GENERAL SILVICAL REPORT

1912

WALLOWA AND MINAM FORESTS.

{*by R.M. Evans*}

1. THE FOREST.

LIST OF TREES ON THE WALLOWA NATIONAL FOREST.

CONIFEROUS SPECIES.

SCIENTIFIC NAME	COMMON NAME
Pinus albicaulis	White bark pine
Pinus ponderosa	Western yellow pine
Pinus contorta	Lodge pole pine
Larix occidentalis	Western larch
Picea engelmanni	Engelmann spruce
Tsuga mertensiana	Mountain hemlock or Black hemlock
Pseudotsuga taxifolia	Douglas fir
Abies lasiocarpa	Sub-alpine fir
Abies grandis	Grand fir or white fir
Juniperus communis	Dwarf juniper
Juniperus scopulorum	Rocky mountain red cedar
Juniperus occidentalis	Western juniper
Taxus brevifolia	Western yew.

DECIDUOUS SPECIES

Scientific Name.	Common Name
Salix Species	Willows
Populus tremuloides	Quaking aspen
Populus balsamifera	Balm of Gilead
Populus trichocarpa	Black cottonwood

Betula occidentalis	Western birch
Betula fontinalis	Mountain birch
Alnus tenuifolia	Mountain alder or Black alder
Alnus oregona	Red alder
Celtis occidentalis	Hackberry
Cercocarpus ledifolius	Mountain mahogany
Amelanchier alnifolia	"Sarvice", serviceberry
Crataegus douglasii	Black haw
Prunus demissa	Western choke cherry
Prunus emarginata	Bitter cherry
Acer glabrum	Dwarf maple or mountain maple
Rhamnus purshiana	Cascara sagrada or Bear berry
Ceanothus velutinus	Sticky laurel or Chaparral
Cornus nuttallii	Western dogwood
Garrya eliptica	Quinine bush
Sambucus glauca	Blue elderberry
Sambucus Canadensis	Red elderberry
Pyrus occidentalis	Mountain ash or bitterberry

SHRUBS.

SCIENTIFIC NAME	COMMON NAME
Artemisia tridentata	Oregon sage
Chrysothamnus nauseous	Rabbit brush
Kunsia tridentata	Antelope brush
Sarcobatus vermiculatus	Greasewood
Berberis nervosa	Oregon grape
Symphoricarpos racemosus	Snowberry
Rosa nutkana Rosa pisocarpa	Wild rose
Artemisia rigida	Scabland sagebrush
Opulaster pauciflorus	Ninebark

Ceanothus sanguineus	Buckbrush
Vaccinium macrophyllum Vaccinium ovalifolium Vaccinium parvifolium Vaccinium scoparium Vaccinium deliciosum	Huckleberries
Rubus parviflorus	Thimbleberry
Rubus spectabilis	Salmonberry
Rubus macropetalus	Dewberry
Rubus strigosus	Red raspberry
Rubus hesperius	
Lonicera involucrata	Honeysuckle
Cornus stolonifera	Red osier
Spiraea corymbosa Spiraea menziesii	Hardhack or arrowwood
Gaultheria ovatifolia	
Myrica gale	Myrtle
Philadelphus lewisii	Syringa
Arctostaphylos uva-ursi	Kinnikinick
Ribes cereum Ribes viscosissimum Ribes irriguum Ribes cognatum	Currants and gooseberries
Rhus glabra	Sumac
Rhus toxicodendron	Poison ivy or oak

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GENERAL DESCRIPTION OF TOPOGRAPHY AND SOIL.

The Wallowa and Minam Forests, together, form a unit with conditions of topography, soil, climate and forests so similar that one description is thought sufficient for both. The report that follows is meant to cover both divisions.

The Wallowa National Forest lies within the physiographic region known as the Columbia plains – a region which is composed of an immense lava flow covering a large portion of eastern Washington, Oregon and Idaho. Through this mass of lava protrude various granitic peaks of more ancient origin known as "steptoes" of which the granite core of the Wallowa Mountains forms the most conspicuous example.

The Forest, itself, includes approximately 1,546,000 acres lying in an irregular crescent shape about the open valley of the Wallowa river. The topography is unusually rough and varied. The entire north and east portion of the Forest to about T 4 S, R 42 E. W.M., may be considered a broad plateau, much dissected by streams and having a maximum elevation varying between 4000 and 7000 feet. The even ridges of the northern part, or what was the old Chesnimnus Forest, make a plateau formation particularly evident. The ridge forming the divide between the Imnaha and Snake Rivers contains the highest elevations of the region. The southern and western portions of the Forest are occupied by the Wallowa mountains which are composed of a granite core surrounded by basaltic lava. The entire region was evidently covered with this lava at one time but erosion and weathering have bared the older granite. The ridges are sharp, the canyons deep and the streams swift. Several peaks rise to an altitude of over 9000 feet and in sheltered spots, snow remains throughout the summer.

The principal streams of the Forest are the Imnaha River and Joseph creek, draining toward the north: The Wallowa and Minam Rivers draining toward the northwest: Catherine creek, draining toward the southwest: and Eagle and Pine creeks draining toward the south and southeast. These streams and their various tributaries carry an immense volume of water and with their storage possibilities are more than adequate to furnish sufficient power and irrigation for the surrounding country. With a few exceptions, the streams head in the heart of the mountains – approximately within the area of a township. Their beds are steep and active erosion is still in progress. Snake River forms the entire eastern boundary of the Forest, running through an enormous gorge, the sides of which will expose the depth and succession of lava flows. A railroad is projected down the west side of this river and this will doubtless be of great value to the Forest in point of increased timber sales.

The soil in, in general, a volcanic ash or clay loam resulting from the decomposition of basaltic rocks. Along stream bottoms, silt, quartz sand, and gravel are common as the result of the waste from the higher mountains. In depth, the soil varies from nothing to many feet. Areas of "Scabland" are frequent. Outcropping of rock or "rimrock" are common in the ridges.

There is a noticeable difference in the vegetation growing upon soils of basaltic and granitic origin even at the same elevation. The former support a much denser growth. This is, no doubt, due to the physical condition of the soil. The basaltic soils are well decomposed, porous, friable, have a slow percolatory property and are strongly retentive of moisture while the granitic soils are poorly decomposed, coarse, and quickly dry out.

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FUNDAMENTAL FOREST TYPES.

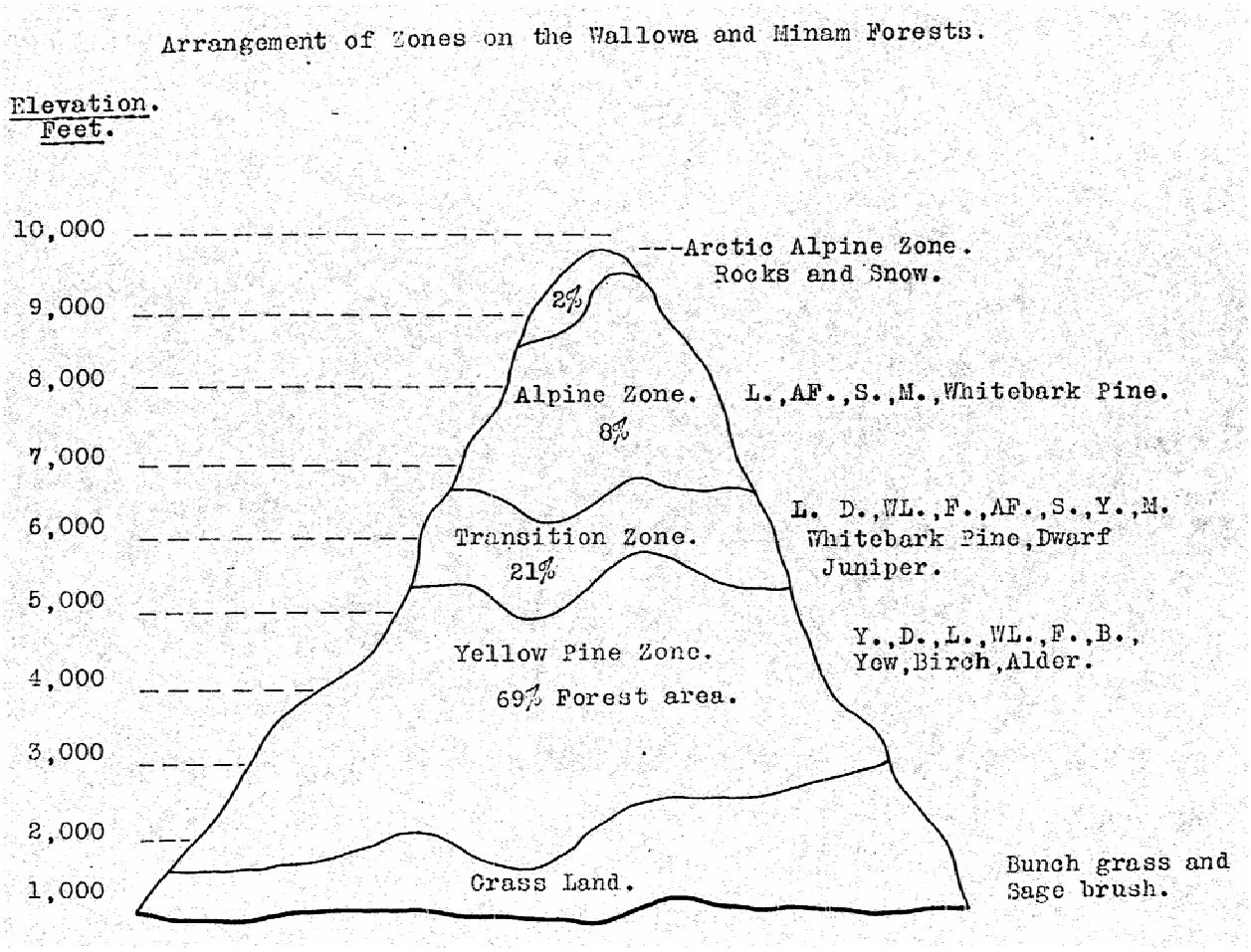
Four fundamental forest types or rather altitudinal zones, may be recognized. These are

a. Yellow pine zone	1,500 – 5,400 feet
b. Transition zone	5,400 – 6,600 feet
c. Alpine zone	6,600 – 8,500 feet
d. Arctic-alpine or timberless zone	8,500 feet plus

It must be borne in mind that there is no sharp line of distinction between these zones but that each merges into the other both above and below. The elevation as given are simply the best averages obtainable. In working out any system of zonations, altitude is a safe guide only in so far as it affects the factors of site, the most potent of which are temperature and moisture. Aspect will frequently overthrow any arbitrary rule of altitude. For example, north slopes are more cool and moist than south slopes and the same difference, although to a less degree, holds true for east and west slopes. Thus, a south slope often presents conditions similar to a north slope one or more thousand feet lower and this is exactly the case on this Forest. Frequently the two sides of a canyon will represent two distinct types. An interesting example is afforded by the lower canyon of the Imnaha River which flows north through a relatively open country. Innumerable side draws run into the main stream, most of them from the east or west, and a thick growth of Douglas fir and larch is usually present near their heads and extends down the north slopes. If one stands on top of the breaks and looks north, the canyon sides appear entirely barren of timber but if one looks south, nothing but timber is to be seen.

A somewhat different condition exists on the south side of the main range of mountains. Here the slope is more gradual from the open sagebrush to the summit of the range and the zonation is much more distinct.

The accompanying diagram is intended to show graphically the arrangement of zones on this Forest.



GENERAL SILVICAL DESCRIPTION OF EACH ZONE.

A. Yellow Pine Zone.

(a) The yellow pine zone covers approximately 69% of the Forest and of this area, some 25% is barren of timber.

(b) With the exception of the high ridge between the Snake and Imnaha Rivers, the yellow pine zone occupies most of the plateau region mentioned in the general description and, in addition, a belt of varying width extending completely around the high mountains. Although lying at the lower elevations, the topography is rugged. It is characterized by deep canyons and high, sharp ridges whose tops are at the same general level. In altitude, the zone lies between 1500 feet, the average elevation of Snake River along the eastern boundary, and 5,400 feet.

Occasional yellow pine trees may be found up to 6,000 feet and, possibly, 6,200 feet, on warm, south slopes, but they are rare. Most of the yellow pine is found between 3,000 and 5,000 and the best timber is found above 4,000 feet. South of the mountains, the yellow pine belt extends from the open bunch grass or sage brush areas up to about 5,500 feet, in a strip varying in width from one or two sections to nine or ten. The type

also extends into the interior of the mountains, following up the main streams. This is notably true of the canyon of the Minam River, which carries a good stand of yellow pine on its benches and well up its south facing slopes to within fifteen miles of its source.

The soil is a clay loam or volcanic ash derived from the decomposition of the basaltic lava of which the plateau and the lower elevations are formed. It is rich in mineral food, porous, and dries out less readily than soils of granite origin. Where sufficiently deep, it is capable of supporting a heavy forest growth. Alkali is not characteristic of the region.

The climate varies between wide extremes. In general, it may be classed rigorous. No records have been kept within the Forest for a sufficient length of time to make accurate statistics possible, either in regard to temperature or precipitation. At La Grande, the records show that as much as 110^{o} is registered in the summer while in the winter the temperature drops to -17^{o}. In the Wallowa Valley, even lower temperatures are recorded, -29^{o} having already been reached during the present winter. In the deep canyons of the Snake, lower Imnaha and Minam Rivers and their more important tributaries, the climate is more moderate and snow rarely falls. The average precipitation of the Wallowa Valley is about 18". This undoubtedly increases with the altitude but at what rate is not known. Much of the precipitation falls as snow in winter and with the exception of occasional electric storms, practically no rain falls from June until September – the period which constitutes the fire season.

(c) As its name signifies, the characteristic tree of this type is yellow pine. However, this rarely occurs pure, its chief associates being Douglas fir, western larch, grand fir, and lodgepole pine. Besides these, black cottonwood, birch and alder are coming along stream bottoms, western juniper is sometimes found on dry ridges and western yew occurs in moist sheltered locations. Of the chief associates mentioned, lodgepole pine is apparently a fugitive tree, its presence usually being due to the influence of some external factor, such as fire, windfall or insect infestation, while its optimum range is in the higher zone. Douglas fir, larch, and grand fir can always be found as scattered individuals, while on north slopes and at the heads of draws, they form a subtype from which yellow pine is practically excluded. The same thing sometimes happens in canyon bottoms, due apparently, to the excess of shade and moisture.

The forest of this zone is typically uneven-aged, with the exception of temporary stands of lodgepole, and occasional stands of larch and fir. In the same stand, it is usually possible to find yellow pine ranging from seedlings to veterans, the latter, however, predominating. Over most of the zone, excellent reproduction is already established. Small openings are quickly occupied.

The stands composed chiefly of yellow pine are open and often park-like. Underbrush is rarely dense, and is confined largely to draws and the regions about springs. Here, sticky laurel, cherry, buckbrush, alder and hardhack grow in abundance. Bitter cherry and sticky laurel form dense patches of chaparral on dry ridges, huckleberry brush is thick in the fir and larch stands, mountain mahogany occurs on dry slopes toward the upper limits of the zone, and dogwood, cascara and dwarf maple are found where there

is sufficient moisture. Pine grass (Calamagrostis suksdorfi) is the dominant herbaceous species. In those portions of the Forest which are grazed sufficiently close to induce the stock to eat the pine grass, which is probably the least palatable of the grasses of this region, the accumulation of litter and humus is not great. This grass becomes dry early in the season and in that condition, a fire spreads rapidly in it. North slopes usually have a heavier collection of dead material than south slopes, and it may be said in general that the larger the percent of fir and larch in the stand, the greater is the amount of litter and humus.

(d) Of the external influences which are operative in the type, fire, insects, lightning, grazing and fungous diseases are the most important. It is difficult to determine which is the more destructive, fire or insects, for the relation that exists between them is very close. A light fire which in itself would probably do little damage to mature trees may weaken them sufficiently to make them a ready prey for insects while, on the other hand, an area of bug-killed timber becomes a fire trap of the worst kind. This Forest has been and is particularly subject to insect infestation. The Bureau of Entomology has estimated that in the belt of yellow pine extending from Catherine Creek to Sparta on the south side of the Forest, an area which contains some of the best timber of the region, at least 18% is dead from this cause alone. The mountain pine and yellow pine beetles are doing most of the damage. Although this is perhaps the worst infested part of the yellow pine zone, evidences of their activity are not lacking elsewhere. Fortunately, their chief ravages are confined to the lodgepole stands. No means of control have been attempted yet, although the habits of the insects are well known. An insect about which little is known seems to attack the leader alone causing a spike top – a defect which is rapidly becoming more noticeable. A weevil, probably similar to the white pine weevil of the East, is attacking and killing yellow pine and lodgepole pine seedings and saplings.

Many destructive fires have occurred in all parts of the Forest; in fact, it is doubtful if a section can be found which has not been burned over at some time. All the important streams have had portions of their canyons cleared by fire. Too often, the succeeding stand has been lodgepole or, if the fires were frequent and severe, only willows and aspens have appeared. In early times, the Forest was burned annually by the Indians: later, the stockman continued the same practice and it is only within the last few years that the fire situation has been brought under reasonable control. The severest fires, however, are not found in this zone but in the heavy stands of lodgepole, fir and larch of the transition zone.

Lightning is a much more distructive {*destructive}* agent than might be imagined. Aside from the obvious and very great damage it does in setting forest fires, there is the often overlooked damage that it does to the individual trees. In traveling over the Forest, one is astonished at the number of trees that have been struck. While few trees are killed outright, each tree that is struck is practically ruined for lumber purposes. It is shaky, pitched, and usually weakened sufficiently to offer a breeding place for insects. Certain localities are particularly subject to electric storms and the lightning appears to show an aversion for trees of certain species. For example, the writer has been unable to learn

of a single lodgepole pine that has been struck. Perhaps yellow pine is struck more often than any of its associates, with Douglas fir, larch, grand fir, and lodgepole following in the order named.

It is believed that under existing conditions grazing is not a detriment to this zone. With few exceptions, a young stand is already established and is now so far along that damage by trampling is unlikely except on overgrazed areas. It is even possible that the sheep aid reproduction by keeping down the ground cover and trampling in the seed. If extensive cuttings were going on, the problem would be different. Undoubtedly, grazing aids in the control of forest fires, both because of the increased number of men circulating through the Forest and available in time of fire, and because of the decreased amount of inflammable material. It is always possible to exclude stock from fresh burns or recent cuttings where it is desired to establish a new stand.

Diseases caused by various parasitic growths are of some importance. Perhaps the one doing the most damage at present is the so-called Douglas fir mistletoe. This causes the tree to be deformed by a growth similar to "witches broom" on the eastern fir, only in more exaggerated form and, in certain localities, every Douglas fir, over considerable areas, is affected. No methods of control have been tried. A yellowish fungous has been noticed growing on lodgepole pine but it has not been identified by the writer.

(e) and (f) Several subtypes may be recognized in the yellow pine zone. The most important are

1. Pure yellow pine
2. Lodgepole pine
3. Douglas fir, grand fir and larch slopes
4. Open grass land.

1. Pure yellow pine subtype.

Any stand containing 80% or more of yellow pine is considered pure. Absolutely pure stands are found only on very limited areas. This subtype probably occupies fifty to sixty per cent of the yellow pine zone and it contains most of the choicest timber. It is found on south and west exposures and often on the tops of broad ridges. The stand is uneven-aged and very irregular, park-like openings of considerable extent are frequent; underbrush is rarely dense and ground-cover, litter and humus are not heavy. The trees are short-bodied, three and four log trees being more common than fire and six. The stand per acre may be 20, 30, or even 40 M. over small areas but the average on large tracts is low, owing to the irregular characteristics of the Forest.

The trees are mostly mature or over-mature, and cutting would be distinctly beneficial. No logging operations of any extent have been carried on within the Forest, but here and there are small areas from which the timber has been taken. Usually, the land has been cut clear of everything large enough to make a scantling. In every case, there is

now excellent reproduction. It does not follow that the reproduction is there as a result of clear cutting, for reproduction is good over the entire subtype. It is doubtful if steam logging will ever be employed in this region and careful skidding with animals offers the minimum injury to young growth. Consequently, it is believed that, in genera, a heavy cutting can and should be made in this type. At least 75% of the stand can be removed without danger. The remaining trees need not be left regularly but should be distributed with reference to the reproduction already on the ground. Yellow pine, alone, should be favored and an effort should be made to get rid of the Douglas fir, larch, grand fir, and lodgepole. Wherever it is possible, brush should be lopped and scattered. This serves to protect the seedlings from trampling by stock, to conserve moisture, and to lessen the danger from frost. In no case should broadcast burning be employed, but where burning seems advisable, the brush should first be piled, care being taken to locate the piles well away from the standing trees and reproduction.

Owing to the inaccessibility of the Government timber and to the large amount of privately owned timber surrounding it, there is no immediate prospect for a large sale.

2. Lodgepole pine type.

Lodgepole pine, where it occurs in pure or nearly pure stands, may be considered a temporary type, established usually as the result of fire. It also occurs to some extent as an associate of yellow pine, but it is believed that, as such, its proportion in the Forest is not increasing. It is not fastidious but is quick to take advantage of any opening caused by fire and usually crowds out other species. The 1910 burn at Devil's Run is an illustration of this. The fire swept through a young stand of lodgepole, leaving the ground in excellent condition for planting. A small area was planted with European larch and Scotch pine, which germinated well, but so did the lodgepole, and it is a question if the European species can survive the competition. The lodgepole stands are young, the trees tall, very slender and unfit for lumber, and insects have caused great ravages. Probably 50% of the entire lodgepole in the Forest is bug killed. If fire can be kept out, this may be a solution of the lodgepole problem for the bug-killed stands are not reproducing with lodgepole. There is no market for lodgepole; in fact, very little could be given away. Free use permits dispose of a small amount of the most accessible. At the present time, the absolute prevention of fire will do more to control its spreading than anything else.

3. Douglas fir, grand fir, and larch slopes.

This might have been called the north slope type for it is found more often on north and east slopes and in the bottoms of canyons than anywhere else. Along the main streams, the head of nearly every draw is timbered with this combination and, frequently, very heavy stands are found in damp swales. Probably the heaviest individual stands of the Forest, although small in extent, are found in this subtype. It is a permanent type since it occupies sites too cool and damp for yellow pine. Except in the densest stands, reproduction of Douglas fir and Grand fir is good. Underbrush is

often dense and the ground cover heavy. Many of these small stands have started after the ground has been cleared by fire and are consequently even aged.

Of the three trees, larch will furnish the most clear material for lumber. Mature grand fir is usually rotten hearted and Douglas fir is short-bodied and scrubby. In any system of management, larch should be favored first, followed by Douglas fir and Grand fir in the order named. Occasionally, Engelmann spruce is found in this mixture but its amount is insignificant. The system of management best suited to this type is clear cutting with scattered seed trees and broadcast burning. The proportion of this type in the yellow pine zone is undoubtedly increasing.

4. Open grass land.

About 250,000 acres or 25% of the yellow pine zone is open grass land and rim-rocks, lying chiefly along the breaks of Snake River, the Imnaha River and Joseph Creek and their tributaries. The vegetation is made up largely of bunch grasses, with pine grass growing in abundance on north slopes. Timber is confined to stream bottoms and the beds of draws. This open country is utilized for winter grazing. In addition to the bunch grass areas, there are patches of "scabland", characterized by very shallow soil, many rock fragments and a total absence of vegetation except in the spring months. It is interesting to note that some of these areas are being occupied by sagebrush where a few years ago, there was none. A possible explanation is that the annual fires of the Indians kept it killed out and now it has a chance to develop. South of the main divide, the Forest boundary follows very closely the line between open sagebrush and yellow pine. Yellow pine is slowly encroaching upon the sagebrush, the chief factor in its rage of advance being moisture, provided fire is kept out. The same statement will hod true in regard to the other open areas as well. As fast as the reproduction has pushed out from under the protection of the parent trees, the periodical fires have killed it back, thus keeping the timber line practically stationary. In recent years, conditions have improved, and it is noticeable that the pine is reaching out, although slowly. The north slopes are being occupied by a thick stand of fir reproduction. Even pine is gaining a foothold here, and is gradually creeping across the ridge to the south slopes. While scarcely affording the best seed-bed, grass by no means precludes the germination of yellow pine seed and it is very probable that it aids in keeping the seedling alive by giving it shelter and preventing the excessive drying out of the soil. If these winter grazing areas are to be retained in the Forest, they present a most important silvical problem. Should they be left as they are to become slowly forested on the most advantageous sites by natural methods, thus tacitly admiting {*admitting*} that they are more valuable for grazing than for the production of timber, or should an effort be made to reforest them by artificial methods? It is by no means certain that the latter can be done except at great expense, and to determine this, a series of experiments will be necessary. It is not possible that there are large areas of known forest land where the necessary money can be expended to better advantage? It is believed that some definite policy should be adopted in regard to this problem.

B. <u>Transition Zone.</u>

(a) This zone covers about 20% of the entire Forest and begins in a narrow strip at the northern end of the high divide between the Snake and Imnaha Rivers, widening toward the south until it spreads over the broad ridges between the upper Imnaha and Big Sheep creek and covers a more or less narrow belt around the mountains and along the upper breaks of the main canyons.

(b) In elevation, the zone lies between 5,400 feet and 6,600 feet. The topography is rough and broken although flat-topped ridges are not uncommon. The soil is similar to that of the yellow pine zone – a clay loam derived from the decomposing lava. Seasonal and daily variations of temperature are great. Precipitation is largely in the form of snow in winter, in addition to a fair amount of rain in spring and fall. It is safe to say that the average yearly precipitation is considerably greater than in the yellow pine zone.

c. In point of density, this zone is the most heavily timbered of the four. Open grass land are infrequent, small in area, and largely confined to "fire glades." Lodgepole pine is the characteristic tree, occurring typically in nearly pure, even-aged stands, some of which are of large area. Many of these plainly owe their origin to fire. Lodge-pole occurs indiscriminately throughout the zone. Next in importance, are Douglas fir, Grande fir, and western larch. Douglas fir and Grand fir will grow on the drier sites, but the best stands are found on cool north and east slopes and the sheltered bottoms of canyons. These trees also form a stand, even-aged in character. Pure young stands of larch are common on old burns. Engelmann spruce appears in mixture with the above trees on the moist but well drained and fertile soils at the heads of the draws and along stream bottoms. Alpine fir is confined to north slopes at the upper limit of the zone, and yellow pine to south slopes at the lower limit. Yellow pine nowhere forms a large percent of the stand. At this altitude, the trees are short and scrubby and of little value for timber. It is found associated with Douglas and Grand firs. Mountain hemlock is limited to the drainage of Bear creek and the lower Minam and Little Minam Rivers in the western part of the Forest. It usually grows in dense stands of small area in the sheltered basins near the canyon tops. Formerly it had a wider distribution but fires have gradually driven it back. Except in the densest stands, there is a thick ground cover of huckleberries and other small brush. On south slopes, sticky laurel and dwarf bitter cherry sometimes form a growth difficult to penetrate, and in the bug-killed lodgepole stands, there is much down timber. Litter and humus vary with the composition of the stand. In thick lodgepole stands, down timber is the principal material on the ground. In the dense young fir stands along ridges, the accumulation on the ground is thin, but in the heavy stands of mature Douglas fir, Grand fir, spruce and larch, there may be from one to eight or ten inches of litter and humus and but little living vegetation.

In general, the transition zone is characterized by dense, even-aged stands, by a minimum of non-timbered areas, and by a great variety of trees.

d. Of the external influences operating in the zone, insects and fire are preeminent. At least 50%, probably more, of the entire amount of lodgepole is dead from insect attacks. It is safe to say that there are entire sections of lodgepole that are 95% dead, while areas of six or eight sections, north and west of the upper Imnaha River and north of Catherine creek are 85% dead, and the destruction is still going on. The dead trees are soon felled by the wind and they are cross-piled until the Forest is almost impenetrable. These stands form the gravest fire menace, and are the most difficult to patrol. In past years, fire has cleared large areas, most of which are being restocked. Grazing is of small importance in this zone and is doing no active injury. Probably it is to some extent beneficial in keeping down the underbrush. Lightning frequently starts fires and windfalls are of some importance. Snowslides, starting in the Alpine zone, do an appreciable amount of damage. The principal snowslide areas are on the upper Imnaha River, and Hurricane, Main Pine and East Eagle Creeks.

(e) and (f)

Three subtypes are of importance.

1. Pure lodgepole pine
2. Douglas fir, Grand fir and larch.
3. Hemlock

The occurance {*occurrence}*, composition and age of these subtypes have already been discussed. All of them are permanent.

The bug-killed lodgepole pine stands present the most interesting problem. The question is, what will succeed the lodgepole? If fire is kept out, lodgepole will evidently not succeed itself, and this is due to the fact that lodgepole seed will not germinate in the mass of material upon the ground in these dense stands. At present, the chief reproduction is of Douglas, Grand and Alpine firs. The young trees of these species seem to be doing well and there is every reason to believe that they will constitute the next stand.

In any system of management, western larch should be favored wherever it will grow. Although the present market for this species is limited, it is bound to improve, and larch attains the best proportions for limber of any of its associates. Pure, even-aged stands of larch should be clear cut and planted. Mixed stands should be cut upon the selection system, favoring the larch and leaving sufficient seed trees to restock the area. At the upper limits of the zone, the timber is chiefly useful for watershed protection and there is no need to attempt to change the composition.

Timber sales in this zone may not be expected for some years and, consequently, recommendations for management at this time have little value.

(C) <u>ALPINE ZONE</u>

This zone occupies approximately 8% of the Forest. Its altitudinal limits are between 6,600 and 8,500 feet and within it are the sources of all the important streams. The topography is characterized by high granite ridges, rising out of the surrounding lava, steep slopes, deep canyons, and much slide rock. It is the roughest portion of the Forest. Most of it lies in unsurveyed territory.

Two kinds of soils are found. On the lower areas and extending approximately to an altitude of 7,800 feet, the soils are of basaltic origin, similar to those found in the lower zones, but above this elevation, they have been formed mainly from granitic rocks. Granitic soils are coarse in texture, and moisture is quickly lost by rapid percolation and evaporation.

The climate is cold. The first snow falls by the middle of September and an enormous amount accumulates during the winter which lasts well into June. Heavy frosts occur throughout the summer. The growing season is short.

White bark pine is the most typical tree of this zone and it marks the sharpest zonal limits of any tree species of the region. Occasional specimens may be found on cool north slopes down to 6,000 but above 6,600 feet and up to the normal timber line, it grows in abundance. Another tree which grows quite as abundantly in this zone is subalpine fir, but it is adapted to a much wider range habitats. Specimens of this tree have been observed at an elevation as low as 4,000 feet. At 5,500 feet, it becomes common in sheltered sites and it is found at the timberline. Consequently, where one encounters this tree, he is by no means certain that he is in or near the alpine zone. Lodgepole pine is common on south slopes up to 7,200 or 7,300 feet. Engelmann spruce and mountain hemlock occur on good soil at the lower limits of the zone and occasional larch and Douglas fir trees are found. Dwarf juniper has been noticed on dry, warm slopes.

The most striking feature of the alpine zone is the open grass land areas and the general broken character of the forests. It varies from meadow to scattered woodland. The open areas covered with mountain bunchgrass are sufficiently frequent and extensive to give character to the landscape. Such areas constitute the most valuable grazing lands of the Forest and have the highest carrying capacity. Extensive experiments have been conducted upon them with a view to the improvement of the range.

The ground cover is confined to grasses and various annuals in the open glades and to huckleberries, arctostaphylos and other small shrubs in the timbered areas. It is rarely dense, and litter and humus is thin.

There is a noticeable decrease in the density of the vegetation as the altitude increases. This is due to the increased exposure and the more rigorous climate but primarily to the decrease in the moisture content of the soil. A more or less sharp break occurs at the line where the lava and granite soils meet. As has already been explained, the granite soils are quick to dry out. Above this line, the trees are apt to be stunted and the stand

very open. The effect of excessive exposure is shown by the stunted and often procumbent habit of white bark pine and subalpine fir.

Fire is the most important external influence operative in the zone. The entire zone has been burned over at least once and much of it several times. The bare white skeletons of the dead trees are characteristic. Reproduction is slowly becoming established over most of the area and there are occasional very dense stands of young subalpine fir. The white bark pine reproduction is poor. The tree seeds at infrequent intervals and the seed is largely eaten by birds and rodents of various kinds. Snowslides keep some hillsides bare, but the area thus affected is not extensive.

The timber of this zone is not merchantable but it is valuable of the protection of the watersheds. No artificial methods of restocking the depleted stands are justifiable at present. The whole problem lies in keeping out fire. If this is done, the forest will in time return to its normal density.

D. ARCTIC-ALPINE OR TIMBERLESS ZONE.

This zone might have been classified as subtype of the alpine zone for no part of the mountain is actually above timberline. Stunted white bark pine and sub-alpine fir trees are found upon the very top of Eagle Cap, the highest peak of the range. The presence or absence of timber is entirely a question of soil and moisture.

The Arctic-alpine zone is the smallest of the four, covering only 2% of the entire Forest. It is characterized by bare rock ridges, slid-rock slopes, small glades covered with grass and a scattering growth of stunted trees. It lies chiefly above 8,500 feet, although on northerly exposures, it is exceptional to find timber above 7,500 feet. It might perhaps be better described as including the barren ares above an elevation of 7,500 feet. It includes, also, the perpetual snowfields of the mountains. The largest of these is on the east slope of Eagle Cap and has, perhaps, an area of half a section. Smaller patches are common in sheltered places throughout the zone.

II.
SILVICS OF EACH SPECIES.

Pinus ponderosa – Western yellow pine.

1. Habit. Two forms of the tree are common, known locally as bull pine and yellow pine. Lumberman maintain that they are distinct species. The difference is due to age. It is not certain at what age a bull pine becomes a yellow pine, but probably between 100 and 150 years. Size is not a safe guide for many bull pines are larger than yellow pines. Bull pine has dark red, brown or blackish bark with narrow ridges and furrows and thick sap. Yellow pine has light red bark with wide plates and furrows and thin sap. Thrifty growing trees in open stands have roughly conical crowns, becoming flat-topped in old age. The branches grow pretty well down to the ground. Thick stands tend to

produce more irregular crowns and longer boles. Even in the open, larger branches are not developed at the expense of stem growth.

The average mature diameter is 30" and the height 110'. The largest tree noted on this Forest is 74" in diameter and has a merchantable length of about 60'. This is an abnormal tree, for above 60', it spreads out into innumerable branches. A short time ago, a tree was scaled by the writer, just outside the Forest, which contained 5,810 board feet and had a total height of 155' and a d.b.h. of 44". Butts 60" in diameter are not uncommon. The form and sizes depend to a great extent upon the mixture. The trees growing in pure open stands clear themselves less readily and are shorter bodies than when growing in mixture with Douglas fir and western larch.

Yellow pine develops a deep, wide-spreading root system. In the juvenile stage, the growth below the ground far exceeds that above. A long tap root is early developed and broad laterals often extend to a distance of a hundred feet or more to the side. Several wind thrown veterans have been noticed which lacked the tap root, and from this it is to be inferred that the tap root is often lost in maturity.

2. Occurrence. Yellow pine is distributed generally through the Forest up to an elevation of about 5,500 feet. Above this, it is confined to warm south slopes and rarely occurs pure. Pure stands of some extent are found on benches near the bottoms of most of the main canyons and upon the flat tops of ridges at an elevation of 4000-4500 feet. At the lower elevations, the sap is thick, the logs heavy to handle, and the percent of clear material low. The best commercial stands are found above 4000 feet. It frequents south and west slopes almost to the exclusion of north and east slopes. Soil is not a factor in its distribution but moisture is of importance. Atmospheric moisture is less vital than soil moisture. The best conditions for its growth are a deep, fertile, well drained soil, exposed to full sunlight. The surface layers of the soil over the greater part of its range become very dry, but its deeply penetrating root system is able to draw moisture from the lower levels.

Its chief associates are Douglas fir, western larch, grand fir, and lodgepole pine. Black cottonwood, birch and alder are found along streams. The most extensive stands of the yellow pine zone are made up of about 80% yellow pine and 20% Douglas fir, grand fir and larch. On north and east slopes, the percent of yellow pine decreases to practically nothing. Lodgepole occurs to some extent in mixture with these species but more often as pure stands on fire denuded areas.

3. Soil and Moisture. Yellow pine is not fastidious in regard to soil. The soil of the yellow pine zone is in general a clay loam, liable to excessive drying out in the surface layers. Yellow pine, of course, does best on deep, rich well-drained soils but it seems to be able to adapt itself to the most impoverished sites. It is very moderate in its moisture requirements, its enormously deep roots allowing it to thrive in very dry soil. The average annual precipitation of the valleys surrounding the mountains is 18", and here yellow pines are scattering. Precipitation increases with the altitude and while there are

no records to prove the truth of the statement, it is probable that there is an annual precipitation of at least 20 inches where commercial stands are found.

4. Tolerance of Shade. Except in the juvenile stage, western yellow pine is very intolerant of shade. Seedlings start under the shelter of the parent trees, and will grow in dense stands until they are 20 to 30 years old. After that, both overhead and side light are necessary, and the trees rapidly become suppressed or die. Badly suppressed trees rarely recover when the stand is thinned. Thrifty mature stands are very open. Yellow pine is more intolerant than any of its associates.

5. Growth and Longevity. For the first 75 to 100 years of its life, yellow pine makes a fairly rapid growth. On favorable sites, the seedlings may reach a height of 3 inches above ground and develop a tap root 9 to 12 inches long during the first year and, at 10 years, it may be 6 or 7 feet in height and an inch in diameter. In dense stands, both diameter and height growth rapidly fall off, but in stands of the proper density, both are maintained up to 100 years. Yellow pine is a long lived tree. Not long ago, a sound tree was noted that was 360 years old, 44 inches in diameter, and contained 5,841 board feet. It will probably remain sound for 400 to 450 years under favorable conditions. The maximum age on record in this office is 470 years.

6. Reproduction. Western yellow pine is a fairly prolific seed producer. Although heavy seed crops are from 3 to 5 years apart, some seed is produced locally nearly every year. A thrifty mature tree may produce several bushels of cones and a tree 20 to 25 years old will bear some cones. The seed is winged and in open stands or on the edges of openings, it may be carried by the wind several hundred yards to a quarter of a mile. Birds and squirrels are doubtless of some assistance in disseminating the seed. The cones mature in August of the second year and most of the seed is scattered from the latter part of August to October. Birds and rodents of various kinds destroy large quantities of the seed. Sometimes several bushels of cones are found in one squirrel cache. The seed is also much affected by a weevil.

Moisture is necessary for the germination of the seed and the early development of the seedling. Germination seems to be best on well drained soil, covered with a thin layer of litter and humus, and protected by the parent tree or by a large covering of brush. On this Forest, seedlings are sometimes found on south slopes exposed to full sunlight. Too much moisture will cause damping off, and early frosts do considerable damage. Seed germinates with difficulty where litter and humus are thick and in grass, but seedlings are sometimes found even here.

7. Susceptibility to Injury.

Western yellow pine is much less susceptible to mechanical injuries of various kinds than many of its associates. Owing to the deep and widespread character of its root system, it is a particularly windfirm tree. It is only exceptional storms or high winds when the ground is soft in the spring that cause any appreciable damage of this nature. The most serious danger is to trees left after the opening of a dense stand.

Frost does considerable damage to seedlings and to saplings up to four or five feet high. Seedlings protected by brush or trees are rarely hurt.

Lightning strikes many trees and while it rarely kills the tree outright, it decreases its value for lumber. If the tree continues to grow, the lightning scar develops into a seam, or it may cause the region about it to become pitched or blued.

Surface and ground fires do little damage to mature trees because of the thick bark. Crown fires in mature stands are extremely rare. Seedlings, particularly in groups, are usually killed by any kind of a fire and many saplings up to several inches in diameter are damaged or killed. In general, yellow pine should be classed as a fire-resistant tree.

Moderate grazing, in yellow pine forests, is not though to be injurious. On overgrazed areas, the seedlings are injured by trampling and to some extent by being nibbled. Along driveways, the reproduction is usually destroyed. In moderately grazed stands, the conditions for the germination of the seed are improved because of the decreased amount of vegetation upon the ground, but after the seed has fallen stock should be excluded from any stand which it is desired to reproduce until the seedlings are large enough to escape trampling. Grazing assists in controling {*controlling}* fires by keeping down grass and other inflammable material.

Bluing, a defect caused by fungi, is serious where logs are allowed to remain on the ground, especially in damp places. This does not cause rot, but it decreases the value of the lumber. Western yellow pine is particularly subject to insect attack. Several species of the genus Dendroctonus of which Dendroctonus monticolae and Dendroctonus brevicomis are the most important, have caused great ravages. These species attack and kill healthy trees and are therefore of primary importance. It is thought that this damage is not increasing rapidly at the present time.

An injury which is becoming more noticeable each year is caused by an insect which attacks the leaders of mature trees, causing them to be stag-headed.

A weevil sometimes kills the seedlings but little is known about this.

Pinus Contorta – Lodgepole pine.

1. Habit. Lodgepole pine does not reach large size in this region. Usually it is found growing in pure dense stands in which the trees are tall and very slender. The average mature diameter is 12 to 20 inches and the height 75 to 100 feet. The largest tree noted on this Forest was 28 inches in diameter, but this was and abnormal tree growing in the open. The open grown tree is comparatively short and has a much branched crown extending well down to the ground. The forest grown tree is tall, straight, has little taper, and a short slender crown. The seedling develops a tap root, but this does not persist. Inn general, the root system is shallow and not wide spreading -- making the tree particularly subject to being thrown by the wind.

2. Occurrence. Lodgepole pine is distributed generally throughout the Forest up to an elevation of 8,000 feet. The region of its optimum growth is between 5,500 and 6,800 feet or in the transition zone, but it is common and does well both above and below these elevations. At the lower elevations, it does best on north or east slopes or on sheltered sites where there is plenty of moisture. As the altitude increases, exposure is of less importance. In this region, soil is not a factor in its distribution. It requires more atmospheric and soil moisture than yellow pine. In the yellow pine zone, lodgepole is often found occupying damp, springy swales where the soil is cold. It frequents high plateaus and benches and basins near the heads of streams.

It is associated most commonly with yellow pine, Douglas fir, western larch, grand fir, alpine fir and Engelmann spruce. The most extensive stands are practically pure; next in importance are the lodgepole-Douglas fir and the lodgepole-alpine fir stands. Sometimes all of the above species except yellow pine occur together and in the yellow pine zone, yellow pine, lodgepole, Douglas fir, western larch and grand fir form a common mixture.

3. Soil and moisture. Lodgepole prefers rather coarse, moist but well drained soils, and here it makes the best growth, but it will adapt itself to any soil found in this region. In its moisture requirements, it is intermediate between yellow pine and Douglas fir and Engelmann spruce and alpine fir.

4. Tolerance of shade. Lodgepole is very intolerant of shade especially in its juvenile stage. It will not reproduce in the shade of its own dense stands. Pure young stands of great density will persist for many years with full overhead light, but under such conditions diameter growth is very slow. Suppressed trees will recover if not too long overtopped.

5. Growth and Longevity. Lodgepole is a tree of rapid growth particularly in the early stages of its development. No one of its associates can equal it in this respect, and for this reason, if it becomes established on an area, it will crowd out all other species. Last fall, it was noticed on the Medical Springs planting area, where European larch and Norway spruce were used, that the seedlings of the European species were only 1 inch to 1.5 inches in height and appeared sickly while the lodgepole seedlings, of which there were many, were 3 or 4 inches high and thrifty in appearance. In pure dense stands, the rapid growth of lodgepole falls off after 50 to 60 years.

Lodgepole is comparatively shortlived {*short-lived}*. It matures at from 100 to 150 years, but pure stands rarely reach this age. Fire, insects or some other external factor usually destroy the stand during the first 50 or 75 years of its life. There is no definite knowledge as to its maximum age.

6. Reproduction. Lodgepole pine is a more prolific seed producer than any of its associates. Considerable seed is produced every year and heavy crops occur at frequent intervals. Cones are matured as early as the 50th year, and the number of

cones depends chiefly upon the density of the stand. The cones ripen in August and September of the second year. In this region, many of the cones open and the seed is scattered during the first season, but others may remain closed for several years. In this respect, it seems to be intermediate between the Rocky Mountain and the Pacific slope varieties. Whether open or closed, the cones remain upon the trees for many year. The seeds are winged and largely disseminated by the wind. Squirrels, mice, etc. are also instrumental and it is not uncommon to find thick clusters of seedlings growing from the seed collected by mice. Birds and rodents destroy large quantities of seed.

Bare mineral soil and full light offer the most favorable conditions for the germination of the seed, and for this reason, lodgepole is quick to occupy burns. Germination rarely occurs in a thick ground cover, or in shade, consequently the lodgepole type spreads very slowly unless aided by some external factor. It is probable that if fire were eliminated, it would gradually become restricted and, in time, completely replaced by other species except on the most favorable sites. The fact that fir and spruce reproduction is becoming established in the present lodgepole stands, to the exclusion of lodgepole reproduction, gives color to this statement.

7. Susceptibility to Injury. Fire, insects and wind are the chief causes of injury to lodgepole. Owing to its thin bark, it is injured or killed outright by even a light fire, while the density of the stands makes crown fires, in which many of the trees are entirely consumed, of common occurrence. It is particularly subject to insect attack, several species of the genus Dendroctonus having killed large areas of it. The shallow root system renders it liable to being thrown by the wind and fire and bug killed stand soon become tangles which are difficult to penetrate. For some reason, lightning seems to avoid this species. A small yellowish fungus has been noticed on this tree, but its name and habits are not known.

Pinus Albicaulis – Whitebark pine.

1. Habit. Whitebark pine is a low, much branched tree. In youth, the trunk is straight with more or less regular whorls of branches appearing from it. Later, many of these branches curve upward and grow into long flexible stems, giving the tree a decidedly bushy appearance which is characteristic. The bole is short and rapidly tapering with rarely over a few feet of clear length, thus removing it from the class of merchantable timber. It is a native of high altitudes and on exposed ridges, it often assumes a procumbent form. The root system is deep and spreading and the tree is not often thrown by the wind. Mature trees may be from 5 to 60 feet high and up to 24 inches in diameter, depending upon the location. Larger specimens may be found, but they are rare.

2. Occurrence. It inhabits high rocky ridges and alpine basins chiefly above 6,500 feet, although specimens are found as low as 6,000 feet. It grows on disintergrated {*disintegrated}* granite and among boulders, where the period of growth is short and where precipitation is confined chiefly to snow. It never grows in dense stands and pure

stands are not common. Its important associates are alpine fir, lodgepole pine, mountain hemlock, and occasionally Engelmann spruce.

3. Soil and Moisture. In common with most other trees, white bark pine does best on deep, moist, well-drained soils, but it makes a fair growth on even the poorest sites. It is found growing among boulders where practically no soil appears and trees 18 inches in diameter and 50 feet high were noted in white quartz sand and gravel where no other vegetation existed. There is very little precipitation during the growing season, and the surface layers of the soil become extremely dry. Usually, however, there is plenty of moisture below from the melting snows of the ridges above.

4. Tolerance of Shade. It is somewhat intolerant in youth, becoming less so with age. It is probably the most intolerant of its associates.

5. Growth and Longevity. It is of very slow growth, but comparatively long lived, trees sometimes reaching an age of 350 years.

6. Reproduction. Full seed years occur at infrequent intervals, and in the meantime, almost no seed is produced. The seeds are wingless and heavy, and dissemination is by gravity or animals. Reproduction is chiefly in the vicinity of the parent trees, which protect the seedlings from storms etc. The seed is largely eaten by birds and animals.

7. Susceptibility to Injury. White bark pine has thin bark and is therefor subject to injury by fire. The bare white skeletons of the fire killed trees remain standing for a long time and form a somewhat distinct feature of the landscape along the windswept ridges. Aside from fire, there are no important sources of injury.

Larix occidentalis – Western larch.

1. Habit. With the exception of yellow pine, western larch reaches the largest size of any species on the Forest. When mature, the diameter is from 30 to 40 inches and the height from 100 to 175 feet. Individuals five or six feet in diameter are not uncommon. In youth, the crown is a somewhat regular pyramid, broad at the base, but in maturity, it is a long narrow pyramid ending in a sharp point. The proportion of crown to bole is remarkably small – not more than one third or one fourth of the entire length being occupied by the crown. The crown is very thin, the branches small and short, and the foliage scanty. The bole is very long and has considerable taper. The root system is wide spreading and fairly deep. A tap root is developed at first but it does not persist.

2. Occurrence. Western larch is distributed throughout the Forest from about 3,000 feet up to 6,000 feet. In the yellow pine zone, it occurs to some extent in mixture with yellow pine on dry slopes and ridges and, with Douglas Fir, it forms an important subtype on north end and east slopes, at the heads of draws, and in sheltered spots where there is plenty of moisture. In the transition zone, it sometimes occurs in pure stands on fire-cleared areas, and with Douglas fir, lodgepole pine, and grand fir, it forms extensive stands. It is somewhat exacting in its moisture requirements, and for this

reason, it makes the best growth on gentle north slopes where the soil is deep, porous, well-watered and well drained, upon flats of the same character and along stream bottoms.

3. Soil and moisture. (See above.)

4. Tolerance of shade. It is very intolerant throughout its life, ranking with yellow pine in this respect. There is no reproduction in the shade. Owing to its rapid height growth, seedlings will usually survive the competition of its associates. It is the dominant tree of the stand throughout its life. On moist sites, it is somewhat more tolerant and here fairly dense pure stands are found.

5. Growth and Longevity. Western larch is a tree of rapid growth, especially in its youth. It will outstrip any of its associates and it maintains its growth for a hundred or more years. It remains sound for 400 to 500 years.

6. Reproduction. It is not a prolific seed producer. Seed years are several years apart and very little seed is produced in the years between. On this Forest, the crop was a total failure this year. The cones mature and open in August and September of the first year, and the seed is soon scattered. It is winged, light, and is carried to considerable distances by the wind. Seedlings will not grow in the shade, and the seed germinates with difficulty in the material found upon the ground under the ordinary stand. The most favorable conditions for germination are found on a freshly burned area and in this it resembles the lodgepole pine. If the larch starts at the same time as the other seedlings, it will survive but if it is overtopped, it quickly dies.

7. Susceptibility to Injury. Western larch is remarkably free from injury. In youth, it is liable to be killed by fire, but after the pole stage, its bark becomes so thick that only the hottest fires have any effect upon it. Its most serious defect is shake. It is rarely thrown by the wind, and insects and fungus have caused little damage. Many lightning struck trees are found.

Pseudotsuga taxifolia – Douglas fir.

1. Habit. With its enormously wide range, Douglas fir probably grows under more diverse climatic conditions than any other important American timber tree. In various parts of this range, it produces at least two distinct forms of growth. These are the Pacific coast form and the Rocky Mountain form. The Wallowa Mountains, while they do not strictly belong to the Rocky Mountain system, have conditions of climate and topography which are similar and, consequently, on this Forest, we have the Rocky Mountain form of Douglas fir. This form has been called the form of "best resistance," in contrast to the form of "best development" of the Pacific slope.

In general, the form found in this region is smaller, more scrubby, of slower growth and of less importance commercially than the Pacific slope form. Its average mature height

is about 100 feet and its diameter 20 to 30 inches. Trees 120 to 140 feet in height and from 3 to 4 feet in diameter are sometimes found.

In youth, the branches are rather short, stiff, close together and curve upward, forming a compact crown. In the open, these branches are maintained well down to the ground throughout its life, and the crown becomes irregular in shape. The bole has a decided taper, is often eccentric, and is clear for only a short distance. The root system seems to accomodate {*accommodate}* itself to the soil in which it grows. In deep, porous soil, it develops several deeply penetrating roots and strong laterals; in shallow or compact soil, it develops a wide spreading, but shallow root system, and it is frequently found sending its roots into the crevices of rocks.

2. Occurrence.

It occurs over a wide variety of soils. It is found on dry slopes and ridges with yellow pine, at the heads of draws, on north slopes, and along stream and canyon bottoms with larch and grand fir, and in the transition zone with lodgepole and spruce. It does best on deep, porous, well-watered and well-drained sandy loam. At the lower elevations, it prefers north and east slopes, gradually working toward south slopes with the increase in elevation.

3. Soil and Moisture.

It is adaptable to varying conditions of soil and moisture. On particularly dry sites, the tree is correspondingly short and knotty. Its form responds to the site upon which it grows. Its best development is where there is plenty of atmospheric and soil moisture.

4. Tolerance of Shade.

Douglas fir is more tolerant than yellow pine, western larch, and lodgepole, but less so than Engelmann spruce, alpine fir and grand fir. Under heavy shade, the seedlings soon die out but under moderate shade, they will make a slow growth for a number of years and if released from suppression, they will recover. Douglas fir clears itself best if it grows in stands sufficiently dense to exclude nearly all side light.

5. Growth and Longevity.

In comparison with the coast form, the Rocky Mountain form is a tree of very slow growth. It has been shown that at high altitudes, it takes 230 years for the eastern form to reach a size which the coast form reaches in 60 years. The chief reasons for this are the shorter growing season and the more adverse conditions of soil and moisture. In youth, Douglas fir is able to hold its own with its associates. At 100 years, its height is 70 to 80 feet and its diameter 14 or 15 inches. At 200 years, both height and diameter growth have practically ceased but the tree may remain sound up to 400 years.

6. Reproduction. Douglas fir is a fairly prolific seed producer. Heavy seed years occur from 3 to 5 years apart but some seed is produced locally nearly every year. Cones are matured as early as the twentieth year, but full crops do not occur until the trees are from 40 to 50 years old. Trees in full light produce the most seed and cones are borne on all parts of the crown. Cones mature in August of the first season. The seeds are winged and are widely distributed by the wind.

Unlike the coast form, a mineral seed bed is not necessary for the germination of the seeds. Fair reproduction is found in the moderate shade of old lodgepole stands and yellow pine and Douglas fir. This indicates that the seed will germinate in the mildly humus soil found in these places. On the coast, extensive pine stands occupy fire-cleared areas, but here this is rarely the case. This is due primarily to the more aggressive nature of lodgepole pine which crowds out the fir. In time, however, if fire is kept out, Douglas fir is quite likely to replace the lodgepole on such areas.

7. Susceptibility to Injury.

Generally speaking, Douglas fir is very little subject to the various forms of injury. After the pole stage, the ordinary fire does little damage owing to the thickness of the bark, but young growth is easily killed. It is windfirm but in mature timber, windshake and frost cracks form serious defects. Lightning stuck trees are common. On this Forest, mistletoe is causing much damage. It causes the tree to be badly deformed and every tree over considerable areas may be affected.

Picea engelmanni – Engelmann spruce.

1. Habit. Engelmann spruce is not a tree of great size or of great commercial importance on this Forest. Its average mature size is from 80 to 100 feet in height and from 18 to 24 inches in diameter. Larger trees are found on the best sites. The crown is a dense and symmetrical pyramid with the branches extending well down to the ground, except in the densest stands. The bole is short and has a rapid taper. The root system does not penetrate deeply but is widespreading and the tree is windfirm.

2. Occurrence. The distribution throughout the Forest is limited. It is found chiefly between 5,500 and 7,500 feet and is confined to the upper courses of streams, the heads of gulches, on north exposures, and marshy plateaus. Moisture, both atmospheric and soil, is the chief factor in determining its distribution. It nowhere forms extensive stands, nor does it occur pure. Its chief associates are Douglas fir, western larch, lodgepole, subalpine fir, and grand fir.

3. Soil and Moisture. It will grow on any soil which will hold moisture.

4. Tolerance of Shade. With the exception of subalpine fir, Engelmann spruce is more tolerant than any of its associates. The seedlings and saplings will endure suppression for many years, and when released, they recover rapidly and make good growth.

5. Growth and Longevity.

It is a tree of very slow growth throughout its life. Stumps often show a period of suppression lasting 30 to 40 years, and then a period of more rapid growth. The tree is mature at from 150 to 200 years and may remain sound for 400 years.

6. Reproduction.

Engelmann spruce is a prolific seeder. Full seed years are usually 3 years apart but some seed is produced locally nearly every year. Moist mineral soil offers the best seed bed and seedlings are rare in humus. Seedlings are most abundant in the shelter of parent trees and frequently groups are built up in this way.

7. Susceptibility to Injury.

Owing to its thin bark, it is readily killed by fire. Insects are an important source of injury. The Engelmann spruce beetle has done considerable damage to this Forest. The seed is affected by a weevil. Wind, frost and lightning do little damage.

Abies lasiocarpa – Sub-alpine fir.

1. Habit. Sub-alpine fir is a small tree, usually from 50 to 90 feet high and from 10 to 20 inches in diameter. The crown is narrow, symmetrical and spire-shaped and, except in dense stands, reaches to the ground. The bole is limby and has a rapid taper. The root system is shallow. On exposed ridges, at high altitudes, the tree may be only a few feet in height with branches spreading out over the ground at the sides.

2. Occurrence.

It occurs from the timberline down to about 4,000 feet. It is commonly found on north slopes, at the heads of streams, in cool canyons, and about mountain lakes. At the higher altitudes, it is found wherever tree growth occurs. It grows on a wide range of sites, but does best on deep, loose, moist soil.

It is commonly associated with white bark pine, Engelmann spruce, lodgepole and, to some extent, larch and Douglas fir.

3. Soil and Moisture.

It is less exacting than spruce for its grows on soils both too dry and too wet for spruce. It is not fastidious although for its best growth, it must have plenty of moisture.

4. Tolerance of shade.

With the exception of the spruce, it is the most tolerant of the associated species. It withstands suppression well and quickly recovers when released.

5. Growth and Longevity.

The tree is of slow growth and short life. It probably matures at from 150 to 175 years and quickly begins to deteriorate. Trees, 100 years old, may be from 2 to 3 to 12 or 14 inches in diameter.

6. Reproduction.

Seed is produced in fair quantities. Seed years occur at intervals of 3 years and sometimes absolutely no cones are matured in the intervening years. Last season, the crop was a total failure on the Forest. The seed has a high percentage of germination. Mineral soil is not necessary for germination but seedlings are found growing in the accumulation of litter common in the typical stands. The ability of the seedlings to endure shade enables the species to be well represented in mixed stands. Reproduction also takes place by layering. The long lower branches which rest upon the ground frequently take root and curve upwards, thus growing into separate trees.

The growing habit is one of the distinguishing characteristics of the tree. In the center will be a mature tree while in a close circle about it will be trees of successively younger age, grading down to seedlings. The center tree may be a large lodgepole or a spruce. Any tree will suffice so long as it gives shelter to the reproduction.

7. Susceptibility to Injury. Its thin bark and low crown render it particularly susceptible to injury by fire. Crown fires are frequent and whole stands may be killed. Other natural agencies are of no particular importance.

Abies grandis – Grand fir.

1. Habit. On favorable sites, grand fir becomes one of the largest trees of the Forest. The average mature diameter is 24 to 36 inches and the average height is from 100 to 150 feet. Much larger trees are found on rich bottoms.

In youth the crown is cone shaped with a broad base and sharp point. Later, owing to the pendulous character of the lower branches and the rounded top, it becomes more irregular and often appears larger in the middle than at the base. In dense stands, the bole is long, clean and has little taper. In the open, branches extend nearly to the ground and the bole tapers rapidly. The root system is comparatively shallow.

2. Occurrence. Grand fir is distributed throughout the Forest up to an elevation of about 6,500 feet. At the upper elevations, it occurs with alpine fir, Douglas fir, spruce, larch and lodgepole. In the yellow pine zone, it is found with Douglas fir, larch, lodgepole and yellow pine and, on north slopes, it forms a part of the Douglas fir-larch sub-type. It is adaptable to a wide range of sites but for good growth, it must have plenty of moisture.

3. Soil and Moisture. Grand fir prefers a fairly deep soil, somewhat moist, but porous and well drained. On this Forest, it makes its best growth on small alluvial flats and springy slopes in the yellow pine zone.

4. Tolerance of Shade. It is more tolerant than Douglas fir, western larch and yellow pine but less so than Engelmann spruce and alpine fir. Seedlings can endure considerable shade but it becomes stunted and dies if too long suppressed. It does best with full overhead light except at the lowest elevation where it seeks the cooler sites.

5. Growth and Longevity. It is a tree of rapid growth, especially in the juvenile stage. At 100 years of age, it may be 24 to 30 inches in diameter and 100 feet high. It is a short lived tree – butt-rot often starting before the tree is mature.

6. Reproduction. It is a moderate seeder. Good seed years are at irregular intervals. The cones mature in August of the first year and by the middle of September, most of them are scattered. The seeds germinate best in thin humus and partial shade is most favorable for the development of the seedling.

7. Susceptibility to Injury. Grand fir is one of the most defective trees of the Forest. At least, 75% of the mature trees are affected with butt-rot and for this reason it is difficult to dispose of the timber. Wind, lightning and fire are also causes of injury.

Tsuga mertensiana – Mountain hemlock.

Mountain hemlock is confined to parts of four townships in the western part of the Forest. Little is known in regard to its habits. Trees 24 to 30 inches in diameter and from 60 to 80 feet high are not uncommon, although the average is probably somewhat less. The branches grow nearly to the ground and the bole tapers rapidly. The crown is very dense and in pure stands, very little light reaches the ground. It occurs in pure stands over small areas or in mixture with alpine fir, lodgepole pine or spruce. It frequents sheltered basins near canyon tops, the upper courses of streams and shows a decided preference for north slopes. Considerable moisture is necessary for its development. Without exception, it is the most tolerant tree of the Forest. Its growth is slow and it is probably long-lived. It is a prolific seeder, the top and tips of the upper branches usually being covered with cones. Seedlings start either in duff or on mineral soil, the latter probably being preferred. The bark is not particularly thick and fire causes considerable damage.

Western yew (Taxus brevifolia) is a tree of rare occurrence on this Forest. Occasional small specimens are found near springs in the yellow pine zone or in the shade of fir and larch stands along stream bottoms. It is of no importance.

The junipers are also of rare occurrence and of little importance. They are confined to the drier sites in the yellow pine zone with the exception of dwarf juniper which is sometimes found as high as the lower limits of the alpine zone.

Black cottonwood (Populus trichocarpa) is the only deciduous species of commercial importance. This is a large tree, sometimes 24 to 30 inches in diameter and from 75 to 80 feet high. The bole is long, clean and has little taper. The crown is short, irregular and flat topped. It is usually found with yellow pine, birch, alder etc. along stream bottoms at the lower elevations. It prefers a moist, sandy soil. It is very intolerant throughout its life. Its growth is rapid and it is probably mature at from 75 to 90 years of age. It seeds abundantly every year and reproduction is good on moist sand bars or in humus. Its rapid growth enables it to persist among more tolerant species.

III.
SILVICAL PROBLEMS.

1. The natural extension of yellow pine over bunch grass areas.

2. The replacement of bug-killed lodgepole stands by other species, notably the firs.

3. The natural reforestation of denuded watersheds in the alpine zone.

{signed} R.M. Evans
(Forest Assistant.)

Approved January 31, 1912

{signed} H.W. Harris
(Forest Supervisor.)