ANNUAL SILVICAL REPORT

MALHEUR NATIONAL FOREST

1911

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THE FOREST

1. LIST OF TREES

(a) Conifers

Pinus monticola	Western white pine
Pinus albicaulis	White-bark pine
Pinus ponderosa	Western yellow pine, Bull pine
Pinus contorta	Lodgepole pine, Black pine
Larix occidentalis	Western larch, Tamarack
Picea engelmanni	Engelmann spruce
Pseudotsuga taxifolia	Red fir, Douglas fir
Abies lasiocarpa	White fir
Abies grandis	White fir
Abies concolor	White fir (?)
Chamaecyparis nootkatensis	Alaska cedar, Yellow cypress
Juniperus communis	Ground juniper
Juniperus scopulorum	Red cedar, Juniper
Juniperus occidentalis	Western juniper
Taxus brevifolia	Yew

(b) Hardwoods

Salix nigra	Black willow
Salix lasiandra	Western black willow
Salix nuttallii	Willow
Populus tremuloides	Aspen, Quaking asp
Populus balsamifera	Balm-of-Gilead, Balsam poplar

Populus trichocarpa	Black cottonwood
Betula fontinalis	Red birch
Alnus rhombifolia	White alder, Mountain alder
Alnus tenuifolia	Mountain alder
Cercocarpus ledifolius	Mahogany

2. SHRUBS

Amelanchier alnifolia	Western service-berry
Crataegus douglassi	Black haw
Berberis nervosa	Oregon grape
Cornus nuttallii	Western dogwood
Kunzia tridentata	Sage brush, Greasewood
Prunus emarginata	Bitter cherry
Prunus demissa	Choke cherry
Artemisia rigida	Scabland sage brush
Rosa gymnocarpus	Wild rose
Rubus parviflorus	Thimbleberry
Rubus leucodermis	Black-cap
Sambucus glauca	Elder berry
Opulaster pauciflorus	Ninebark
Vaccinium ovalifolium	Huckleberry
Vaccinium parvifolium	Red huckleberry
Symphoricarpos racemosa	Snowberry
Ceanothus velutinous	Laurel, Sweet laurel, Buck brush

3. FUNDAMENTAL FOREST TYPES

Bottom-land type
Slope type
Alpine type
Transition type

BOTTOM-LAND TYPE. This type is characteristic along streams, in canyon bottoms, on lake shores and in meadows and swamps. The climate in general is clement, although frosts occur late in the spring and early in the autumn. In the highest

meadows frost probably occurs every night in the year. The soil on the lower bottoms is alluvial, and on the higher meadows it is glacial drift. The elevation of the lower bottoms is approximately from 3,000 to 5,000 feet, and of the higher meadows from 5,000 to 6,000 feet.

SLOPE TYPE. The slope type is found on the mountain sides at an elevation of from 3,000 to 7,000, or 7,500 feet. The climate is mild in summer, but severe during the winter. There being little or no rainfall during the summer, the mountain sides become very dry. This type may be properly divided into two classes, the south slope and the north slope. The south slope is characterized by long, moderate to fairly steep mountain sides bearing alluvial and rocky glacial-drift soil, ridges and benches. The north slope is characterized by very steep, rough, rocky glacial-drift and alluvial bearing canyon sides.

ALPINE TYPE. The alpine type occurs at an elevation of from 7,500 to 9,000 feet, which is the timber line, on the rough, steep, rocky glacial-drift soils of the upper mountain sides. The climate here is very dry in summer and cold and bleak in winter. This type is exposed to strong, cold winds. Early and late snows abound. In the upper parts of this type snow is occasionally present on the northern aspects throughout the year.

TRANSITION TYPE. The transition type, a type of very minor importance, consists of a narrow strip at the juncture of the slope type with the alpine type. The juncture is very distinct in many places, almost precluding the transition type, while in other places the characteristics of the slope and alpine types intermingle, forming the proper transition type.

4. GENERAL SILVICAL DESCRIPTION

BOTTOM-LAND TYPE

(a) This type forms approximately 20% of the area of the Forest.

(b) The type has a very warm, dry climate during the summer, and a cold climate during the winter. Rain falls abundantly in the early spring and late autumn and there is much snow during the winter. Frost occurs in the lower bottoms from late in August, or early September to late June, and in the higher meadows probably throughout the year. The soil of the lower bottoms is alluvial deposit lying along the stream beds, in meadows, deep glades and at canyon bottoms. The alluvial soil is also found in the upper stream beds and in the higher meadows with glacial-drift soil. The altitudinal range of the type is approximately from 3,000 feet to 6,000 feet.

(c) The lower bottoms contain chiefly alders, willows and the quaking asp, balm-of-Gilead, black cottonwood, bitter cherry, mountain birch, and the various shrubs named in the list. The trees of the higher bottoms are lodgepole pine, Douglas fir, white fir, western larch, quaking asp, willows and alders. Straggling Douglas fir and western

larch occur in the lower bottoms. Engelmann spruce is found sparingly near streams in the upper bottoms. The line of demarcation between this type and the slope type is very abrupt, the yellow pine of the slope type occasionally straggling into the bottoms. The stands are even-aged. Grass covers the ground abundantly and there is a fair accumulation of humus. There is no timber of importance in this type except in the lodgepole stands of the higher parts. The land in this type is chiefly valuable for agriculture below an altitude of approximately 5,000 feet where cultivation is possible. Above this altitude hay is the only crop which can be raised and the chief use of the high meadows is for grazing. Reproduction of lodgepole is very good.

(d) The lower parts of the type are not subject to fire, grazing, nor severe storms. The upper parts are grazed under supervision of the Forest Service. Fire is not prevalent in this part of the type owing to the presence of moisture in the wooded parts, and the absence of any growth but grass and chaparral on the high meadows and prairies. Windfall is not a source of harm because of the density of the stand. The beetle Dendroctonus frontalis is especially prevalent in suppressed lodgepole.

(e) Since the lower parts of the type are practically all patented lands, no recommendations for silvical management are applicable to them. In the lodgepole stands of the higher parts of the type, improvement thinnings should be made to remove the overtopped and suppressed trees which are largely infested with the Dendroctonus frontalis. The over-mature fir and tamarack should be removed.

(f) No subtypes nor temporary types have been observed.

SLOPE TYPE.

(a) The slope type comprises approximately 60% of the Forest.

(b) The type, which has an approximate altitudinal range of from 3,000 to 7,000, or 7,500 feet, has a hot, very dry summer climate with no rainfall from about the first of June to the first of October. The winters are severe with much snow and strong west and northwest winds. Rain is fairly plentiful during spring and autumn. On the lower slopes frost occurs from early fall to late spring, while on the higher slopes the occurrence of frost probably extends over a longer period. The type, as has been stated, may be divided into two classes, the south slope and the north slope. The south slope is found on the long slopes of montain {*mountain}* sides having a moderate to fairly steep ascent and bearing alluvial soil on the lower slopes and rocky glacial-drift on the upper slopes. Benches and minor ridges frequently break the continuity of the slope, and frequent outcropping of rimrock are found at the upper edges of the type. The north slope is found on a very steep, rough canyon sides. The soil is alluvial near the bottoms of the canyons, and above it is rocky glacial-drift.

(c) The best and most important timber occurs in this type. The stand on the south slope is composed chiefly of yellow pine, with a sparse mixture of Douglas fir. Toward the tops of the slopes Douglas fir becomes more prominent, forming nearly one-half of

the stand, and white fir appears. The north slope stand is composed of Douglas fir, white fir, and western larch in about even proportions, with scatteringly yellow pine. Very excellent yellow pine is found at the upper edges of the north slopes, showing its delight in cool, fairly dry and well lighted situations. Throughout both slopes are found dry knobs bearing juniper and mountain mahogany. The stand on the north slopes is much denser than that on the south slopes, being composed of much more tolerant trees. The stand on both slopes is mainly of standards and veterans, with large poles. Reproduction on the south slopes is excellent in wells and only fair under the mature timber. Reproduction on the north slopes is generally good throughout the stand. The ground cover of both slopes is pine grass and scattering chaparral. There is much litter of needles on both slopes and it is especially thick on the south slopes. There is almost no humus present on the south slopes and very little on the north slopes, due to the dryness of the region which makes decay very slow. Humus is present mixed with the mineral soil, but there is no definite layer of humus under the litter, as there is in a hardwood forest.

(d) Grazing of sheep, cattle and horses is very extensive throughout the type. The most striking effect of this is seen in the very close cropping of the grass, especially where sheep have grazed, and the loosening of the soil. No injury to reproduction has been observed.

Injury to the needles of yellow pine by the larva of the pine butterfly, (Anastaphia menapia) is widespread. "Witches' Broom" caused by a fungus, (Razoumofski robusta) is prevalent on Douglas fir, white fir, western larch and lodgepole, and is found occasionally on yellow pine. Windthrow is extensive throughout the type, chiefly among the over-mature veterans, and especially on fire swept areas.

Fire is a great menace to reproduction and it destroys the litter of needles, thus exposing the soil to the drying action of the sun and wind. Inasmuch as the fires in this type have been ground fires the mature trees are apparently uninjured, except that in the butts of many over-mature trees which are affected by decay, "goosepens" have been formed by the very hot fire in a deep accumulation of litter.

Much of the yellow pine, Douglas fir and western larch is over-mature and rot is starting in the heartwood, a fact which is evidenced by the appearance of stag-headedness.

Injury to seedlings and saplings by porcupines and other rodents gnawing the bark has been observed.

Injury by snow-bending and break has been observed in dense stand on the north slopes.

Broken tops, splits and gashes are everywhere evident as a result of the striking of lightning.

(e) Since the greater part of the stand in this type is mature and over-mature and is deteriorating, it is recommended that this timber be removed as speedily as possible. As reproduction in the open wells on the south slopes is excellent, it will be safe to remove all the mature timber from the immediate vicinity of the wells. Where the stand is dense it will be best to leave the poles and trees below eight or ten inches in diameter to furnish seed and another crop within twenty to thirty years, and to protect the soil from washing and drying out. The mature and over-mature timber on the north slopes should be removed and the poles left for a future crop. The white fir which is of low value, should all be removed and preference given to Douglas fir and western larch. Dead and down timber should be disposed of by sale at a low price, by free use, or by burning at once. The removal of deteriorating timber, and of dead and down timber by other means than by burning, will necessarily be slow, because of the sparse settlement of the region and the lack of any large demand for timber.

(f) No subtypes nor temporary types have been seen in the slope type.

ALPINE TYPE.

(a) The alpine type forms approximately 15% of the Forest.

(b) The altitudinal range of this type is approximately from 7,500 to 9,000 feet. The timber line on this Forest is at about 9,000 feet elevation.

The climate of this type is warm and very dry during the summer. The rainy season is identical with that of the slope type. Snow instead of rain is likely to fall on the upper part of the type, and especially on northern exposures, and on these places snow is occasionally found throughout the year in depressions and hollows protected from the hot sun. Frost is probably prevalent here from one year's end to another. The type is exposed to bleak, cold, strong winds, and severe winter storms. The soil is rocky glacial-drift on the steep, very rough upper mountain sides and secondary ridge backs. The roughness, steepness and high elevation of the type makes it nigh inaccessible except on foot or on horseback.

(c) The stand is composed mainly of white fir and Douglas fir, lodgepole pine and western larch, with some white-barked pine and alpine fir, and, at the lower edge of the type, scattering yellow pine. The firs and western larch are found on the slopes where there is some moisture, the lodgepole pine is found at the heads of creeks, in small meadows and in glades, and the white-barked and alpine fir on the drier portions of the type. There is an abundance of chaparral brush throughout the type. The stand is uniformly even-aged, consisting of standards, veterans and some few large poles. The timber is inferior and of value only to hold the soil from washing and sliding, to hold the snows, and to secure a sustained water supply. Reproduction of fir and western larch is good. The ground cover is sparse grass, low shrubs and creeping vines. The locally called laurel, a low spreading shrub, is very abundant in this type.

The humus conditions in this type are very similar to those in the slope type. Under the lodgepole pine stands near creek beds and on northerly aspects under denser fir and the less dense western larch, humus is more plentiful than in the slope type, and on the southerly aspects of the alpine type.

(d) The chief external influence operative in this type is wind. Severe north and northwest storms accompanied by strong winds, stunt, distort and break the trees.

Snow-break and bending is naturally widespread in this type.

Grazing is carried on in this type as in the slope type and the effects noticed are similar to the effects of grazing in the slope type.

The effect of fire has been noticed rather extensively in this type. There is much burned over area upon which blown down timber is thick. The litter on these areas has been destroyed. Reproduction and saplings have been injured by fire, but injury to mature timber is not apparent. Reproduction of lodgepole, fir and western larch is coming in well on burned areas.

(e) The use of this type should be to protect the soil, and to conserve the water supply. It would be well to remove dead and down timber which would probably be disposed of by burning. The mature timber may be taken when the upper parts of the slope are logged. There is some good mature yellow pine timber in the lower part of this type which can be taken with the timber in the upper part of the slope type.

(f) There have been observed no temporary nor subtypes in the alpine type.

TRANSITION TYPE.

(a) The transition type comprises approximately 5% of the Forest.

(b) The climate of this very minor and unimportant type is practically the same as that of the alpine type. The soil is the rough, stony glacial-drift characteristic of the upper mountain slopes. The elevation of the type is approximately 7,500 feet.

(c) This type is a commingling of the trees of the slope type and the alpine type at the juncture between these two types. There is in some places a very distinct break from the slope type to the alpine type. In other places there is a very gradual merging of the two types, forming the real transition type. The sharp line between the slope and the alpine types occurs at points where rough, rocky ridges separate the two types. The merging of the two types occurs where the mountain side continues up from the slope type into the alpine type in an unbroken slope. The good yellow pine timber, which has been spoken of as occurring in the lower parts of the alpine type, occurs at these places. There are also some very good firs and larches in these places.

(d) The external influences observed in this type are the same as those observed in the alpine type.

(e) The type should be managed in the same way that the alpine type is managed.

(f) No subtypes nor temporary types occur in the transition type.

II. SILVICS OF SPECIES

Pinus ponderosa
Western yellow pine

1. Habit

The average maximum diameter of yellow pine is between 50 and 60 inches. Its average diameter at maturity is about 48 inches or less. This tree grows to a usual height of 90 to 110 feet or a little over. Trees from 150 to 200 feet high have been seen. Most mature trees have a height of 90 to 100 feet.

The young trees have a straight bole with a conical crown well to the ground. After passing the early part of the sapling stage, the tree cleans itself and the small, open crown near the top of the bole, so characteristic of mature trees, begins to form. The crown of the mature tree is formed of short, twisted, scraggly heavy limbs, with the leaf-bearing branches near the ends.

The seedling has a well developed tap-root which later disappears in the formation of a strong lateral root system. The lateral roots of mature trees are very large and spreading. Trees in openings at the edges of stand have been seen with heavy lateral roots extending for 40 to 50 feet on and just under the surface of the ground. In dense stands the roots are naturally restricted, but as this tree never occurs in very dense stand, the trees have a firm footing in the ground.

2. Occurrence.

Yellow pine is found on the south slopes chiefly, where the finest timber grows. The stand is pure and even aged. In this situation yellow pine forms nearly 90% of the stand. The tree is also found on the north slopes, but in no great numbers. Near the tops of the north slope in the slope type the finest yellow pine timber grows. It is in moist well drained soil where it can get plenty of light. Very fine specimens of this tree are found down lower on the north slopes with the firs, but always in the open spaces where they can get light.

The tree ranges in altitude from 3,000 to about 7,000 feet. The best yellow pine is found in pure stands from the edges of bottom lands up nearly to the edges of the alpine type. Above the pure stands is found mahogany with Douglas and white firs, western larch, lodgepole and Engelmann spruce. Yellow pine is found with lodgepole

pine at the lower parts of canyons. It associates on the north slopes with firs, western larch and lodgepole pine.

3. Soil and moisture.

Yellow pine prefers a sandy loam with a fair admixture of clay, but it is by no means confined to this kind of soil. It grows on the dry sandy glacial-drift soils at the upper part of its range, and on the heavier loams of the slopes and benches and is found at the edges of stream bottoms of the very moist clay-loams. The tree evidently desires a good supply of water as it sends its roots out for considerable distances. The benches upon which it grows have ground water percolating beneath the surface. Expect in the higher parts of its range, this type is in a locality where the atmospheric moisture is slight for the greater part of the year. The tree seems to be able to reach out and find water on very dry portions of its range.

4. Tolerance of Shade.

The yellow pine is the most intolerant tree on the Forest, next to the black cottonwood. This tree never forms very dense stands, but the pure stands are open and well lighted, and in mixture with its associates it is found in open spaces. The characteristic intolerance of this tree is prominent throughout its life.

5. Growth and Longevity.

The height and diameter growth of yellow pine is rapid especially between the ages of 25 and 75 years. The increase in height at this time is frequently from 1 to 2 feet, and in diameter the increase is about one-half inch. The mature age of the tree is approximately 200 years. The tree remains sound to an age of about 250 years. The maximum age recorded is 400 years. In rapidity of height growth is about equal with the firs, slightly slower than the western larch, and a very little faster than lodgepole pine.

The figures given here are the results of studies of age made on stumps on a cut over area.

Yellow Pine

Stump Height	Diameter	Age
2 feet	39 inches	325 years
2 feet	30 inches	200 years
2 feet 1 inch	34 inches	300 years
Growth in diameter during first 100 years		11.5 inches
Growth in diameter during second 100 years		4 inches
Growth in diameter during third 100 years		1.5 inches

Stump Height	Diameter	Age
2 feet	32 inches	315 years

The ring count was taken at a point 5 feet and 4 inches above the ground.

Growth in diameter during first 100 years	8.66-2/3 inches
Growth in diameter during second 100 years	9 inches
Growth in diameter during third 100 years	2 inches

Growth in diameter from 63 to 140 years of age, 77 years, 7.75 inches.

6. Reproduction

(a) Seed production

Yellow pine bears annually a good crop of seeds and a prolific crop every three or four years. The cones require two years in which to mature. The cones become ripe in late August and early September and shed the heavy, winged seeds, which are chiefly disseminated by wind and water. Birds and rodents consume much yellow pine seed. Squirrels make large hordes of the cones.

(b) Seedling Development

The seed requires mineral soil in which to germinate well, although it will germinate in soil over which is a slight litter of needles. The seedling thrives best in mineral soil. Seedling development is best in the partial or slight shade furnished in the wells throughout the Forest. This is apparently due to the need of moisture which is present in these places. Seedlings have been found in very open and dry situations. Seedling development is sparse in all places except the wells.

7. Susceptibility to Injury.

Yellow pine is very free from overthrow by wind. At higher elevations it becomes distorted by strong winds, and dwarfed. Frost exercises but slight injury, occasionally blighting the terminal shoot, producing "spike tops". Yellow pine is often struck by lightning.

Fire, which burns fiercely in the litter of dry needles, quickly destroys the seedlings, but has little effect on the mature trees, because of the very thick bark. Fire forms "goosepens" in the butts of trees affected by rot.

The larva of the pine butterfly (Neophasia menapia) injures the needles to a slight extent. No other injurious insect has been observed on this tree.

The mistletoe (Razoumofski robusta) if found sparingly on yellow pine.

Grazing is widely carried on in yellow pine stands with apparently no injurious effect. The surface soil is loosened, and the grass is kept short, but readily recovers under proper regulation of the grazing. In the fall the grass is very short and soil baked, but the fall rains cause the grass quickly to recover and the soil to become soft and mellow.

Pinus contorta
Lodgepole pine

1. Habit.

The lodgepole pine attains a maximum diameter of 20 inches and maximum height of 80 feet. The mature tree has an average diameter of 16 to 18 inches, and an average height of 50 to 60 feet.

The tree when young has a straight, slowly tapering bole, with branches extending well to the ground, forming a pyramidal crown. The tree begins to clean itself when it has reached the height of about 40 feet, and from that time on it has a small, conical crown occupying the upper third of the bole.

The root system of lodgepole pine is not extensive, but consists of numerous, large lateral roots confined to a small space about the tree. A decided tap-root has been observed, especially in the drier places. The presence of the tap-root may be accounted for by the dryness of the region.

2. Occurrence.

The lodgepole pine is found in this Forest on the alluvial soils of the creek bottoms and glacial-drift soils of the meadows, along stream beds, and on the moist north slopes, at an elevation of from 4,000 feet to timber line. At the timber line it is but a stunted, twisted tree on the sides of the ridges. It is found but scatteringly in this latter place. Lodgepole pine is commonly associated with western larch, Douglas fir, white fir and yellow pine. It forms pure stands along the higher water courses and ridges of the meadows. On the north slopes it grows with Douglas fir, white fir and Engelmann spruce, lower down in the creek bottoms it is found with yellow pine and in pure stands.

3. Soil and Moisture.

The lodgepole pine evidently prefers a moist, but well drained loamy soil with a fair admixture of sand, although it is found on light, dry ridges. The best trees are found in the very moist bottoms and on moist slopes, indicating the tree's delight in plenty of water. It has, indeed, been found on the very edges of streams. The tree occurs in those parts of the Forest where is found the most atmospheric moisture.

4. Tolerance of Shade.

The lodgepole pine next to the yellow pine and western larch is the most intolerant tree on the Forest. It forms fairly dense pure stand in its lower situations, with about 20% dominant trees and the remainder overtopped and suppressed. When found in mixture with other trees it is found in the more open places. It is very much less tolerant than Douglas fir and white fir. It will grow in dense shade, but only poorly. Its recovery from suppression is good, if this is accomplished before the tree reaches the large pole stage.

5. Growth and Longevity.

Lodgepole pine is a very slow grower in height, about equal with its association. The growth in diameter is much slower than the height growth. No studies of the age of this tree have been made, but it probably remains sound and vigorous for 100 years, or a little over. It is known to have reached the age of 150 and 200 years.

6. Reproduction.

(a) Seed Production

The lodgepole pine in this region is a prolific annual seed producer. The cones, which are abundant, ripen in August. Many cones remain closed for years, and are opened by the heat of fire which destroys the stand. The stand is in this way renewed, as the seed quickly germinates, and the seedlings thrive in the exposed mineral soil. Empty cones are persistent. Trees as young as 8 to 10 years bear fertile cones. Seed is dispersed by wind. The seed requires direct sunlight for germination, as do the seedlings for good growth. Squirrels horde the seed in large quantities, and birds eat many seeds.

(b) Seedling Development

The seed germinates best in mineral soil and direct sunlight. The seedlings will grow in the more or less open shade of yellow pine, and in the less shaded places among firs, but they do best in the open sunlight.

7. Susceptibility to Injury.

Inasmuch as the lodgepole pine has a shallow lateral root-system, it is easily blown over by wind, especially after afire. The timber on all fire swept areas which I have seen has been blown over, which is a very different case from that of the yellow pine and firs on such areas. The presence of the tap root in this region seems to be of no help in saving the trees from blow-down, which leads me to think that the tap root is developed as a means by which to get water, and has not yet become sufficiently well developed to act as a firm anchor. Distortion by wind is frequent. The tree is very susceptible to injury by fire because its bark is very thin. Fire does not injure the seed in unopened cones.

Lightning causes broken tops and gashes. It probably causes many fires in the lodgepole stands.

No injurious effect from grazing have been noticed. The soil at the surface is trampled and loosened to a slight extent.

The tree is apparently uninjured by frost.

A mistletoe, (Razoumofski robusta) produces "Witches' Broom" among the smaller branches and twigs, and swellings on the larger branches. This pest is not widespread on the lodgepole pine.

There is a very widespread and severe attack of Dendroctonus frontalis throughout the Forest. The infestation is confined to the overtopped and suppressed trees, and in these the injury is very severe. The infested trees are rapidly succumbing to the attack. In one or two instances the beetle has been found in mature timber where the infestation of the under wood is particularly bad, but in no case is it more than sporadic. The lodgepole pine is the only tree in which this insect has been found.

Larix occidentalis
Western larch – Tamarack

1. Habit.

Western larch grows to a height of 180 to 200 feet. The average height at maturity is 100 to 150 feet. Trees with a diameter of 4 feet or a little over have been seen. The usual diameter is 2 to 3 feet. When young the tree has a symmetrical crown extending well to the ground forming a pyramid. The tree cleans itself very early, and soon forms a pyramidal crown occupying the upper fourth of the bole. The bole is tall, straight, and has a fairly rapid taper.

The seedling has a tap root which, at the third or fourth year disappears, and there is formed a lateral root-system, not quite so spreading as the root-system of yellow pine.

2. Occurrence.

Western larch is found on the north and northwest exposures of the north slopes and on the higher benches of the south slopes, and in creek bottoms. It occurs here on clay-loam which is moist, and in localities where it receives a good supply of rain, and, on the north slopes, fog.

This tree is commonly associated with Douglas fir and white fir, lodgepole pine and yellow pine.

3. Soil and Moisture.

Western larch demands a clay-loam soil, which is rich and moist. The benches and depressions on the south slopes where this tree grows have underground water. There

is considerable atmospheric moisture in the situations occupied by this tree, and, during the rainy season, considerable rainfall.

4. Tolerance of Shade.

The western larch ranks next to yellow pine in intolerance. Only in the seedling stage does it bear shade. It is found at the middle and upper reaches of the north slopes with its crown well up in the light. It never forms dense stands, and if it finds itself in a dense stand, it pushes its way above its associates. From this it may be inferred that it will recover well from suppression.

5. Growth and Longevity.

No studies of growth and age have been made in detail, but the height growth has been observed to be rapid and the tree's diameter growth rapid and even. It is faster in height growth than its associates, and in diameter growth ranks with Douglas fir and yellow pine.

This tree remains sound for 150 years or more, and probably lives to be 200 or 300 years old.

6. Reproduction.

(a) Seed Production

The cones mature in one season, releasing abundant light winged seed in August. In the middle of the autumn the cones fall. The seed is disseminated by wind, water and sparingly by rodents.

(b) Seedling Development

The seed germinates and the seedling thrive on the rich moist soil, and in the shade of the north slopes and benches of the south slopes. The seedling, however, rapidly pushes its way up into the light, passing its more tolerant neighbors. The seed requires shade and moisture for germination, and the seedling requires like conditions for development.

7. Susceptibility to Injury.

The tree is fairly wind firm. The strong winds at the upper parts of this tree's range stunt and dwarf it. Injury from frost has not been observed. Lightning strikes the high, pointed tops of this tree.

Fire destroys the seedlings, but, owing to the thickness of the bark, does no damage to large trees. Fire forms "goosepens" in the butts of over mature trees which are rotting.

The effect of grazing on western larch is the same as that of yellow pine.

No insect pests have been seen on this tree.

The mistletoe, (Razoumofski robusta) has been found rather widespread on this tree.

Picea engelmanni
Engelmann spruce

1. Habit.

The Engelmann spruce grows to a height of about 75 to 100 feet in this region. The diameter is from 16 to 24 inches.

The bole is straight, regular, and has a very appreciable taper. The bole is usually well clothed with branches to within 20 or 30 feet of the ground. In very dense stands the bole cleans itself early, the crown occupying the upper one-third or one-half of the bole. The crown is spire-formed, narrow and pointed, composed of short thick branches. This tree has a shallow, restricted lateral root-system wherever it has been seen on this Forest.

2. Occurrence.

Engelmann spruce is found at an elevation of from 5,000 feet to near the timber line, on north slopes, moist bottoms at stream heads, and in moist hollows at the upper parts of its range. It is found where there is an abundance of soil moisture, and where the heaviest precipitation occurs. It is not found on hot, dry slopes which are exposed to direct sunlight. It occurs with Douglas fir and white fir, lodgepole pine, western larch, cottonwoods and occasionally with yellow pine.

3. Soil and Moisture.

This tree seems to prefer the moist loam-soils of stream bottoms near their heads, and in the depressions and little vales in the higher ranges. Near the timber line the soil is glacial-drift, watered by melting snows. The tree seems to delight in the abundant rainfall during the rainy season, and the fairly frequent occurrence of fog.

4. Tolerance of Shade.

The Engelmann spruce is very tolerant of shade, occurring in dense stands, usually crowded and shaded by an overwood of fir, lodgepole pine and western larch. Next to white fir it is the most tolerant species of the Forest, and it is occasionally found on fairly open sites, but never in direct sunlight. The growth in dense stands and shade is slow, and the response to freedom from suppression is rapid.

5. Growth and Longevity.

No studies of the growth and length of life of this tree have been made. The growth is very slow, and the tree probably lives to be in the neighborhood of 300 years old.

6. Reproduction.

(a) Seed production

Annual seed production is fairly abundant, with large crops every three or four years. The cones mature the latter part of August, and the seeds are scattered by wind, water, and to some extend by animals.

(b) Seedling Development

The seedlings seem to develop best in the deep, moist soil of the shaded stands.

7. Susceptibility to Injury.

Engelmann spruce at the higher elevations is dwarfed by strong winds. Injury by fire is slight.

No other injuries have been observed, except the occasional presence of "Witches' Broom" cause by Razoumofski robusta.

Pseudotsuga taxifolia
Red fir – Douglas fir

1. Habit.

The average mature diameter observed is 30 to 50 inches, and the maximum diameter is about 60 inches. The height of the tree ranges from 80 to 120 and 150 feet.

The bole of this tree is straight, tall, and slightly tapering. The crown is full and extends well toward the ground, while the tree is young. The bole clears itself in the pole stage forming a symmetrical pyramid occupying the upper one-half or two-thirds of the tree.

The tree has throughout its life a well developed firm lateral root-system.

2. Occurrence.

Douglas fir occurs in fairly dense stands on north slopes and scatteringly on south slopes. It is the dominant tree on the north slopes, where it ranges in altitude from 4,000 to 6,000 feet. It occurs sparsely among the yellow pine on the south slope types. This tree is not abundant at high elevations, but is found there mixed with white firs. It occurs at canyon bottoms with lodgepole pine and western larch. Its associated

species are white fir, yellow pine, western larch and lodgepole pine and Engelmann spruce.

3. Soil and Moisture.

The Douglas fir prefers deep moist soil found on north slopes and in canyon bottoms. It will grow in the drier soils on south slopes. At the higher parts of its range, this tree grows on southern exposures where it gets heat. The tree shows a preference for mineral soil. The tree requires more moisture than does yellow pine, but seems to be able to adapt itself to moderately dry soils. Douglas fir delights in abundant atmospheric moisture, its situation being at places where rainfall and fog is fairly plentiful, in fact where these conditions are best in this region.

4. Tolerance of Shade.

Douglas fir is slightly more tolerant than western larch, yellow pine and lodgepole pine, and less tolerant than white fir and Engelmann spruce. It occurs in fairly dense stands when pure, and in the open spaces among its more tolerant associates. It bears well the shade of yellow pine. When growing in dense stands of lodgepole pine it overtops the latter. This tree recovers well from suppression.

5. Growth and Longevity.

The rate of growth of this tree in diameter is regular, slightly faster during the first 100 years of its life than after that. The height growth is rapid, frequently being 10 to 18 inches a year. The tree forces itself over its more tolerant competitors. Douglas fir remains sound and vigorous to an age of about 150 to 200 years. The maximum age recorded is 231 years, but trees much older than this could probably be found by thorough study.

The following figures may be of interest:

Diameter at 24 feet from ground	26 inches	Age 215 years
Stump height 2 feet	Diameter 28 inches	Age 155 years
Growth in diameter during first 100 years	9 inches	
Growth in diameter during next 55 years	5.5 inches	
Stump height 2 feet	Diameter 32 inches	Age 231 years

6. Reproduction.

(a) Seed Production

The Douglas fir is an abundant annual seed producer with very large seed crops at intervals of three to five years. The cones ripen in August and drop the seeds in

September. The seed is disseminated by wind, water and rodents. No agencies detrimental to the seed have been observed.

(b) Seedling Development

The seedlings require mineral soil in which to thrive. Development in its own shade is poor, fair under other species, and best in open spaces partially shaded. Abundant moisture is necessary for germination and good growth.

7. Susceptibility to Injury.

Fire does little harm except to the butts of over-mature trees, owing to the thick bark. Ground fires are destructive to reproduction. Hot fire will probably injure saplings which have not developed thick bark.

Grazing is probably beneficial to reproduction by loosening and exposing the mineral soil.

Wind stunts and distorts Douglas fir at high points, but as the bulk of the stand is in sheltered places, overthrow is rare except after fire. Snow break is common as large quantities of snow lodge on the thick branches.

No insects have been found in this tree.

Distortions and "Witches' Broom" causes by the fungus Razoumofski robusta are common.

Injuries from lightning have been occasionally seen. No injury from frost has been observed.

Abies grandis
White fir

1. Habit.

The white fir in this region has a diameter of 30 to 50 inches and a height of 80 to 120, or 130 feet.

It has a tall straight bole, tapering rapidly at the top. The crown is in the form of a long, narrow, rounded cone, with branches well to the ground. The root-system is lateral, confined to a small area.

2. Occurrence.

The white fir occurs on the moist loams of north, northwest and northeast slopes principally near the canyon bottoms. It extends sparsely to the upper reaches of the

slope type. It associates with Douglas fir, lodgepole pine and western larch. It ranges in altitude from 3,000 to 6,000 feet.

3. Soil and Moisture.

This tree delights in very moist soil and regions where the air is cool and moist, with fog. It grows best in mountain dells and spring holes where is found rich loamy soil.

4. Tolerance of Shade.

White fir next to Engelmann spruce is the most tolerant tree of the Forest. It is tolerant throughout its life. The tree is capable of growing in dense stands at the lower parts of its range, and is scattered among Douglas fir and lodgepole pine. It is found sparingly on southerly aspects at the highest parts of its range among Douglas fir, lodgepole pine and yellow pine. The white fir is able to hold its own in the dense shade of its associates and will probably recover will from suppression.

5. Growth and Longevity.

No studies of this matter with respect to white fir have been made, but trees on this Forest are probably in the neighborhood of 200 to 300 years old. Growth seems to be regular and even. Height and diameter growth is moderate, the height growth being slightly slower than that of Douglas fir. The heart of white fir is quick to decay, as a rule all trees over 15 or 20 inches in diameter being rotten in the heart.

6. Reproduction.

(a) Seed Production.

Annual seed production is good. The cones mature early in the fall and soon release the seed which is disseminated by wind and water.

(b) Seedling Development

The seedlings thrive excellently in rich moist soil under dense cover, and especially in the sparsely lighted openings among the white and Douglas firs.

7. Susceptibility to Injury.

Windthrow, especially after fire, is widespread. Injury from fire is similar to that of Douglas fir. Snow break is common. Strong winds at the higher elevations stunt and distort this tree.

No injury from grazing has been observed.

The fungus Razoumofski robusta is prevalent on this tree.

Populus tremuloides
Aspen, Quaking asp

1. Habit.

Aspen has a diameter of from 6 to 10 inches and a height of from 20 to 50 feet. Rare trees are found which are 15 to 20 inches in diameter and 90 to 100 feet tall.

The bole is straight with a dome shaped crown at the upper third of its length. The tree has a shallow lateral root-system.

2. Occurrence.

Aspen is found in creek bottoms, glades and spring holes at an elevation of from 3,000 to 5,000 feet. Its associates are bitter cherry, balsam and black poplars, serviceberry, black haw, mountain birch and willows.

3. Soil and Moisture.

Aspen prefers deep, rich loams with abundant ground water. It will grow in gravelly soils provided that is ground water percolating through them. It requires considerable rainfall.

4. Tolerance of Shade.

The tree is moderately tolerant throughout its life, having a thick crown in shade and a more open crown at the top. It occurs in fairly light mountain glades surrounded by conifers.

5. Growth and Longevity.

This tree is commonly 40 to 50 years old, occasionally 75, or 80 years old. The diameter growth is slow, while the height growth is rapid in early life and slower as the tree approaches maturity.

6. Reproduction.

(a) Seed Production

Abundant seed production takes place in early spring. The seed, which is very light and winged is borne long distances by the wind. The seed requires moist soil and sunlight for germination, and for the growth of the seedling.

(b) Seedling Development

The seedlings develop best on moist open ground, and especially after fire on cleared areas.

7. Susceptibility to Injury.

Injury by wind-break when the branches have been snow laden has been seen. Beavers fell large numbers of this tree. Fire is injurious to seedlings, and probably to mature trees because of the thin bark, although fire is uncommon on the areas where this tree grows.

Grazing is not common on the sites occupied by this tree, and injury from this source is not apparent.

Populus balsamifera
Balm-of-Gilead, Balsam Poplar

1. Habit.

Balsam poplar grows to a height of from 80 to 90 feet, having a diameter of from 15 to 24 inches.

The bole is straight, topped in the upper two-thirds of its length by a vase shaped crown. It has a shallow lateral root-system.

2. Occurrence.

The tree grows on rich deep, very moist loam soils in the canyon bottoms below 4,000 feet elevation. It is commonly associated with Populus tremulides and trichocarpa, mountain birch, willows, black haw, elderberry and service-berry.

3. Soil and Moisture.

The tree requires abundant soil moisture and is not exacting in the matter of rainfall. Its presences along streams in well watered gravels and about ponds shows its dependence on soil moisture.

4. Tolerance of Shade.

Balm-of-Gilead is an intolerant tree, but becomes more tolerant with age. It extends its branches well into the light.

5. Growth and Longevity.

No studies have been made, but the tree probably lives to be 50 or 75 years old. Diameter and height growth is rapid.

6. Reproduction.

(a) Seed production

Abundant seed is produced in April and May, which is light and winged, and is blown far by the wind.

(b) Seedling Development

The seedlings develop best on rich moist soil in the partial shade of the overwood.

7. Susceptibility to Injury.

No injuries have been notes.

Populus trichocarpa
Black cottonwood

1. Habit.

Black cottonwood grows to a height of 80 to 120 feet, with a diameter of from 15 to 36 inches. It has a long, straight bole, with a short, close crown. The root-system is lateral and shallow, not wide spreading.

2. Occurrence.

This tree grows on very moist loams and gravels in the lower canyons and stream valleys. It associates with the other poplars, with service-berry, wild cherry, black hay and willows.

3. Soil and Moisture.

This tree requires large quantities of soil moisture as it is in a region where rainfall is sparse.

4. Tolerance of Shade.

Black cottonwood is very intolerant throughout its life. It is more intolerant than any of its associates and pushes its head above them.

5. Growth and Longevity.

Height growth is extremely rapid, while diameter growth is much slower. This tree probably lives to be 100 years or more of age.

6. Reproduction.

(a) Seed production

Seeds are borne abundantly in early spring and are widely disseminated by wind and water.

(b) Seedling Development

The seed germinates and the seedlings grow best in deep, rich moist soils in direct light.

7. Susceptibility to Injury.

The buds are at times injured by frost.

The trees given in the list which have not been described have not been sufficiently studied for this report.

III. SILVICAL PROBLEMS

Subjects For Especial Silvical Studies Which Would Be Of Value To This Forest

1. The effects of different methods of brush disposal on reproduction.

2. The reproduction of Pinus ponderosa, or any other species on the Forest.

3. The occurrence of species in mixture on the Forest and the reasons therefore.

4. The rate of height, diameter and volume growth of yellow pine, Douglas fir, or some other important timber tree on the Forest.

5. The effect of cattle, sheep, or horse grazing on reproduction on the Malheur National Forest.

6. Injury to seedlings and saplings by rodents.

7. Reproduction after fire.

8. The effect of fire on standing mature and immature timber.

Species	Tolerance beginning with least tolerant	Maximum and average height	Maximum and average Diameter	Maximum and average Volume	Period of greatest growth	Soil and soil moisture	Site	Maximum and average age
Yellow Pine	Yellow Pine	150-200 ft. 90-110 ft.	50-60 in. 48 in.	5970 b.f 4530 b.f.	25-125 years of age.	Moist sandy loam and well watered gravels.	South slopes, upper parts of north slopes, and benches.	400 years 200 years
Western Larch	Western Larch	180-200 ft. 100-150 ft.	48 inches 24-36 inches	4000 b.f. 1740 b.f.	25--75 years of age.	Very moist rich loams and clays.	North, northeast, and northwest slopes, mountain vales and stream bottoms.	200-300 years 150 years
Lodgepole Pine	Lodgepole Pine	80 ft. 50-60 ft.	20 inches 16 inches	345 b.f. 160 b.f.	25-100 or 125 years of age.	Moist, well drained loams and watered gravels.	Creek bottoms, meadows and north slopes.	200 years 100-125 years
Douglas Fir	Douglas Fir	150 ft. 80-120 ft.	60 inches 30-50 inches	7130 b.f. 1160 b.f.	25-150 years of age.	Rich, moist loams and well watered gravels.	North, north-west and north-east slopes, bottom lands and glades.	231 years 150 years
Engelmann Spruce	Engelmann Spruce	100 feet 75 feet	24 inches 16 inches		First 100 years.	Very moist rich loams.	North slopes and vales.	300 years 175-200 years

Species	Tolerance beginning with least tolerant	Maximum and average height	Maximum and average Diameter	Maximum and average Volume	Period of greatest growth	Soil and soil moisture	Site	Maximum and average age
White Fir	White Fir	120-130 ft. 80 ft.	50 inches 24-30 inches		Probably during first 75-100 years.	Rich, heavy, wet loams and clays.	North glades and stream bottoms.	200-300 years 150 years