does not require much soil moisture.

Exposure — It does not grow in very exposed situations since the shallow root system predisposes it to windfall.

Absolute altitude — Its altitudinal range is from 3,000 to 6,000 feet elevation.

Effect of Tolerance and Rate of Growth upon Site Locations

Lodgepole pine is relatively intolerant and so does not do well in the draws or canyons where it has to compete with such tolerant species as spruce and fir, and being of slow growth it can not overtop its faster neighbors. The tamarack and yellow pine, on the other hand though intolerant, do well in draws and in canyons because they grow faster than their associates and quickly dominate them.

Optimum and Possible Site Locations

As has been said, black pine does well in the shallow draws in the Flat, but other more valuable species do equally well. On the Flat, lodgepole pine is often the characteristic tree and does well here. Black pine comes up in pure stand after logging, or fire, and grows well. It should therefore be favored in such sites unless yellow pine or some other more valuable species would do equally as well. This is the case on the Flat of lower altitudes. Here of course the yellow pine should be given the preference.

Tolerance of Shade

In youth lodgepole pine is tolerant of shade growing in pure stand where it gets overhead light but no side light. In such situations even the lower branches persist and live, indicating that side light is not essential. In mixed stands, however, when shaded by older or faster growing species it can not grow.

In later years it is able to stand some shade, but is comparatively intolerant though not to as great a degree as yellow pine or tamarack.

In draws when associated with tall trees of other species it is intolerant, although here it has the advantage of fresh, deep soil, while on the hills where it characteristically grows in pure stand, it is more tolerant especially in youth.

Reproduction

Seed production — Nothing definite has as yet been determined regarding the frequency and regularity of seed years. A tree on the edge of a clearing or a road where it gets side light may bear cones as early as 8 years of age, but this is not at all

common. Seeding in general begins at the 20th to the 30th year, while the most prolific yield occurs when the tree is 70 to 80 years of age.

There are several conditions which affect the productivity of seed. The general vigor and health of the tree is one — a sound, healthy tree being more productive than a weak or diseased one. Light condition, perhaps more than any one factor, influences the production of seed. A tree on the edge of a clearing or road, or standing isolated with plenty of side light will produce seed earlier in life, and in more abundance than a tree standing in the forest. Moisture seems to have less effect except in so far as a certain amount of moisture is necessary for the healthy functions of the tree. Altitude in itself has little effect, except that near the upper or lower altitudinal limits of the species black pine does not grow or reproduce so well.

Dissemination of seed — The seed are borne a long distance on the wind, and squirrels aid too in their dissemination. After a burn a thick, even-aged stand of black pine often occurs, although there be no seed bearing trees for a distance of many rods.

Germination — The conditions favorable to germination are an open soil with little or no underbrush or humus. The soil should have sufficient moisture content, though the seed will germinate in relatively dry soil. The exposure of the mineral soil is the prime requisite for germination. After clear cutting, and more especially after a burn, black pine comes in thick, pure, even-aged stands. This is noticeable on the Flat and in burns on the summit type. In openings too in stands of mixed conifers, if the mineral soil be exposed, black pine will take possession in pure stand.

Development of seedlings — The seedlings grow faster than when older. But a few measurements have been taken of seedlings. Growth is variable. For example one tree measured was 12 years old, 17 feet tall, 2.5 inches in diameter at the base. Another 20 years old was only 11 feet tall and measured 1.5 inches in diameter at the ground. Both were intermediate trees on the same acre.

Notes on seeding are appended for all important species on Form 977. [Compiler's Note: form 977s were not present with the microfilm version of this document.]

Relations with Other Species

Lodgepole pine often grows in pure, even-aged stands of from a fraction of an acre to several acres in extent. Even when practically pure stand, however, tamarack is often found scattered among the lodgepole pine. Tamarack is mostly related to black pine silvically, its requirements being similar, and the two are often found together. White fir is another common associate of black pine, while Engelmann spruce and red fir may be mentioned among its lesser common associates.

On the flat and summit type practically the only competitor of black pine on cut-over or burned areas is tamarack. Tamarack grows faster than the pine in early youth, but is rather less tolerant of shade, while the seeding power of tamarack is inferior to black

pine, nor are the seed carried so far. For this reason black pine often takes possession of the soil to the exclusion of tamarack, although if a few tamarack gain access they may be able to overtop the black pine about them.

Maturity

Maturity is attained about the 90th year and the trees remain sound for 130 years or more before decay sets in. The merchantable size is about 6 to 8 inches in diameter, and this diameter is reached at about the 60th to 70th year. Sufficient measurements and stem analyses have not been taken to form an accurate average. These figures are therefore given as general observations open to correction as more accurate data is obtained.

Fire

Fire seems to be the cause of an increase rather than decrease of the area occupied by lodgepole pine. On purely lodgepole pine sites this may be an advantage, but in mixed stands or on sites where other species may compete for the locality, lodgepole pine reproduction stimulated by fire may oust more valuable species such as yellow pine. Young lodgepole pine is easily killed by fire, but older trees receive but slight injury.

Tamarack

General Characteristics

Tamarack has a loose, open crown wider generally than spruce, but not so wide as red fir. The spread of the crown is about 18 feet on a tree 100 feet tall. The branches curve slightly upward. The bole is usually markedly cylindrical and tall. The bark is similar in general appearance to that of yellow pine, but is smoother and thinner, being generally about .5 to 1.5 inches in thickness at the stump. It clears itself of branches readily and early — mature trees being clear of branches for about one half their height.

In draws tamarack attains a greater height growth in comparison with the diameter than on the rolling hills of the Flat.

Type	Average height	Maximum height	Average diam. breasthigh	Maximum diam. breasthigh	No. of trees
Rolling hill	84	110	12	17	36
Draw	105	127	14	19	15

This is another way of saying that the "Quality of the Locality" is better in the draws in the deep, fresh to moist soil than it is on the dryer, shallower soil of the rolling hills.

Site Requirements as Influencing Its Distribution and Development

Topographic distribution — Tamarack is one of the typical trees of the Flat. It occurs also, though rarely, in the canyon bottoms above an elevation of 2,700 feet and is not infrequent on the mountain tops. It does not occur on the typical summit type, though, like black pine, it often grows on the broad tops of high mountains which partake more of the nature of the Flat type.

Soil — It grows in a clay or clay loam soil. Its altitudinal range on the Wenaha Reserve is from 2,700 to 6,000 feet.

Effect of Tolerance and Rate of Growth upon Site Locations

Tamarack is rather intolerant of shade but its rapid rate of growth compensates in a certain measure for its inability to bear shade. In the draws where it has to compete with more tolerant species it would fare ill if it were not for the fact that it grows faster than these and so is enabled to keep its head above them, where it gets plenty of top light.

Tolerance of Shade

Tamarack must be classed as an intolerant species thruout life. It is rather less tolerant than yellow pine.

Reproduction

It seeds regularly and abundantly, the seedlings coming up in thick, pure stand or in mixture with firs and pines on flats where there is soil moisture sufficient for germination. In opens on the flat type reproduction is often thick.

Maturity

Tamarack is a relatively long-lived tree, the trees remaining sound for one hundred and fifty years or more before the decay incident to old age sets in.

Injuries

Tamarack suffers very little from fire after it is about 3 inches in diameter. No timber trees were found which were injured by insect attacks.

Engelmann Spruce

General Characteristics

The crown is very narrow and spike-shaped. A tree 100 feet tall will have a crown perhaps only 5 feet across, but it may extend down the trunk one-half or even two-thirds its length even when grown in fairly dense stands. The stem is cylindrical but generally

knotty owing to the persistent living branches, since the species does not readily prune itself. The following figures are based on measurements of 12 trees on the Flat type:

AVERAGE HEIGHT	MAXIMUM HEIGHT	AVERAGE DIAMETER	MAXIMUM DIAMETER
Feet	Feet	Inches	Inches
75	101	10	15

Site Requirements

Engelmann spruce occurs characteristically on the mountain summits and ridges and on the Flat type within its altitudinal limits. It requires considerable soil moisture and for this reason is found in draws and upper canyon bottoms, while it does not grow on steep slopes or shallow soil. Its altitudinal limits are 3,000 feet and above.

Tolerance of Shade

Engelmann spruce is one of the most tolerant species of the Wenaha Forest Reserve. It readily germinates and grows under the shade of firs and pines providing it has sufficient soil moisture.

Reproduction

Reproduction is very meagre. On the flats, however, in localities where there is sufficient soil moisture, spruce comes in in mixture with firs and pines, though never in large amounts.

Sugar Pine – Blue Spruce

These species are not important commercially on the Wenaha Forest Reserve. The spruce, although important as a forest cover on the high ridges, is not to be classed as a timber tree; while the sugar pine, known as "white pine" is a rare tree and was found within the reserve only in very small numbers on some of the high ridges of Oregon.

The few sugar pine which were seen were of good merchantable dimensions and quality, and standing on a locality easily accessible to logging operations, but so far removed from a market as to be without stumpage value at present.

Red Fir

General Characteristics

Red fir has rather a wide crown as compared with spruce, tamarack, or black pine. The branches usually curve upward, but occasionally droop downward. When growing in the open the crown envelopes the entire stem to within a few feet from the ground.

Such trees have a tapering stem. In the forest, the stem is straight and undivided, clear of branches for about one-half its length, with a conical crown producing a dense leaf canopy. Unless in mixture with pines in rather dense stand, the dead lower branches may persist indefinitely as in the eastern white pine. The stem of a forest grown tree is cylindrical with a root swelling extending often four to five feet from the ground. The bark is corky, dark, and deeply fissured, and on large trees is often 3 inches thick. The resistance to fire from this cause is exceptional, pines often being severely injured owing to the inflammable nature of their bark, though thick, when veteran red fir are unscathed.

Site Requirements

Red fir though not confined to special sites or soils does best on northern and eastern mountain slopes and canyon bottoms. Its nearest silvical associate is the yellow pine, the altitudinal range and requirements of soil and situation being similar in the case of both species. Yellow pine, although it occurs at lower altitudes than red fir, is scrubby below the lower limit of red fir, which is about 2,500 feet. Red fir rarely ascend to elevations above 4,000 feet. In all logging operations red fir is cut with yellow pine. Trees occur in small groups mixed with tamarack and yellow pine in the canyon bottoms, and on the slopes and ridges mixed with yellow pine and white fir. On southern slopes they stand far apart and form but poor, scrubby boles.

Light Requirements

Red fir is rather intolerant of shade. But little reproduction occurs under a close stand of large trees and the lower limbs of the mature trees though still persistent rapidly die from want of light.

Reproduction

Reproduction of red fir is usually satisfactory on sites adapted for germination and growth. On northern and eastern slopes and in the canyon bottoms red fir reproduction is found mixed with yellow pine and white fir, often occurring in groups in blanks formed by logging or windfall.

Enemies

Fire, if it attacks the young trees before they have encased themselves in the corky, armor-like bark of maturity, will kill the reproduction, while sheep do some damage, which can not be accurately measured, by trampling and stripping off the bark and branches of young trees.

Lowland White Fir *(Abies grandis)* Lindl.

Lowland fir has a deep tap root. The branches droop and the crown is rather wide especially in young trees, but in older trees it is relatively narrow, since the crown does not increase so much in spread with the growth of the tree.

This species is found in all types at altitudes above 2,500 feet. It is not particular as to chemical quality of soil and does well on dryer soil than many species with which it is associated. It occurs on fairly steep slopes generally on northern exposures, and on mountain tops and canyon bottoms.

Lowland fir is more tolerant of shade than the pines although scarcely so shade-enduring as Engelmann spruce.

In draws and upper canyons reproduction of white fir is abundant, while reproduction of other species are rare; but of mature timber there is considerable tamarack, spruce, and lodgepole pine. The reason for this prevalence of white fir reproduction as compared with other species is probably that white fir is more tolerant of shade, especially in early youth, than the surrounding species, since in these rich, deep-soiled draws the trees stand close together, and though the forest cover is broken it is dense in patches.

Lowland fir frequently comes in on cut-over slopes when the tamarack is removed, and successfully competes in the second growth with the tamarack.

White Fir *(Abies concolor)* (Gord.) Parry

The white fir is found on the higher ridges and more exposed situations at altitudes exceeding 4,000 feet. The trees often grow in groups or patches of pure stand and are often associated with blue spruce. When growing far apart the trees are limby, the limbs extending even to the ground forming a close, conical crown. The bole in such cases is conical. When growing in greater density, or in mixture with other species the crown is confined to the top and the bole is nearly cylindrical. The branches are short and stout and arranged in regular whorls standing out horizontally from the trunk or slightly curved upward at the tips.

The trees on the more exposed ridges are gnarled and broken by storms, but when not storm-shaken the tree assumes a very regular form with a conical crown extending down about one-half its length. The bark is smooth and light, and the foliage silvery white as viewed from a distance, owing to the parallel silvery white lines on the lower surface of the leaves which are turned upward by the curving branches.

This species is more important as a protection to watersheds than as a timber tree, since it does not grow at the lower altitudes which, as a rule, are alone accessible to logging operations.

General Silvical Notes

Tolerance of Shade

The most important species on the reserve in the order of their tolerance.

1. Engelmann spruce
2. White fir
3. Blue spruce
4. Lowland fir
5. Red fir
6. Lodgepole pine
7. Yellow pine
8. Tamarack

Demands upon Soil and Moisture

The most important species on the reserve in the order of their demand upon moisture and quality of soil.

1. Tamarack
2. Yellow pine
3. Red fir
4. Engelmann spruce
5. Lowland fir
6. Lodgepole pine
7. White fir
8. Blue spruce

Height Growth

Three of the most important species on the reserve in order of their rapidity of height growth.

(From curves)

1. Engelmann spruce
2. Tamarack
3. Lodgepole pine

Diameter Growth

Five of the most important species on the reserve in the order of their rapidity of growth.

(From curves)

1. Yellow pine
2. Red fir
3. Tamarack
4. Engelmann spruce
5. Lodgepole pine

During the short time devoted to this study but one or two stem analyses could be made of each species, so it is impossible to judge accurately of the rate of growth from the meagre data at hand. These notes, however, are given subject to revision as more data becomes available.

Altitudinal Range of Several Species within the Wenaha Forest Reserve

Species	Lower limit Feet	Upper limit Feet
Sugar pine	5,000	7,000
Yellow pine	1,500	4,000
Lodgepole pine	3,000	6,000
Tamarack	2,700	7,000
Species	**Lower limit Feet**	**Upper limit Feet**
Engelmann spruce	3,000	7,000
Blue spruce	5,000	7,000
Red fir	2,500	4,000
Lowland fir	2,500	6,000
White fir	4,000	7,000

Forest Enemies

Fire

No serious forest fires have occurred on the area now included in the Wenaha Forest Reserve for several years. During the dry summer and fall months, however, surface fires which usually do not cover a large area are more or less frequent. These fires, which are often started by lightning, run over the ground, burning the litter and any dead timber standing and down, but unless there is a tangle of dead and down timber they rarely do any serious damage to timber trees. In several localities there are old burns covering several acres which are now covered with a tangle of dead and fallen trees among which young trees are growing. If fire should start in such patches it would burn until all dead trees and all the young second growth were destroyed. A fire burning on a slope usually travels upward and burns itself out when it reaches the crest of the ridge.

White fir is especially susceptible to fire. It is often killed when trees of other species of the same size are uninjured. Red fir is perhaps the most fire-resistant species remaining unscathed when yellow pines are scorched and killed. However, yellow pines above 3 inches in diameter are usually not killed by these surface fires.

The worst effects from fires upon slopes is the destruction or injury to the forest floor. The humus is burned off leaving a shallow soil unprotected from erosion. Rocks and burning logs are often loosened by the heat and roll down the steep slopes doing further

damage by spreading the fire. The soil is left dry and is destroyed in patches furnishing but a poor seedbed for further restocking.

Insects

Very little damage was noted from this cause. Yellow pine is injured by the yellow pine bark borer (*Dendroctonus*) the larvae of which burrow extensive channels in the inner bark. The leaves turn brown and the bark drops off and the tree dies. This injury is not, however, widespread.

There is an insect which forms a gall on the twigs of both species of spruce. Though common, it does no damage to the timber so far as was discovered. A similar disease was noticed on the upper twigs of the tamarack, though this is not as common as the spruce gall.

Atmospheric Agencies

These are considered under "Climate."

A List of Trees and Shrubs of the Wenaha Forest Reserve Washington and Oregon

COMMON NAME	LOCAL NAME	SCIENTIFIC NAME
Sugar pine	White pine	*Pinus lambertiana* Dougl.
Western yellow pine	Bull or yellow pine	*Pinus ponderosa* Laws.
Lodgepole pine	Black pine	*Pinus murryana* "Oreg.Com."
Engelmann spruce	Spruce	*Picea engelmanni* Engelm.
Blue spruce	Spruce	*Picea parryana* (Andre) Parry
Douglas spruce	Red fir	*Pseudotsuga taxifolia* (Lam.) Britton
Lowland fir	White or balsam fir	*Abies grandis* Landl.
White fir	White fir	*Abies concolor* (Gord.) Parry
Pacific yew	Yew	*Taxus brevifolia* Nutt.
Willow	Willow	*Salix* (several species)
Aspen	Quaking asp	*Populus tremuloides* Michx.
Black cottonwood	Bam tree	*Populus trichocarpa* Forr. and Gr.
Western birch	Birch	*Betula occidentalis* Hook.
Paperleaf alder	Alder	*Alnus tenuifolia* Nutt.
Black haw	Haw	*Crataegus douglasii* Lindl.
Bitter cherry	Wild cherry	*Prunus emarginata* (Dougl.) Walp.
Western choke cherry	Choke cherry	*Prunus demissa* (Nutt.) Walp.
Dwarf maple	Maple	*Acer glabrum* Torr.
Pacific dogwood	Dogwood	*Cornus nuttalii* And.
Pale elderberry	Elderberry	*Sambucus glanca* Nutt.

Shrubs

Salal	Salal	*Gaultheria shallon* Pursch
Red huckleberry	Huckleberry	*Vaccinium parvifolium* Smith
Blue huckleberry	Huckleberry	*Vaccinium ovalifolium* Smith
Buck brush	Buck brush, goat brush, or wild box	*Pachystima mysinites* Raf.
Mountain mahogany	Mahogany	*Cercocarpus parvifolius* Nutt.
Service berry	Sarvice	*Amelanchier alnifolia* Nutt.
Wild rose	Wild rose	*Rosa gymnocarpa* Nutt.
	Raspberry	*Rubus nutkanus* Moc.
	Raspberry	*Rubus spectabilis* Pursch.