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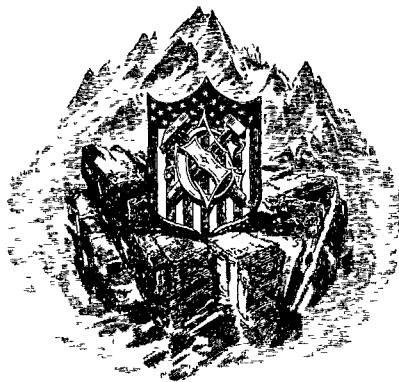
FOREST CONDITIONS

IN THE

NORTHERN SIERRA NEVADA, CALIFORNIA

BY

JOHN B. LEIBERG



WASHINGTON
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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 17, 1902.

SIR: I transmit herewith, for publication in the series of Professional Papers, a report prepared by Mr. John B. Leiberg on forest conditions in the northern part of the Sierra Nevada, including the areas of the Bidwell Bar, Downieville, Sierraville, Smartsville, Colfax, and Truckee quadrangles.

Very respectfully, yours,

HENRY GANNETT,
Geographer.

HON. CHARLES D. WALCOTT,
Director United States Geological Survey.

FOREST CONDITIONS IN THE NORTHERN SIERRA NEVADA, CALIFORNIA.

By JOHN B. LEIBERG.

EXTENT AND POSITION OF THE REGION EXAMINED.

The region covered by this examination consists of a tract of country situated in the north-central portion of California, between latitudes 39° and 40° north and longitudes 120° and $121^{\circ} 30'$ west, hence covering a section of the main range of the Sierra Nevada, together with its western and eastern slopes. The region is represented on the Bidwell Bar, Downieville, Sierraville, Truckee, Colfax, and Smartsville sheets of the topographic map of the United States (see Pls. I-VI, in pocket). The areal extent of the region is 3,491,100 acres, of which about 69,000 acres are level or gently rolling tracts situated in the Sacramento Valley, while the remainder consists of foothills, mountains, canyons and intermontane lakes and valleys. The areal extent of the lakes is estimated to be 72,800 acres.

TOPOGRAPHY.

The topographic features of a mountain region must of necessity exert a marked influence upon its forest cover. The principal factor is the character and amount of relief. The altitudes, obviously enough, produce varied climatic conditions; but the low portions, the canyons and valleys, are quite as potent factors in their way, although perhaps their effects are not so conspicuous at first glance. Yet the depth to which the chief drainage channels have been excavated and the extent to which the ramifications of the lateral systems of feeders have been developed in great measure decide the composition of the forest in any particular region. The character of the stream channels largely determines the rapidity of the run-off, and the rapidity of run-off in its turn influences the average soil humidity, a matter as vitally important to the forest growth as to that of any other sort of vegetation, and one not altogether determined by the amount of precipitation. As this examination is directed chiefly to the

forest conditions of the region, only those general features of topography which have a bearing upon the character, composition, and extent of the forest growth are here considered

The area of high relief of the region may be considered as consisting primarily of the main range of the Sierra Nevada, a secondary chain of mountains to the east of it paralleling it at distances varying from 10 to 20 miles. From these ranges proceed in all directions a multitude of ridges, which together constitute the mountain system of the region.

The main uplift of the Sierra is a continuous northwest-southeast range, and forms the geographic divide throughout most of the region. In the northern part of the Downieville quadrangle it is cut through by the Middle Fork of Feather River, which heads in the eastern range. The summit of the Sierra varies in elevation; most of it rarely falls below 7,000 feet. South of Donner Pass numerous peaks rise to altitudes of over 8,000 feet, while Mount Lola reaches an elevation of 9,167 feet. The eastern slope of the range is generally short and abrupt, its western slope is longer and has a more gradual descent. The Sierra has been subjected to glaciation in all portions above 5,500 feet, and abounds in rocky and boulder-strewn slopes, narrow summits, semicircular glacial basins, and tracts of bare rock from which all soil has been swept away. None of its peaks rise above timber line, although Castle Peak, at an elevation of 9,140 feet, has a narrow line of perpetual snow on its northeastern slopes, and the higher peaks south of Donner Pass usually hold banks of snow throughout the summer on northern slopes in the lee of projecting combs.

The secondary range east of the Sierra is not an uninterrupted range within the area under consideration, as Truckee River breaks through it in a narrow canyon 1,200 to 3,000 feet in depth. It is connected with the Sierra by transverse ridges; one is at the head of Long Valley; the other, passing around the north end of Lake Tahoe, is cut in two by the upper Truckee Canyon. The secondary range within the region discussed varies in elevation from 6,000 to 8,800 feet. It is a rocky range with a narrow crest line and steep fronts.

The region divides naturally into a number of drainage basins. Commencing at the north, on the western side of the Sierra, they are as follows: North, Middle, and South forks of Feather River, North, Middle, and South forks of Yuba River; Yuba River, Bear River, North and Middle forks of American River, and Rubicon River. These streams eventually empty into Sacramento River, either directly or through the channels of other streams, beyond the boundaries of the area under consideration. The watersheds of North Fork of Feather River, Yuba River, Bear River, Middle Fork of American River, and Rubicon River lie only in part inside the limits of this examination. The

drainage basins of the other streams enumerated are wholly within their boundaries. East of the Sierra two basins are included in part, that of Long Valley Creek, a small stream flowing into Honey Lake, and that of Truckee River, flowing into Pyramid Lake.

The streams of the region are remarkable for the gorge-like character of their canyons and the great depths they have reached. Few of them flow at a depth less than 2,500 feet below the summits of the inclosing ridges in the central portions of their courses, and in some places they are sunk as much as 4,000 or even 5,000 feet. The slopes of the canyons are usually extremely steep, always so in the last 1,000 feet, and not infrequently from the top to the bottom. As most of the basins are long and narrow, stretching from east to west, the lateral streams descend to the main channel over steep declivities and in many cases have excavated gorges but little inferior in their dimensions to those of the chief streams of the drainage. Most of the larger streams have level tracts at their heads. Sometimes, as in the case of the smaller streams, they consist of glades, ponds, or lakelets, while a few of the larger have their origin in big valleys or lakes. Thus Middle Fork of Feather River issues from a large level tract known as Sierra Valley, containing about 60,000 acres, and Truckee River flows out of Lake Tahoe, a sheet of water covering more than 190 square miles; but, on the contrary, the large North and Middle forks of American River head in small, insignificant glades or rise directly on the slopes of steep mountain sides.

The intermontane valleys of the region consist of broad levels bordering the chief streams. They are mostly situated near the heads of the rivers, above the place where the gorge-like portions of the canyons begin. Sierra Valley, mentioned above, is the largest of the level intermontane valleys. Grizzly Valley and American Valley are wide, level tracts bordering the upper portions of the southeastern tributaries of the North Fork of Feather River. Mohawk Valley is situated in the upper canyon of the Middle Fork of Feather River. Truckee Valley is a nearly level tract situated between the upper and lower canyons of Truckee River. In addition to the valleys here enumerated, there are many others of lesser area and importance.

The orographic features of the region make it possible to divide it into four districts, extending from north to south, as follows: Foothill, central, eastern, and trans-Sierran districts.

The foothill region consists of hills and ridges of comparatively low relief, ranging in altitude from 500 to 2,300 feet, and traversed by canyons and ravines of moderate depth. It constitutes a part of the western slope of the Sierra, forming a transition from the Sacramento Valley to the mountain areas in the east. The area of foothills is situated at the junction of the forks of

Feather River, at the confluence of the Yuba forks, along the upper and middle portions of Yuba River, along the middle and lower portions of Bear River, and on the lower portion of North Fork of American River.

The central area consists of a tract 18 to 25 miles wide, which may be considered as having once formed a plateau region; later it was cut through by the main streams and eroded by the system of laterals to which they have given rise. It now consists of comparatively narrow blocks of ground, level or with moderate amount of surface relief, and margined by the brinks of the profound canyons which traverse it. The altitude of the central portions varies from 3,500 to 6,500 feet.

The eastern district consists of the main range of the Sierra and numerous spurs and ridges connecting with it. The region is of high relief, reaching an altitude of 9,140 feet. Between the spurs lie many small and a few large tracts of valley land.

The trans-Sierran district comprises Long Valley and Truckee River Basin. Long Valley is a narrow, trough-like depression between the Sierra and the secondary range paralleling it. Truckee River Basin is formed by two semicircular depressions situated between the Sierra and its secondary range. One of these depressions holds Lake Tahoe; the other is valley like, in some portions level, in others broken by low ridges or by the terminations of spurs projecting eastward from the Sierra. The elevation of the district varies from 5,000 feet for the levels to 8,800 feet for the summits of the ridges.

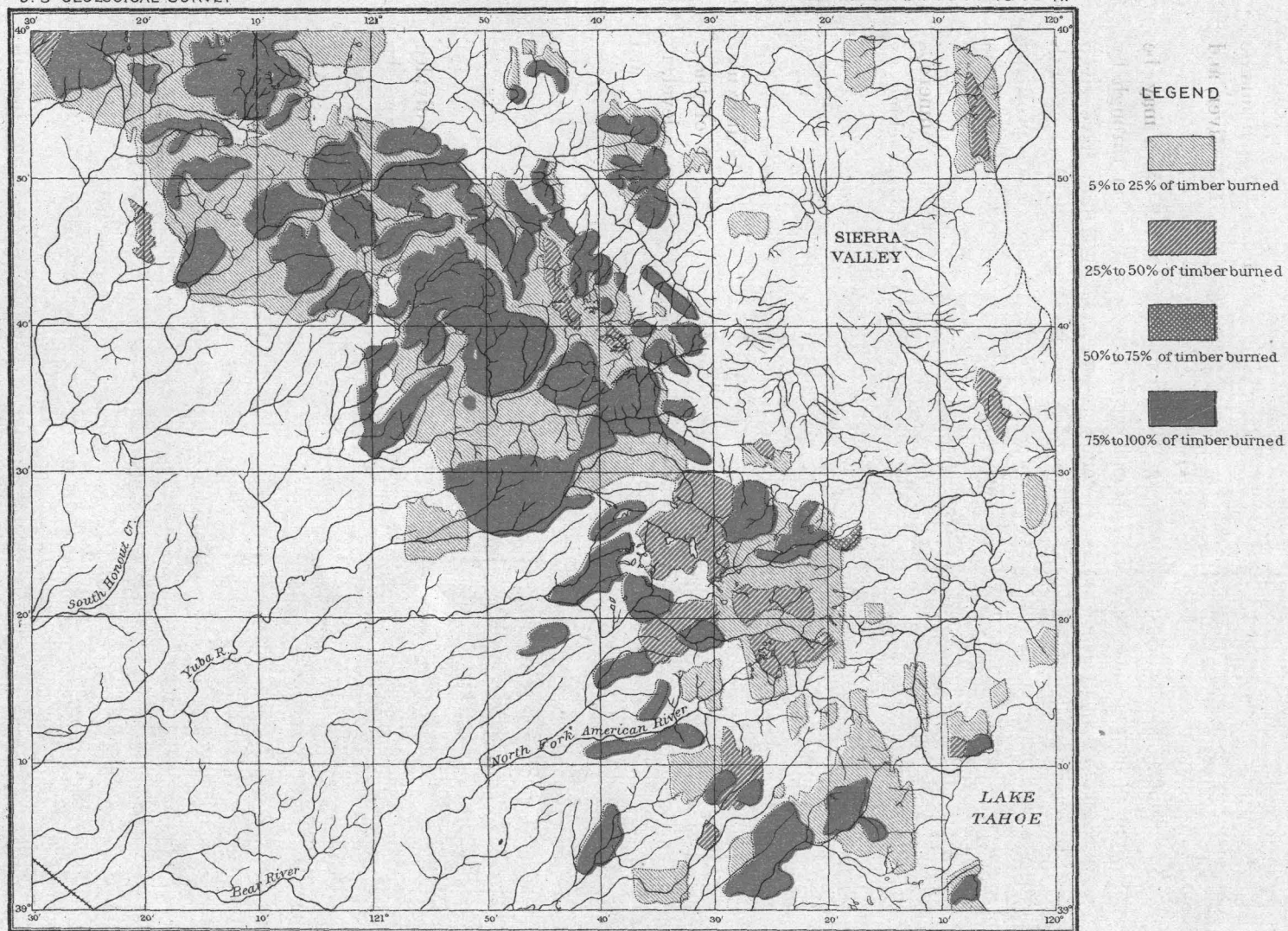
THE FOREST.

CLASSIFICATION.

In the classification here adopted the forested tracts of the region are divided into woodland, or wooded areas, and forest. The chief distinctions between the two are drawn along the line of mill-timber production. Thus the woodland growth consists of species of trees seldom or never attaining dimensions which render them suitable for mill-timber purposes. On the other hand, the forested areas bear species of trees which, under proper conditions, grow to the size necessary to meet such requirements. Outside of these specifications the line between woodland and forest is, in this region, in many instances arbitrary; for a great deal of the woodland carries as much arborescent growth, measured in cubic feet, as do many of the forested tracts, fire and logging in numerous localities having greatly thinned the latter.

EXTENT AND ACREAGE OF WOODLAND AND FOREST.

The woodland areas comprise 364,000 acres and are confined to the foothill district of the region. They are so situated as to form a transition from the



NORTHERN SIERRA NEVADA, CALIFORNIA

Showing location of burns

Scale

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JULIUS BIEN & CO. LITH. N.Y.

nontimbered levels of the Sacramento Valley to the forested region of the mountains.

The areas covered with forest embrace 2,337,930 acres and occupy all of the central, eastern, and trans-Sierran districts, except where the lack of soil or the climatic conditions preclude the existence of arborescent growth. It is a fact worthy of note that in the trans-Sierran district no woodland exists to form a transition ground between forest and desert, unless scattered trees of the western juniper may be so considered. The forest comes to the edge of the arid, nontimbered tracts in Long Valley and Truckee Basin, and there stops.

COMPOSITION OF THE FOREST

Coniferous species of trees constitute fully 95 per cent of the arborescent growth in the region. The remaining 5 per cent consists mostly of different species of oak, ash, maple, mountain mahogany, aspen, cottonwood, California buckeye, western red bud, arborescent willows, alders, etc. The conifers are the most important, as all the lumber-producing trees in the region belong to this family. The species are as follows:

Conifers found in northern Sierra Nevada

Yellow pine.....	Pinus ponderosa
Jeffrey pine.....	Pinus jeffreyi
Sugar pine.....	Pinus lambertiana
Lodgepole pine.....	Pinus murrayana
White pine.....	Pinus monticola
Digger pine.....	Pinus sabiniana
White-bark pine.....	Pinus albicaulis
Red fir.....	Pseudotsuga taxifolia
White fir.....	Abies concolor
Shasta fir.....	Abies magnifica
Patton hemlock.....	Tsuga pattoniana
Incense cedar.....	Libocedrus decurrens
Western juniper.....	Juniperus occidentalis
Yew.....	Taxus brevifolia

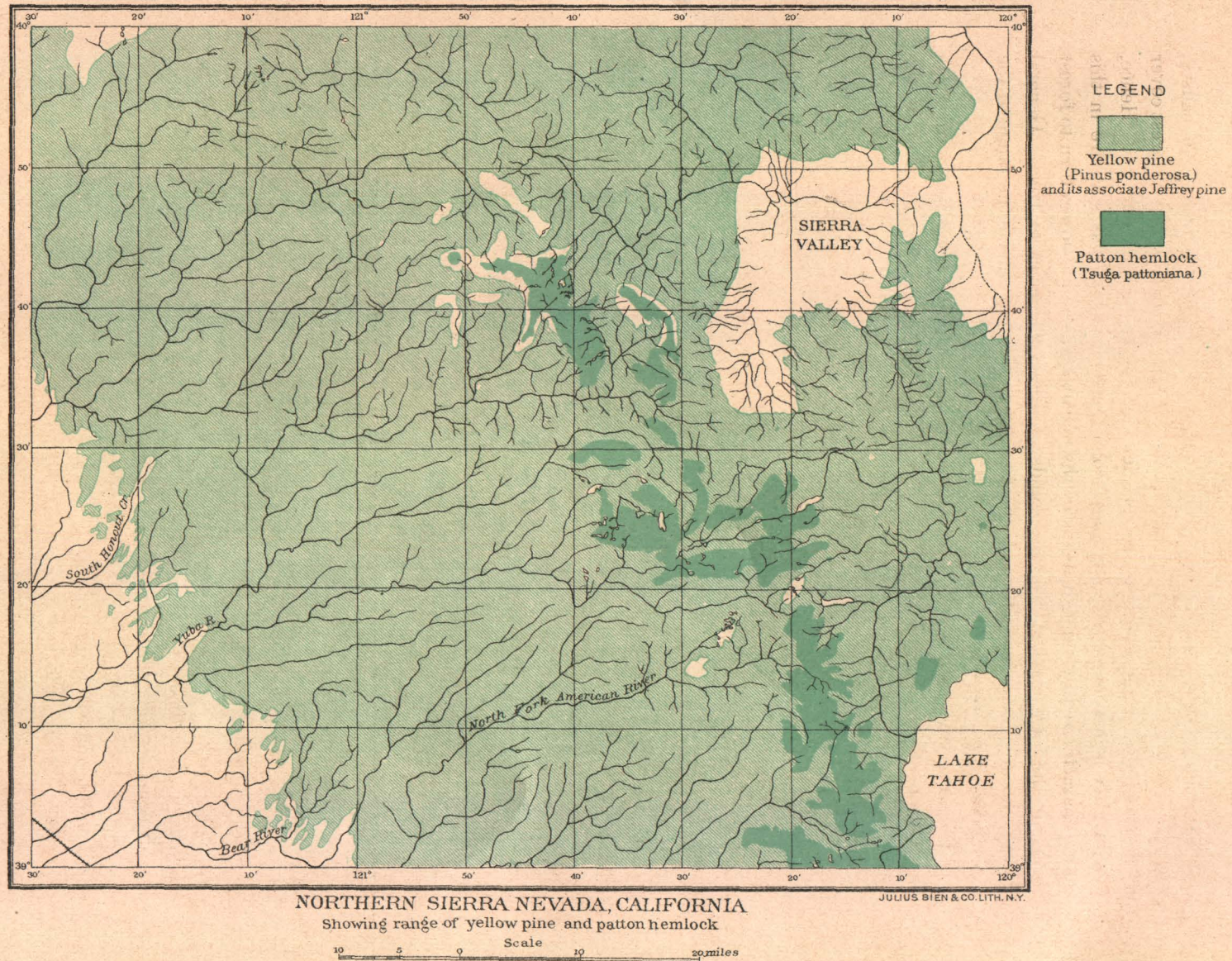
RANGE OF CONIFEROUS TREES.

The range of the different species of trees is determined by the various elements of climate, one of the most pronounced and conspicuous of which is aridity. Owing to the important part assumed by it in limiting the range of the different species, an account of the areas upon which its influence is most marked seems appropriate at this place.

The aridity of the region is of two kinds—general and local. The first is due to deficient rainfall, and is characterized by the introduction, over wide areas, of species of trees whose growth is compatible with a low annual rainfall. The local-

ized form is, in effect, soil aridity, and is dependent upon a multitude of causes, such as excessive relief and rapid run-off, thin soil, and destruction of the forest cover by fires and accelerated evaporation from denuded surfaces caused thereby. Hence, local aridity is not necessarily a climatic condition. Areas of this sort are in this region characterized by dense brush growths—chaparral—and a slow return to forest cover, or they are marked by thin stands of different species of trees. General aridity, due to climatic conditions, is the factor which chiefly affects the range of the forest trees in the region.

The arid tracts lie south and west of a line which sweeps eastward from the Sacramento Valley and incloses all the areas situated at the junction of the forks of Feather River, extending from 6 to 10 miles up the valleys of the fork of that stream. Near Sunset Hill this line passes into the Smartsville quadrangle, where it has a general southeasterly trend. It runs along the eastern termination of Hedge Hill and over the western slope of Oregon Peak, ascends the valleys of the North and Middle forks of Yuba for a distance of 4 or 5 miles above their point of junction, crosses the divide between the Middle and South forks of Yuba along the line running through Birchville, and ascends the valley of the South Fork of Yuba, a distance of nearly 22 miles, as far as the western termination of the great Eagle Bird gorge. It then turns westward, passing 2 or 3 miles west of Nevada City and Grass Valley, and, after abruptly turning eastward at the head of Rattlesnake Creek, enters the Colfax quadrangle. Near Chicago Park the line turns southward, passes through Colfax and ascends the North Fork of American River, a distance of 8 or 9 miles from Toll House bridge, on the Colfax-Iowa Hill wagon road. At this point the line again turns southward, and, following the course of North Fork of American River, passes outside the area under consideration. On none of these tracts are the arid conditions sufficiently intense to preclude an arborescent growth high and dense enough to be classed as woodland. In the trans-Sierran district the arid tracts are east and south of a line which sweeps westward from the Nevada deserts. Beginning at the north, in the region delineated on the Downieville sheet, where it probably adjoins similar areas in the Honey Lake region, the limit of its westward sweep is reached along the summit of Grizzly Mountains. It follows this range in a southeasterly or nearly easterly direction into the Sierraville quadrangle. At the head of Charles Valley the line turns southward, and after following for some distance the western edge of Sierra Valley turns to the east at the south end of this depression, whence it continues in a general easterly direction a distance of 12 miles, and after again turning south enters Truckee Basin. The arid tract includes all of the northern portion of this drainage, extending across the main



range of the Sierra in numerous localities; it sends a long lobe westward down the valley of the Middle Fork of Yuba, and another down the canyon of South Fork of Yuba, where a distance of only 6 miles separates its most western point from the eastern termination of the western arid region. In the southern portion of Truckee Basin the aridity is less than in the northern, but is not wholly absent anywhere, even along the highest summits of the main range of the Sierra.

The aridity over a considerable tract of the country in these districts is sufficiently great to preclude the growth of trees. The areas so affected consist of the eastern and central portions of the Long Valley drainage, a tract along the main range of the Sierra at Beckwith Pass, 5 or 6 miles wide; all of Sierra Valley; and a fringe from 1 to 2 miles in width on the slopes of the mountains which hem in the valley on the north, east, and west. To the above-mentioned areas should be added small tracts in the northern portion of Truckee Basin apparently too arid for tree growth.

DIGGER PINE

The Digger pine is the principal coniferous tree in the western or foothill district. Its range follows closely the limits of the arid region, but it does not extend into the Sacramento Valley. The upward and downward limits of the species lie chiefly between the 500-foot and 2,500-foot levels, though occasionally it ascends to elevations of 3,000 feet, and in the canyon of the South Fork of Yuba to 4,200 feet.

WESTERN JUNIPER

The range of this species is chiefly in the eastern and trans-Sierran regions between 5,000 and 8,800 feet, where various degrees of aridity prevail, and it extends westward to the summit of Grizzly Mountains. It is found throughout all portions of the main range of the Sierra situated within the limits of the area examined, on all the secondary ranges and spurs north of Sierra Valley, and as a narrow fringe at the lowest levels east and south of the valley. It extends throughout all portions of the Truckee Basin, except here and there in the region around Tahoe, Independence, Webber, and Donner lakes, and seemingly also on the northern slopes of Mount Pluto ridge. Its most western extensions are reached on the slopes and summits of the bare granite areas west of Summit City. It is not found in the Bidwell Bar or Smartsville quadrangles. Along the South Fork of Yuba Canyon it approaches within 5 or 6 miles of the eastern termination of the Digger pine. As the western juniper is a typical tree of the arid regions east of the Sierra, and the Digger pine of the semiarid country west of the range, it follows that along the South Fork of Yuba Canyon the two areas practically unite across this portion of California.

YEW.

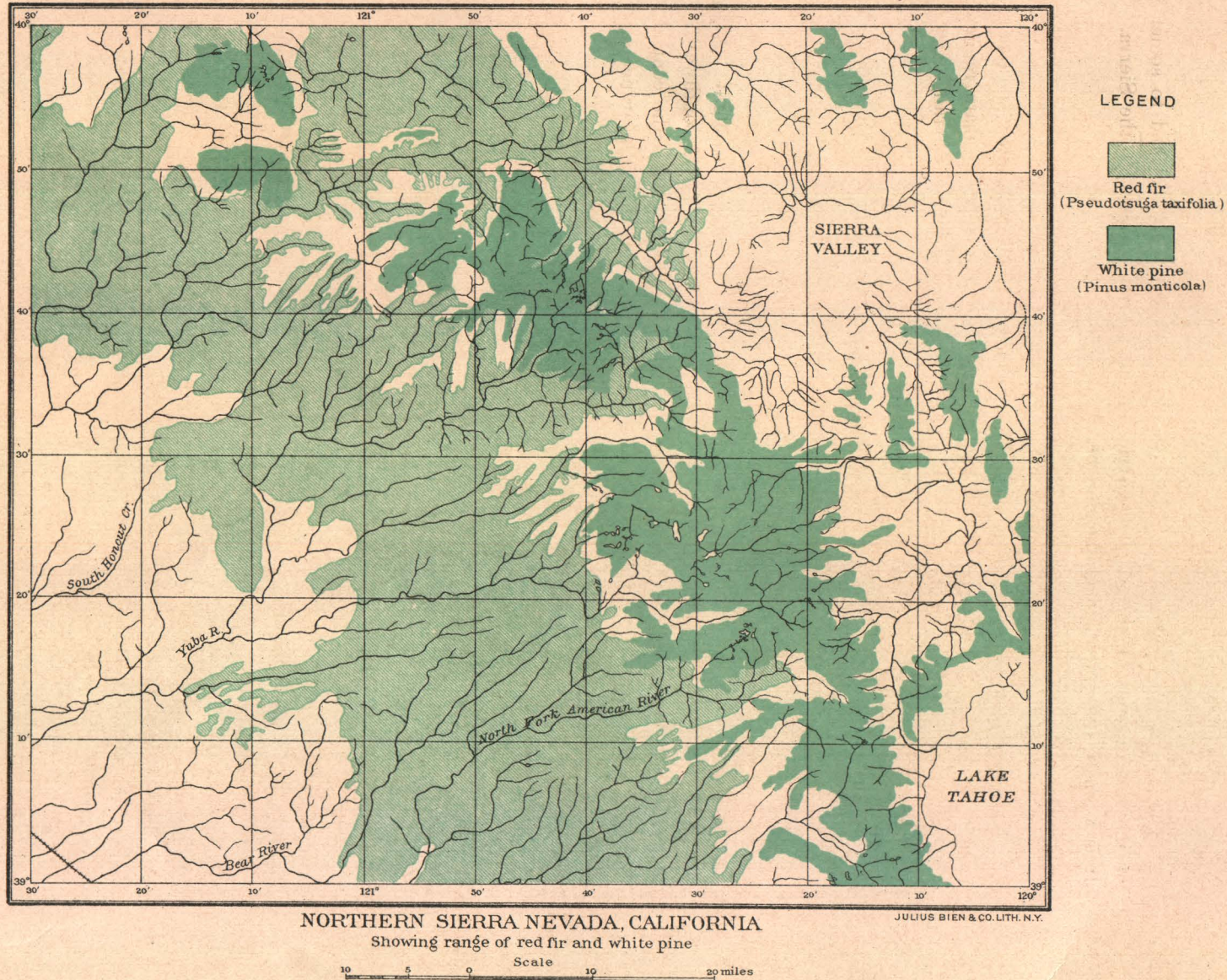
The yew is a species limited in its range to the central district and to some of the wet canyons of the eastern district, along the main range of the Sierra. It is a small, infrequent, insignificant tree.

INCENSE CEDAR.

This species occurs in all sections of the region at elevations below 7,500 feet, except in the Long Valley drainage, and on some portions of the main range and secondary western ridges north of Sierra Valley. Its principal range lies between altitudes of 3,500 and 6,000 feet.

PATTON HEMLOCK.

The Patton hemlock is a species characteristic of the highest summits and slopes in the region. Its distribution is much interrupted and uneven. It first appears in the northern area on the very summit of Mount Pleasant, in the Spanish Peak range. It is there a mere shrub, 4 to 5 feet in height. No individuals having the stature of trees were observed. Continuing southward, the species evidently follows the granite axis which strikes through the central district, but between its habitat on Mount Pleasant and its next appearance on Mount Fillmore, a distance of over 27 miles in a direct line, none of the species was seen. From Mount Fillmore to Sierra Buttes the range of the tree is nearly continuous, broken only by a low gap east of Mount Fillmore. At Sierra Buttes the extension of the species ends along this line, the southward continuation being shifted to the crest of the Mohawk Valley-North Fork of Yuba divide, which it follows to Hay Press Valley. The continuity is again broken at this point by the interposition of several low valleys. The species again appears at Bald Ridge, where another break in its southward range is caused by the canyon of the Middle Fork of Yuba, reappearing on the high ridges south of the canyon around Findley Peak. Again its range is cut, this time by a low saddle between Findley Peak and English Mountain. At this point the species becomes abundant, materially widening its range westward so as to cover all of the high granite areas west of Summit City. At Old Man Mountain the range of the tree turns sharply east and follows the summits of the high ridges on either side of North Creek to the main range of the Sierra, where it extends northward to Webber Peak and southward to a point about 2 miles south of Castle Peak. At this point its southward course is broken by the gap in the Sierra at Donner Pass. South of Donner pass the species extends over all the high slopes of the Sierra to Miller Creek, where a clean break of not more than one-half mile in width separates it from the tracts at the head of



and adjacent to the Rubicon River, where the tree attains greater proportions than in any locality within the region considered.

The extensions of the Patton hemlock are noteworthy, because in this region, at least, they seem to coincide exactly with the lines of heaviest precipitation.

The tree is not found in any portion of the main range of the Sierra from the south end of Sierra Valley to the northern boundaries of the Sierraville quadrangle, although many points on the range attain elevations of over 8,000 feet, an altitude which commonly insures the presence of the species on the ridges in the central district.

SHASTA FIR

This species has a wide range throughout all of the more highly elevated areas of the region. Commencing in the Bidwell Bar quadrangle the species enters this region in the northwest corner; thence stretching diagonally across the quadrangle, it crosses the central district between elevations of 5,000 and 7,000 feet, the continuity of its range being broken by the canyons of North and Middle forks of Feather River. It continues in a southeasterly course across the Downieville quadrangle. It also enters this quadrangle in a narrow lobe from the north along the crest of Grizzly Mountains, which it follows to Penman Peak. Crossing the Downieville quadrangle, it enters the Sierraville quadrangle, following the crest of the main range of the Sierra, south of Sierra Valley, eastward to Smithneck Canyon and Sardine Valley; thence entering the Truckee quadrangle it covers all the slopes and summits of the Sierra to its southern limits, extending on the eastern side of the range to the shores of Lake Tahoe, Donner Lake, etc., and generally to the 6,200-foot levels on the slopes and summits directly connected with the main range. It extends eastward beyond the region examined, along the Mount Pluto ridge, and occurs detached on the summits on and near Crystal Peak. In the Colfax quadrangle the species covers all the high granite areas west of Summit City, extending westward nearly to Snow Point and southward on the divide between the South and Middle forks of Yuba River to the brink of the North Fork of American River Canyon, following the divide between North and Middle forks of American River nearly to Red Point. The species is absent from all portions of the main divide of the Sierra bordering Sierra Valley, and generally from all tracts below 4,800 feet elevation elsewhere in the region. The Shasta fir is essentially a tree of the mountain regions, where the annual precipitation ranges from 50 inches upward.

WHITE FIR.

The white fir is found throughout the forested region, except in the foothills. It is encountered chiefly between 3,500 and 7,500 feet, but on the section of main range east of Sierra Valley it ascends to 8,700 feet; otherwise its areas coincide closely with those of the incense cedar.

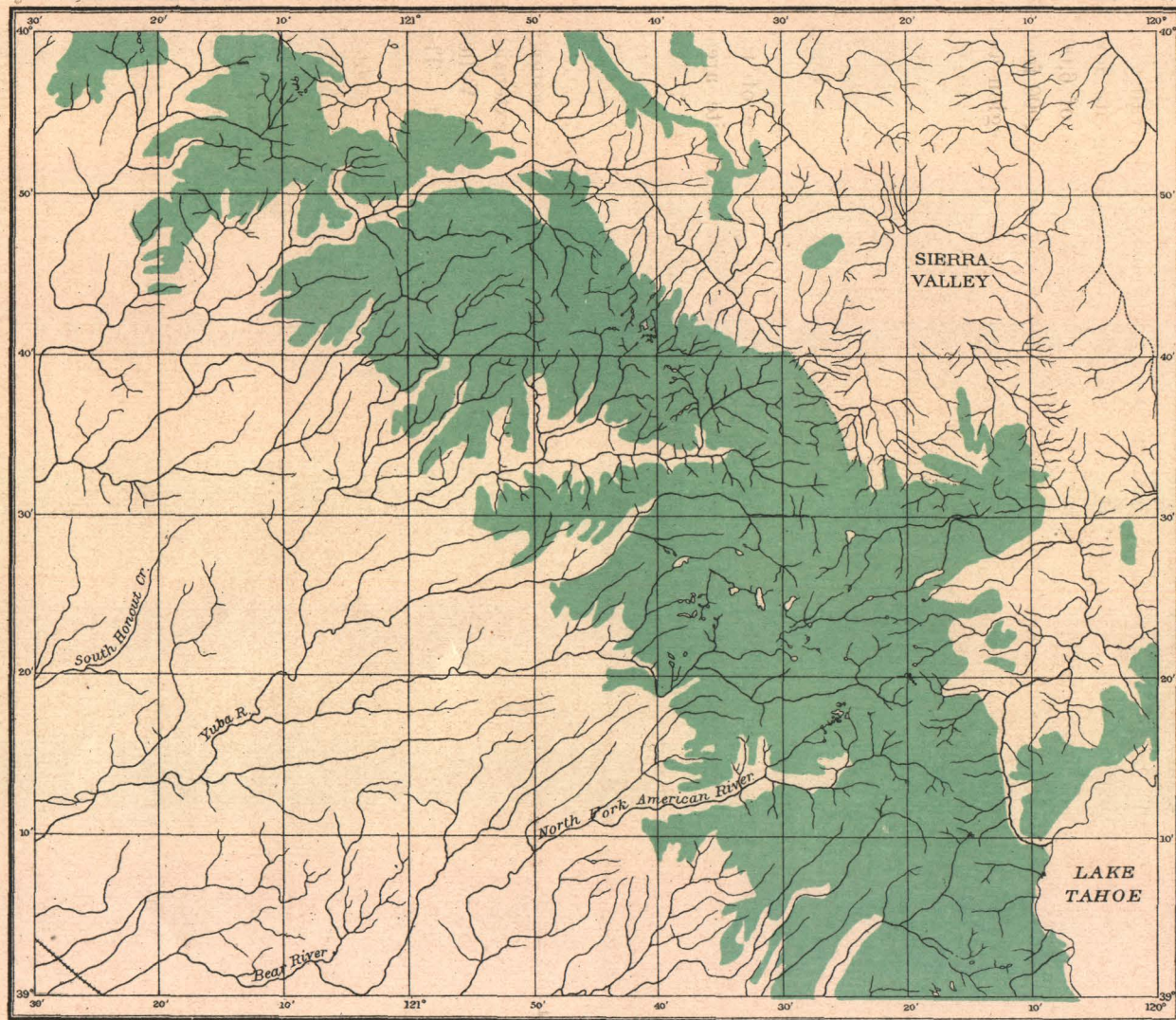
RED FIR.

The range of the red fir is irregular. Its occurrence along the low canyon bottoms and slopes carries it in some places almost to the western foot of the Sierra, while tracts of high ground projecting westward from the central mass of mountains often force it far to the west. The species is wholly lacking on the area east of the main divide of the Sierra.

Crossing the range from the east the red fir is first found in the valley of the North Fork of American River. It comes up this canyon along its low-lying bottoms to within 2 miles of Soda Springs, reaching an altitude of 6,000 feet, and in some places, as on the southern slopes of Snow Mountain, 7,000 feet. At Soda Springs the tree reaches its most eastern extension in this region and practically touches the foot of the main divide of the Sierra. In the basin of the Middle Fork of American River the species comes up along the main canyon, follows Duncan Creek to altitudes of 6,000 feet and crosses the divide between this stream and French Meadows, reaching elevations of 7,000 feet. Thence, in a nearly due north and south line, it ranges over the watersheds of the Long Canyon drainage and across the Rubicon, beyond the area examined.

North of the basin of the North Fork of American River the range of the species takes a long westerly sweep, avoiding the high, barren granite areas west of Summit City, but otherwise covering all the area shown on the Colfax sheet with the exception of a small tract west of Duncan Peak. North of the Colfax quadrangle the species is found extending up the basins of North Fork of Yuba and Middle Fork of Feather River, in both regions generally limited by the 6,000-foot level, but in the Feather River basin cut off in its easterly extension not so much by altitude as by aridity. Hence, the easterly extension of the species gradually thins out in long narrow lobes, as in the Mohawk Valley and toward the heads of the small streams entering this valley from the east. The tree is entirely lacking in the regions bordering Sierra Valley. In the western portion of the Feather River basin it is abundant, but is lacking on all the high areas of the Spanish Peak range, Bucks Mountain, Grizzly Hill, Franklin Hill, etc. The species is absent from most of the foothill region, occurring here and there in the eastern portions where the elevation rises to 2,400 feet, and in a few isolated cases at elevations of 1,500 feet where local conditions of seepage favorable to its growth exist.

Within the area examined the species does not reach its lowest altitudinal limits in this portion of California. West of the area represented on the Bidwell Bar sheet—that is, in the Chico quadrangle, the tree was observed growing along the margins of creeks in shady canyons at elevations of 800 or 900 feet, in company with the California nutmeg and the yellow pine. Throughout this portion of California the red fir is commonly known as spruce.



LEGEND

 Shasta fir
(*Abies magnifica*)

NORTHERN SIERRA NEVADA, CALIFORNIA
Showing range of Shasta fir

JULIUS BIEN & CO. LITH. N.Y.

Scale 10 5 0 10 20 miles

WHITE-BARK PINE

The white-bark pine was observed on the summit of Castle Peak, where a few trees, nearly prostrate and of scrubby growth, were scattered here and there. The species was not seen elsewhere, but may occur on some of the high ridges and peaks south of Donner Pass.

WHITE PINE

This species occurs throughout the entire region where the altitude is above 7,000 feet. Its downward range is, however, not wholly limited by that elevation, as on northern slopes it was frequently observed at altitudes of 6,500 feet. The upper limit of its range is not reached by any point in the region.

LODGEPOLE PINE.

The range of the lodgepole pine is nearly identical with that of the Shasta fir. In some localities both east and west of the Sierra the species descends to altitudes of 4,500 feet, in such cases passing rather below the limits of the Shasta fir. The tree is a characteristic feature along the margins of creeks, glades, and lakes situated at altitudes of 6,000 feet and upwards, where it usually forms a fringe of nearly pure growth in the wet and swampy portions of the ground.

SUGAR PINE.

The sugar pine is of wide range in this region. On the Pacific side of the Sierra it extends over all the western portions of the Feather River Basin except the foothill country at the junction of the forks, the portions of the North and Middle fork canyons which lie below 2,500 feet, and the high areas around Snows mine, the Spanish Peak Range, and Grizzly Hill. It extends into the central area of the Feather River drainage, following up Mohawk Valley to its head, and occurs along the slopes of Grizzly Mountains to the point where they front on Sierra Valley. It is absent on the mountains east, north, and south of this valley, but on the west follows the ridges around the head of North Fork of Yuba River, ending abruptly on the mountains east of Bald Ridge at the head of Middle Fork of Yuba. It extends throughout nearly all of the Yuba Basin, with the exception of the high areas which form the northern portion of the watershed of the North Fork of Yuba and the granite area west of Summit City. It extends over all the western, central, and the western half of the eastern portions of North and Middle Forks of American River drainage, its range here being nearly identical with that of the red fir. It is lacking in the western and central portions of the foothill country below elevations of 2,000 feet, and occurs only in the eastern areas at these elevations in detached, fragmentary bodies or as scattered trees. East of the mountains it is lacking, except in the southern portion of Truckee Basin, where it fringes the lower lake

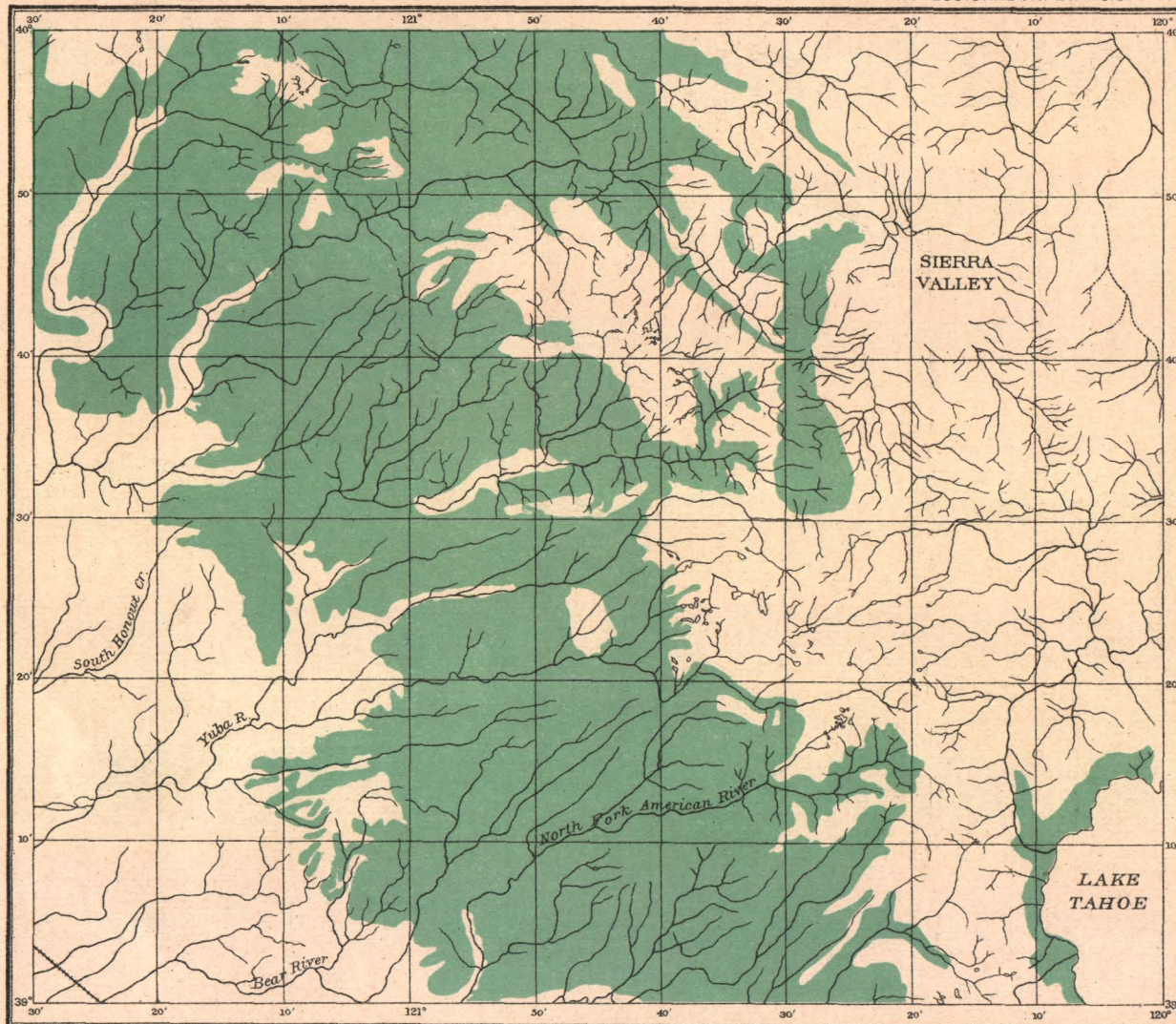
terraces of Tahoe with a sparse and scattering growth, and extends a few miles down the upper canyon of Truckee River. In no place in this region does the species cross the Sierra. The nearest approach to a crossing is at the head of the North Fork of American River and the upper canyon of Truckee River, where a space of only 6 miles in a direct line separates two localities in which the species occurs.

YELLOW PINE AND JEFFREY PINE.


The yellow pine and the Jeffrey pine are forms of one species, the former being considered as the type, the latter as a variety. The two forms differ chiefly in the size of the cones, in the tint and odor of the foliage, and in the color and thickness of the bark, differences which are insufficient to constitute specific characters. The most conspicuous of the above differences is that in the size of the cones, which may seemingly hold good if only a few hundred trees are examined. But when one comes to deal with thousands of individuals the distinction vanishes. It is common to find trees of the Jeffrey type as to foliage and bark that bear the big cones and the characteristic smaller cones of the typical yellow pine, both at the same time and on the same individual, while old cones strewn about on the ground indicate that in some seasons trees of the Jeffrey type produce only small-sized cones. The odor and the color of leaves and bark are more or less dependent on soil conditions and the inherent vitality of the individual tree, and the same characters are found in specimens belonging to the yellow and the Jeffrey pine. It was noticeable that the big-cone variety preferably grew at considerable elevations and on rocky, sterile ground, while the typical form of the yellow pine prevailed throughout the lower regions and on tracts with a more generous soil.

The yellow pine is of wider range than any other tree in the region and occurs everywhere except in the localities here noted. In the foothill country the species is generally absent from all areas below 1,000 feet, and in the vicinity of the Sacramento Valley from areas below 1,500 feet. In the central districts the tree is lacking on the high ridges stretching from Mount Fillmore to Sierra Buttes, above elevations of 7,000 feet on the higher portions of the Mohawk Valley-North Fork of Yuba divide, on most of the granite areas west of Summit City above elevations of 6,500 or 7,000 feet, on the main range of the Sierra from Webber Lake to Donner Pass, on the main range south of Donner Pass to Miller Creek, and on the high, rocky areas south and west of Rubicon Springs. In the eastern areas the species is lacking in Sierra Valley and on some of the ridges fronting on the valley, as well as on the main range of the Sierra for a distance of 2 or 3 miles north and south of Beckwith Pass. In the trans-Sierran district the tree is absent from most of the Long Valley drainage.

The lack of the species in the western foothill region and in the eastern and trans-Sierran areas is due to aridity, but in the central area it must be attributed to



LEGEND

 Sugar pine
(*Pinus lambertiana*)

NORTHERN SIERRA NEVADA, CALIFORNIA
Showing range of sugar pine

JULIUS BIEN & CO. LITH. N.Y.

Scale 10 5 0 10 20 miles

greater precipitation and lower mean temperature than the species can endure. The species passes over the main divide at all points north of Webber Peak. South of this point it crosses at Donner Pass and at the heads of Miller and McKinney creeks, in both places as a thin line, or rather as scattering trees mixed with Shasta fir and white pine.

The range of the sugar pine, red fir, and alpine hemlock, trees characteristic of the different types which they represent, demonstrates beyond a doubt that north of Webber Peak the geographic divide and the phytographic divide of the Sierra do not correspond, but that within our limits the granitic axis stretching from Donner Pass to Spanish Peak and beyond, together with Grizzly Mountains in part, is the line which demarcates the phytographic areas.

FOREST TYPES.

The term forest types is here employed to designate combinations of two or more species of trees; a single kind, if occurring over large areas and in stands of pure growth, may also constitute a type.

The trees in the region examined form a vast number of combinations, each differing from the other in a greater or lesser degree according to the number of species and the percentage of each species in the combination. But running through all the different assemblages of species are three well-marked general types, which are considered here. They are designated in this report as the Digger-pine type, the yellow-pine type, and the Shasta-fir type. The two last named of these types are characterized by having in their composition a larger proportion of the species of trees whose name they bear than of any other. None of the types have very closely marked limits. There is between each a transition ground where species belonging to either of two types meet, but in their general features the three types are very clearly differentiated and readily distinguishable.

DIGGER-PINE TYPE.

Range.—The Digger-pine type constitutes the arborescent growth on the tracts termed woodlands in this report, and covers all of the foothill country between elevations of 500 and 2,400 feet, in exceptional cases reaching 2,600 feet. It is a type whose development is coexistent with the most arid areas in the western district of the region. The type covers 364,000 acres of the region examined.

Composition.—The type is composed of Digger pine and oak, with small admixtures of yellow pine and red fir in the eastern portions of its range, the tracts where these two species mingle with the Digger-pine type forming the transition ground to the yellow-pine type. The percentage of the trees composing the type varies considerably. Contiguous to the timberless levels of the

Sacramento Valley the oak runs as high as 80 per cent, Digger pine forming the balance. Toward the east the proportion of the latter species increases, but rarely exceeds 35 per cent.

Age.—Digger pine and most of the species of oak are long-lived trees, and in the old stands are found up to 175 years of age. Little of the Digger pine in the region has reached that number of years, however, as most of the largest trees were cut for timber or fuel long ago.

Size of trees.—The Digger pine attains a diameter as great as 3 feet, and is sometimes 90 feet in height. Most of the present growth varies from 14 to 20 inches at the base and 40 to 60 feet in height. The different kinds of oak, chiefly evergreen species, reach diameters of 3 feet and heights of 30 to 50 feet. Most of the oak is less than 20 inches in diameter and 35 feet in height.

Density.—This varies greatly, owing to cutting, but the growth throughout is open, even where no cutting has taken place for years. It is difficult to assign, even approximately, a true average for the region, but it is safe to say that the capacity of the stand is about equal to 4 cords per acre.

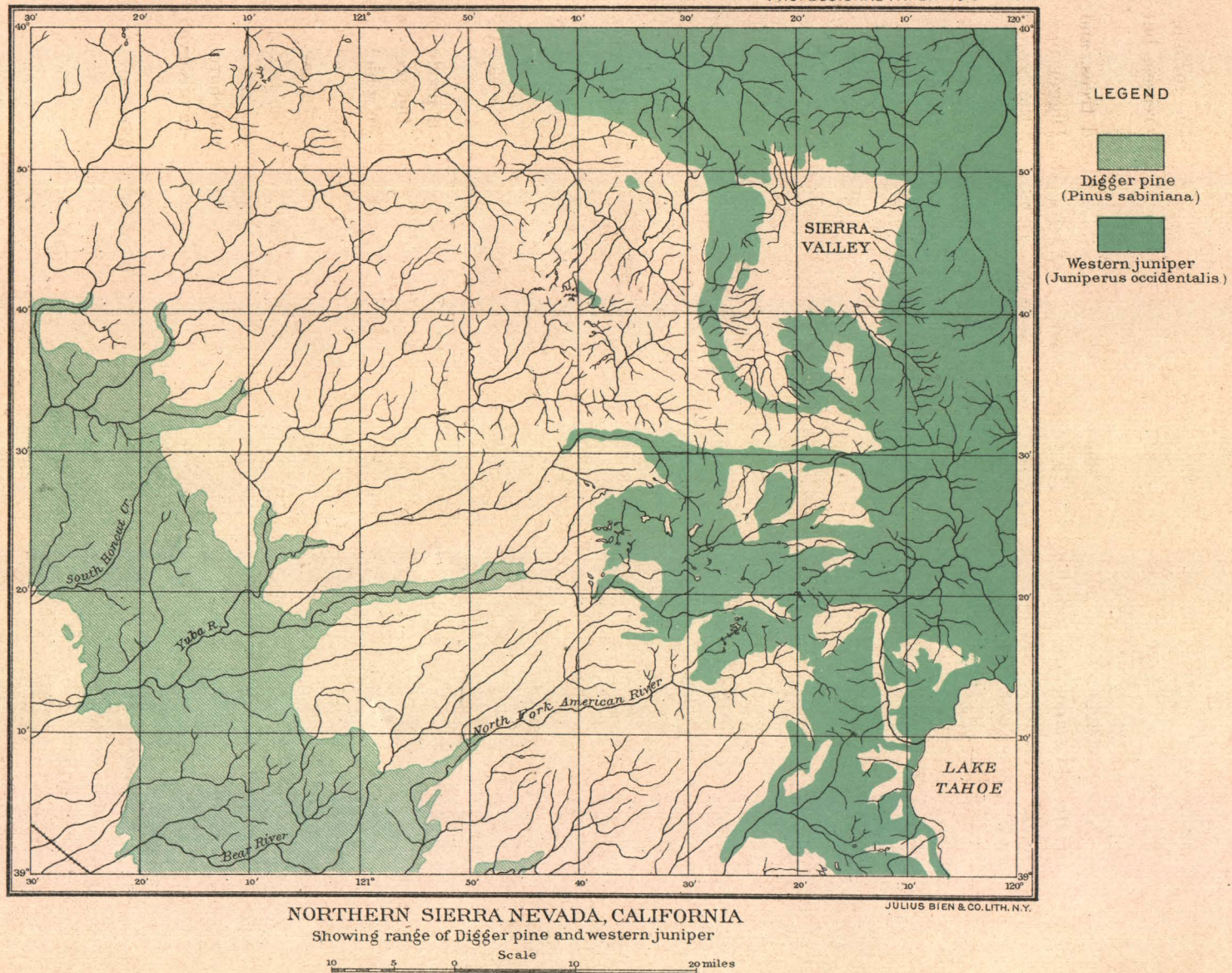
Litter.—There is no litter in stands of the type, except such as is formed from rejected tree tops where the timber has been cut for cord wood.

Humus.—The forest floor is bare, or at the most covered with an extremely thin layer of pine needles and oak leaves.

Undergrowth.—Normally there is only a moderate amount of undergrowth throughout the stands of the type, but on areas swept by fire it greatly increases in density and forms large, dense clumps. It is chiefly composed of *Ceanothus cuneatus* and *Arctostaphylos glauca*, the latter shrub a species of manzanita.

Commercial value.—In past times the type may have had value as a producer of mill timber, and outside this region, in the foothills east of Chico, the tree is yet occasionally sawed into lumber. Owing to its habit in branching, in which it resembles some species of arborescent willows, there is rarely any straight, clear trunk to the tree; but there are exceptions, as individuals have been observed having trunks 24 inches in diameter at the base and 20 feet in clear length. In this region, however, the only value of the Digger pine and its associate species of oak is for fuel. In past times a great deal of the type was cut and converted into charcoal. Such may yet be the case, but no charcoal pits or kilns in operation were observed in the region.

Reproduction.—The reproduction of the type is abundant. There are no appearances tending to show either an extension or retraction of its range. However, it is evident that there is an increase in the percentage of oak everywhere throughout it, due wholly to cutting, most of the oak springing up from the root when cut down, while the only method of reproduction of Digger pine is from seed.



YELLOW-PINE TYPE.

Range—The yellow-pine type extends over an area of 1,778,000 acres, or a trifle more than 70 per cent of the tracts bearing or capable of bearing forest cover. It includes most of the region between elevations of 2,500 and 6,500 feet. In the central districts of the basin it scarcely ever ascends beyond the latter altitude, but in the trans-Sierran district it is found at elevations of 7,000 or 7,300 feet. It is noticeable that as the eastern area is approached there is a gradual increase in the altitudinal range of the type due to lessened precipitation and probably higher mean temperature during the growing season for elevations above 6,500 feet than prevail in the central area at similar altitudes.

Composition.—The yellow-pine type of forest consists of the following coniferous trees. Yellow pine and its variety Jeffrey pine, sugar pine, red fir, white fir, incense cedar, and western juniper. Various other trees of different families, such as alder, cottonwood, arborescent willow, large-leaved maple, ash, and oak also occur in the type. Along the upper limits of its range it is mixed with small quantities of Shasta fir, while in its lower portions scattered Digger pines occasionally appear.

The most conspicuous and important tree in the type is the yellow pine. It occurs abundantly between elevations of 3,000 and 4,500 feet in the central area, while in the eastern and trans-Sierran districts it is most common between altitudes of 4,500 and 5,800 feet. In past times, before logging operations commenced, it may have been the dominant species as regards the number of trees, but owing to the vast amount of cutting it is so no longer. It has been more exhaustively logged than any other species in the type except the sugar pine, and restocking has not kept pace with the cutting. It is still the dominant species in amount of mill timber.

The following table exhibits the approximate composition of the coniferous portion of the type as regards numbers of individuals of the different species with basal diameter above 3 inches.

Composition of coniferous portion of yellow-pine type in northern Sierra Nevada, counting trees above 3 inches basal diameter

Species	Entire region	Central district	Eastern and trans-Sierran districts
	<i>Per cent</i>	<i>Per cent</i>	<i>Per cent</i>
Yellow pine	25	30	26
Sugar pine.....	1	8	—1
Red fir	25	30	8
White fir	44	25	64
Incense cedar.....	5	7	2

Yellow pine is particularly abundant throughout the western portions of the different river basins, except in the main Yuba and Bear river basins, in the eastern sections of the Middle Fork of Feather River Basin, and in the Truckee drainage. On the mountains bordering Sierra Valley and in the northern areas of the Truckee Basin it comes nearer being the predominant tree than anywhere else in the old growth of the region. In reforestation after logging on the western areas of the Yuba River forks it is easily the dominant species.

Sugar pine is the prevailing tree on small tracts between North Fork and West Fork of Feather River, on various areas between Middle and South Forks of the same stream, and on areas south of Texas Hill, on the slopes leading to the North Fork of American River. In these sections the species constitutes from 30 to 70 per cent of the type, but as the total acreage of the tracts does not exceed 40,000 acres the high proportion here falls far short of raising the percentage when the entire region is taken into account. The largest proportion and heaviest stands of the species occur along a line drawn from Break Neck Creek, in the northwest corner of the region, southwest to the junction of Duncan Canyon with the Middle Fork of American River. This strip of country in which sugar pine especially abounds, or did before it was removed by logging operations, is situated between elevations of 3,900 and 4,500 feet, and is about 12 miles in width. It is, on the whole, a clear, well-marked line, although the stands never were continuous owing to the breaks caused by the great river gorges which traverse the region. Another block of forest with a considerable proportion of sugar pine is found in the Spring Garden Creek region of the upper and eastern Spanish Creek drainage, the species here forming about 8 per cent of the forest. The western side of Mohawk Valley also carries a moderate stand of sugar pine, the amount varying from 2 to 6 per cent. Elsewhere the species occurs as scattered trees among masses of yellow pine and red and white fir.

The red fir is most plentiful along the line where the heavy stands of sugar pine occur, but it takes in a wider strip of country than that species, the region of greatest density varying from 20 to 35 miles in width. The species does not, however, form exceptionally close stands nor predominant proportions, except on tracts that have been logged and where most of the yellow pine has been cut out. In localities of this sort it frequently constitutes from 50 to 70 per cent of the forest.

The white fir is dispersed mostly along the central and higher limits of the type. It is abundant throughout all of these tracts, but is especially common in the Truckee Basin and in the region around Sierra Valley. In the country around Truckee it frequently forms 70 per cent of the forest on logged areas, while along the 7,000 foot level on the mountains around Sierra Valley its proportions reach 85 per cent.

The incense cedar is distributed throughout nearly all of the region of the type, being absent only on some of the drier areas north and east of Sierra Valley and in the northern portions of Truckee Basin. The region of its greatest density coincides approximately with that of the sugar pine. It is, however, also extremely abundant on the mountains south of Sierra Valley, where sugar pine is lacking.

The western juniper occurs only in small proportions. It is mostly confined to the eastern and trans-Sierran districts, and its presence always denotes aridity.

Among the broad-leaved trees which form a notable addition to the type, the different species of oak occupy the most prominent place. The region of their greatest development follows closely the line of the sugar pine.

Age.—All the coniferous species of the type are long-lived trees. The yellow pine attains an age of 250 to 450 years; the sugar pine, 400 to 450 years; red fir, 200 to 275 years, white fir, 175 to 275 years; incense cedar, 100 to 175 years. Little of the first-class mill timber, 24 inches at the base, is less than 175 years old.

Size of trees.—In the central district the yellow pine reaches 5 feet in diameter and 100 to 200 feet in height, with clear trunks 20 to 70 feet in length. In the eastern and trans-Sierran districts it dwindles to smaller dimensions, the average for mature trees being 2 to 3 feet in diameter, 75 to 100 feet in height, with clear trunks 15 to 35 feet in length. On the western slope of the Sierra the Jeffrey variety is usually a more stocky tree than the typical yellow pine, seldom exceeding 100 feet in height, with diameters between 2 and 3 feet.

At elevations between 3,900 and 4,800 feet the sugar pine reaches dimensions as follows: diameter up to 7 feet, height, 150 to 275 feet; length of clear trunk, 50 to 90 feet. At elevations above 5,000 feet it usually becomes stocky and is frequently found with diameters of 3 to 5 feet, while the height does not exceed 65 or 70 feet.

Most of the red fir in the region is of comparatively slender growth, being 16 to 24 inches in diameter, and 100 to 150 feet in height. Here and there, however, larger dimensions are reached, as in the western portions of the Feather River drainage, where the species grows 150 to 200 feet in height and 3 to 4 feet in diameter, with clear trunks 30 to 90 feet in length. The large red fir in this region generally has a disproportionately long crown compared with the species as it grows in Oregon.

The white fir attains diameters ranging from 3 to 5 feet, the common size for well-matured trees in good soil and at middle elevations being between 3 and 4 feet. Its height varies from 80 feet at high altitudes to 150 or 175 feet at elevations at or below the 6,000-foot level. The crown usually occupies two-thirds of the length of the tree and sometimes three-fourths.

The incense cedar grows from 75 to 100 feet in length and from 2 to 4 feet in diameter. Its length of clear trunk varies from 10 to 20 feet.

Density and capacity in mill timber.—In the eastern and trans-Sierran districts of the region the old-growth forests of the type are generally open on all slopes except the northern and on tracts with much seepage. In such localities the white fir is present in large quantities and gives density to the stands. In the central district, outside the canyon areas, the forest is of moderate density and is rarely what might be called open, except in stands of very old growth. Elsewhere large quantities of white and red fir with oak combine to form thickset stands. On the rocky slopes of canyons and in the great gorges of the rivers the forest is always very open and scattered.

The capacity of the type in mill timber varies from 500 to 50,000 feet B. M. per acre. The lesser quantity is obtained on rocky slopes or on tracts where the forest has been closely logged. Areas in the Truckee Basin have been logged so closely that they do not carry as much as 100 feet B. M. per acre. The old growth stands of mixed yellow and sugar pine are the most productive and will yield the higher figure. The average capacity in mill timber for the entire area covered with forest of the yellow-pine type is 7,400 feet B. M. per acre.

Litter.—There is little litter except on areas logged or culled to considerable extent, where masses of tree tops and rejected portions of trunks form great heaps of débris.

Humus.—There is no humus, the forest floor is bare, or at the most is covered with a layer of pine needles rarely exceeding 2 inches in depth, most commonly an inch or less.

Undergrowth.—With the exception of the tracts north and east of Sierra Valley, the eastern area of Truckee Basin north of Mount Pluto ridge, and the thickset restockings of young growth in the central districts of the region, there is a great amount of undergrowth in the forest which has attained its present proportions chiefly through the agency of fires. Most of it consists of species of *ceanothus*, collectively named "buckbrush" by the inhabitants of the region. This undergrowth shows no evidence of dying out, but appears rather to be increasing in density and constitutes a decided obstacle to reproduction.

Commercial value.—The yellow-pine type is of great commercial importance, as it supplies nearly all of the timber sawed into lumber in the region. The species of trees utilized are as follows. In the central district, yellow pine, sugar pine, and small quantities of red and white fir; in the eastern and trans-Sierran districts, yellow pine and white fir. The incense cedar is rarely cut owing to the common defect of worm holes, which extend longitudinally through the trunk of the tree. Most of the cut is for mill purposes, in the eastern and trans-Sierran districts considerable quantities of cord wood are cut, in the northern portions of Truckee Basin the white fir is being cut for pulp wood when too small for saw logs, while

in the central district a good deal of sugar pine is converted into shakes in addition to supplying mill timber. The value of this type for mill timber is best seen from the following table, which gives the amount of standing mill timber in the forests of yellow-pine type:

Amount of mill timber in yellow-pine type in northern Sierra Nevada

Species	Local practice—above 12 inches basal di- ameter for yellow pine, 16 inches for white fir	Michigan practice— above 8 inches ba- sal diameter and 10 feet clear trunk
	<i>Feet B M</i>	<i>Feet B M</i>
Yellow pine	4, 000, 000, 000	5, 000, 000, 000
Sugar pine	2, 214, 000, 000	2, 622, 000, 000
Shasta fir	100, 000, 000	155, 000, 000
Red fir	1, 767, 000, 000	2, 825, 000, 000
White fir	1, 606, 000, 000	2, 498, 000, 000
Total	9, 687, 000, 000	13, 100, 000, 000

Reproduction.—The type as a whole is maintaining its territorial extensions, but the relative proportion of its species is undergoing a decided change. The principal variations consist of a greatly lessened percentage of sugar pine, a decided increase in yellow pine in the northern portion of the central district of the region, and a uniform increase throughout all the areas in the proportion of incense cedar and white fir, with a corresponding decrease of yellow pine. The changes are due to logging operations and to fires.

SHASTA-FIR TYPE.

Range.—The Shasta-fir type occupies the highest altitudinal position in the three chief forest types of the region. Its range in the central district lies generally above the 5,800-foot level; in the eastern and trans-Sierran districts above elevations of 7,300 feet. Occasionally it descends as low as 5,500 feet, mostly on northern slopes in the central area. It is the prevailing type on the summits of the main ridge of the Sierra and on all the high divides between the different drainage basins. In its range the type conforms strictly to the line of heaviest precipitation and lowest mean annual temperature, descending below its chief altitudinal limits only where seepage and northern exposure combined compensate for difference in elevation. The areal extent of the type in the region is, in round numbers, 871,000 acres.

Composition.—The Shasta-fir type is composed of the following species of conifers: Shasta fir, lodge-pole pine, white pine, white-bark pine, and alpine

hemlock. A few species of broad-leaved trees also occur. The principal are alder, cottonwood, arborescent willow, aspen, and mountain mahogany. Along the lower limits of its range small quantities of white fir and yellow pine are mixed with it, whilst scattered trees of the latter species frequently extend to altitudes only a thousand feet below the highest limits of the range of the type.

The chief tree of the type is the Shasta fir. Both in number and volume it far surpasses all the other species, singly or combined, and gives the characteristic tone to the composition of the forest which distinguishes it as a type. The following table exhibits its relative importance in the districts of the region:

Composition of Shasta-fir type in northern Sierra Nevada

Species	Central district	Eastern and trans-Sierran districts,
	<i>Per cent</i>	<i>Per cent</i>
Shasta fir	83	74
Lodgepole pine.....	12	18
White pine	3	4
Patton hemlock.....	2	4

While the Shasta fir is so largely the dominant species, there are localities in which the tree is lacking and where the type is represented by lodgepole and white pine, with a small admixture of white fir coming up from the yellow-pine type. Such tracts occur along the section of the main divide of the Sierra east of Sierra Valley and on the secondary ranges north of that locality. Here the composition of the type is generally as follows:

	<i>Per cent</i>
Lodgepole pine	40
White pine.....	55
White fir.....	5

But occasionally the white pine runs up to 85 per cent, the white fir disappears, and lodgepole pine makes up a scant 15 per cent of the remainder.

In the central district the Shasta fir often forms stands of which it constitutes 95 per cent, practically pure growths, as the admixtures, generally lodgepole pine or a few white pines, merely fringe the edges of the stands. The tree has a decided tendency to form these pure stands wherever deep soil and plenty of seepage insure rapid and vigorous development during the seedling and sapling stage.

Next in importance after the Shasta fir comes the lodgepole pine. It is distributed everywhere within the limits of the type, but is not exceptionally abundant in any locality except within narrow limits, such as the margins of lakes and marshy

glades, where it forms pure stands, and along meadows bordering creeks flowing into the eastern portions of the basins of the North and Middle forks of Feather River, where the tree occurs in park-like stands, of which 60 to 70 per cent is of the species.

White pine comes next in general distribution and proportion. It is a component of the type throughout all of its range. It is especially plentiful along the main ridge of the Sierra, sometimes occurring in stands 85 per cent pure. It generally occurs as scattered trees in stands of lodgepole pine and Shasta fir.

The white-bark pine is a mere chance factor in the type and is of no importance. It is limited to Castle Peak and the high summits of the main Sierra south of Donner Pass.

The Patton hemlock comes next to the white pine in proportion and importance. It occupies the highest altitudinal position in the type, and if a timber line existed in the region, would constitute the timber-line tree. It is especially abundant on the mountains south of Eureka Peak, where it forms stands from 60 to 80 per cent pure.

As a rule the Shasta-fir type is not at all complex in its combinations. The species composing it are too few in number and their altitudinal range too narrow to allow much variation in their assemblages. Besides, every species of the type has a tendency to form pure-growth stands.

Age.—The Shasta fir and white pine are long-lived trees, attaining 300 or 400 years. The Patton hemlock should be quite as long lived, but of all the individuals seen none appeared to be over 175 years old, and the greater number were much below this age. Under favorable circumstances the lodgepole pine may reach 150 years of age, and individuals 4 feet in diameter occasionally observed were probably older than this. Most of the Shasta fir and white pine consist of old growth, 125 years old or more. About one-third of the lodgepole pine is over 100 years old; the balance varies from saplings up.

Size of trees.—The Shasta fir grows to large size. Individuals 6 feet in diameter breast-high from the ground are not uncommon. The average size of the species within our area varies from 3 to 5 feet in diameter 3 feet from the ground, 100 to 150 feet in height, with clear trunks from 30 to 110 feet in length. In close-set stands the Shasta fir develops a remarkable length of clear trunk in proportion to its height, the crown often occupying only about one-fourth of the total length of the tree. The species commonly develops a swelled butt, or rather a sort of knee, due to heavy snows partially crushing or bending the tree while in the sapling stage and forming a permanent curve in the stem near its base.

The white pine is mostly a stocky tree, often large in diameter and of low stature. Average dimensions are: Diameter at base, 3 to 4 feet; height, 50 to 90 feet; length of clear trunk, 15 to 25 feet. Occasionally individuals of the species

are found with long columnar trunks 100 or 110 feet in height, the port of such specimens much resembling that of the mountain white pine of Idaho.

The lodgepole pine is mostly a small tree, rarely 2 feet in diameter and 90 feet in height. In close stands it varies from 12 to 20 inches in diameter and 50 to 80 feet in height. The clear portion varies from 5 or 6 feet to 15 feet, though where the species is close it sometimes forms clear trunks 50 feet in length.

The Patton hemlock is a small tree, sometimes attaining diameters of 24 to 25 inches at the base. Most of the species is less than 20 inches in basal diameter and 50 to 60 feet in height. Usually it is limby to the ground, but occasionally clear trunks are developed 15 feet to 25 feet in length.

Density and capacity in mill timber.—Where the Shasta-fir type has not been decimated by fire it is apt to form thick stands, especially if it consists of pure growth. Occasionally the lodgepole pine develops moderately close stands, but never to the same extent that the species does in Washington, Oregon, or Idaho. The tendency of the tree in this region is toward open, park-like groves. The Patton hemlock sometimes occurs in thick stands. In such cases the growth is nearly pure and the trees stand very close together, 4,000 or 5,000 individuals on an acre.

The type as a whole is scattering and patchy. Everywhere along the main divide of the Sierra it is made up of blocks of forest, separated by sedge or weed-covered openings or by tracts of naked rock. In the central district the stands form long thin lines, here widening into a fairly compact or heavy body of timber a few hundred acres in extent, there narrowing into irregular, straggling groups or lines of trees. The great expanses of chaparral which occur almost everywhere throughout this district break and interrupt the stands of the type at frequent intervals. Wet glades and expanses of bare rock are common in these areas, and contribute toward the patchy character of these forests.

The average mill-timber capacity of the type is 5,300 feet B. M. per acre. That of the different stands varies from 1,000 up to 150,000 feet B. M. per acre. The pure-growth Shasta fir stands are often extremely productive. Small tracts occur here and there capable of yielding 450 saw logs per acre, each log being 12 feet long and from 18 to 24 inches in diameter. Such stands are not common, but their existence indicates the possible productiveness of Shasta fir in this region under favorable circumstances.

Litter.—The litter consists of broken trees and tree tops. Very little is due to the agency of nature, as all the species of the type are fashioned to withstand the asperities of climatic conditions at high elevations, but throughout all the areas logged, such as the summit and slopes of Mount Pluto ridge, in the Truckee Basin, and a strip 5 or 6 miles wide along the Southern Pacific Railroad from

Bonner Lake to Emigrant Gap, there is a vast amount of litter left behind by the timber cutters.

Humus.—The humus consists of a thin layer of pine needles, usually an inch or less in thickness, except on tracts not swept by fire during the last forty or fifty years, where a layer sometimes 2 or 3 inches in thickness has accumulated; but on much of the area covered by the type there is no humus whatever, the forest floor consisting of bare sand, gravel, or mold.

Undergrowth.—Nearly all of the type situated at altitudes below 7,000 feet carries a vast amount of undergrowth. It consists mostly of species of manzanita, ceanothus, scrub oak, and chinquapin. All of the chaparral tracts of the central and eastern districts of the region are situated within the limits of the type, and within historic times have borne forests of Shasta fir and associated species. Above the 7,000-foot level the underbrush generally begins to thin out and consists largely of *Ceanothus cordulatus*, a spiny shrub, but on the main divide of the Sierra east of Sierra Valley close growths of scrub mountain mahogany and low bushy aspen extend to elevations of 8,800 feet. The dense undergrowth is wholly the result of fires, ancient and modern, its absence at high altitudes being due to climatic conditions which are inimical to the growth of the different shrubs of the region.

Commercial value.—The value of the type for lumber is not great, owing to its inaccessibility. Where it is situated so that it can be logged the Shasta fir is cut for mill timber. Such has been the case on the area adjacent to Lake Tahoe and along the line of the Southern Pacific Railroad, where large quantities have been cut. A great deal has also been converted into cord wood for the use of the Southern Pacific Railroad. Locally, these trees are cut for mining purposes. Many of the quartz mines and mining camps in the central district are situated within the area of the type and have no other accessible timber. In such cases all the species are sawed except lodgepole pine, which is used for fuel.

The stand of mill timber of the type is as follows:

Mill timber in stands of Shasta-fir type

	Michigan practice— over 8 inches basal diameter and 10 feet clear trunk	Local practice—over 16 inches basal di- ameter for all spe- cies
	<i>Feet B M</i>	<i>Feet B M</i>
Yellow pine.....	1,000,000,000	440,000,000
Shasta fir.....	3,473,000,000	2,039,000,000
White pine.....	141,500,000	67,900,000
Patton hemlock.....	23,100,000	1,300,000
Total.....	4,637,600,000	2,548,200,000

The yellow pine in the above estimates consists of scattered trees and small groups extending into the stands of the Shasta-fir type.

Reproduction.—The type does not appear to be gaining in its territorial extensions, but, on the contrary, it is losing ground slightly. The loss is in the northern portion of Truckee Basin and at the head of the Middle Fork of Yuba River. It is clear that on southern slopes draining into the last-mentioned stream, situated 3 or 4 miles south of Webber Peak and well within the area of the Shasta fir, arid conditions now exist which preclude the growth of the type. As is shown by old stumps, the region was once covered with Shasta fir. Fire destroyed the growth, soil aridity ensued, and the ordinary sagebrush of the desert has taken possession. However, tracts like these are collectively of small extent, and do not count for much in comparison with the great tracts covered with stands of the type which show no signs of permanent change.

DESTRUCTIVE AGENCIES.

The forces of destruction at work in the forest are in part due to climatic conditions, in part to ravages of fungi and insects, and, lastly, to human agencies. Only those caused by the latter are here considered. The methods employed by man in destroying the forest in this region are chiefly of four kinds, namely, cutting, fire, grazing, and mining, enumerated in the order of their importance and effectiveness. Before lumbering operations began, fire was the principal instrument of destruction and grazing the second, but in recent times cutting has risen to the chief rank.

CUTTING.

Under this heading are included lumbering operations and in general all systematic cutting of the forest. The cutting has been, and is, for three chief purposes, agricultural clearings, fuel, and mill timber.

CUTTING FOR AGRICULTURAL CLEARINGS

There have been cleared for tillage, in round numbers, 83,000 acres, of which about 35,000 acres are situated in the forested tracts and 48,000 acres in the areas classed as woodland. It will thus be seen that the forest has not suffered severely from the inroads of agriculture. In reality it has suffered less than these figures indicate, since the woodland tracts now under tillage were undoubtedly partially bare of timber growth when settled upon, and most of the timber remains standing in the cultivated fields, while the forested area had been denuded by logging operations before final clearing preparatory to tillage was made.

CUTTING FOR FUEL

It is impossible to segregate the tracts cut over for this purpose in the forested areas from those where the cutting has been for mill timber. Hence no estimate is possible as to the quantity of cordwood removed from these tracts. It must, however, have been very large, as a strip about 4 miles wide, from Truckee to Colfax, paralleling the Southern Pacific Railroad, is said to have yielded up its forest chiefly to supply the locomotives, in addition to great quantities cut at different points farther away from the line. In the woodlands practically the entire area of 364,000 acres has been culled, chiefly for fuel. The cut has not been very great except on areas contiguous to the Sacramento Valley, where a strip of woodland about 10 miles wide, and running the full length of the region, has yielded 50 per cent of its timber for fuel purposes. In addition to that cut from the tracts mentioned above, considerable timber has been cut for fuel during the last fifty years by settlers and miners throughout the entire region.

CUTTING FOR MILL TIMBER

There have been cut over and culled for mill-timber purposes, including timber used in the rough for mines, 1,022,890 acres. Including the woodland in this estimate, as some of the cutting there has been for domestic purposes other than firewood, we have a total of 1,386,890 acres, on which systematic cutting has been carried on within the last fifty-two years. Most of the cutting outside the woodland tracts has been in the yellow-pine type.

The areas cut in the forested tracts of the different basins are as follows:

Areas cut in northern Sierra Nevada.

Basin.	Cut and culled	Forested
	<i>Acres</i>	<i>Acres</i>
North Fork Feather River	100,880	370,160
Middle Fork Feather River	99,890	532,000
South Fork Feather River	35,150	71,740
North Fork Yuba River	131,420	230,850
Middle Fork Yuba River	100,330	124,630
South Fork Yuba River	153,520	226,990
Main Yuba River	28,700	28,700
Bear River	65,000	65,920
North Fork American River	86,100	156,000
Middle Fork American River	46,800	218,700
Truckee River	170,000	279,000
Long Valley	5,100	33,240
Total	1,022,890	2,337,930

Only a rough estimate is possible regarding the quantity of timber removed from the areas here enumerated. A general average per acre can not be struck owing to the uneven cut, which varies from 5 to 99 per cent of the total stand. Besides, it is impossible to know with certainty the original quantity in the stands. It doubtless was quite as uneven as in the remaining uncut stands, where it varies from 2,000 to over 25,000 feet B. M. per acre, estimated along broad lines. But, by adopting a moderate estimate for the several basins, founded upon the general condition of the unlogged areas, the cut, including that for fuel, may be stated as follows:

Quantity of timber cut in northern Sierra Nevada

	Feet B M
North Fork Feather River Basin.....	580,000,000
Middle Fork Feather River Basin.....	680,000,000
South Fork Feather River Basin.....	250,000,000
North Fork Yuba River Basin.....	398,000,000
Middle Fork Yuba River Basin.....	700,000,000
South Fork Yuba River Basin.....	800,000,000
Main Yuba River Basin.....	320,000,000
Bear River Basin.....	380,000,000
North Fork American River Basin.....	520,000,000
Middle Fork American River Basin.....	300,000,000
Truckee River Basin.....	1,450,000,000
Long Valley River Basin.....	20,000,000
Total.....	6,398,000,000

In other words, the cut equals 35 per cent of the present stand of timber, estimated by Michigan practice, and about 52 per cent when estimated by local practice. In connection with these estimates it is to be noted that a very large proportion—probably 30 per cent—of the standing timber grows in places practically inaccessible, and will never become available for use, except, perhaps, locally for mining timber.

FIRES.

The most potent factor in shaping the forest of the region has been, and still is, fire. The general character of the forest, the relative ratio of the different species composing it, the density and capacity in mill timber of the different stands, litter, undergrowth, etc., in fact almost every phase of its condition, has been determined by the element of fire.

AGE AND ORIGIN OF FIRES.

Fires ravaged the forest long before the American occupation of California. The aboriginal inhabitants undoubtedly started them at periodic intervals to keep down the young growth and the underbrush. When the miners came, fires

followed them. Contemporaneous with the advent of the miners, or soon after, came the flock masters with their sheep. The belief is generally held that the sheep herders fired the country in all directions and have been responsible for most of the fires of recent years. However that may be, all the fires observed during the last summer closely followed the sheep camps. It is evident that during the last decade forest fires in this region have greatly diminished in extent and frequency, and those which have covered the largest area during this period burned in the chaparral.

The only older burns which give any clue to their age are those which stretch in a line from northwest to southeast through the central district of the region. They are marked by the occurrence of large tracts covered with chaparral. Most of these areas are situated contiguous to placer camps, worked from the earliest times, and might be regarded as having been burned over by fires spreading from such camps. In some instances this most likely happened, but a large proportion of the chaparral tracts was denuded of forest so long ago that nearly all the stumps have decayed. Hence the fires which overran them probably date back to the early part of the last century.

Here, as elsewhere in the West, lightning is popularly supposed to be the cause of many fires. It is within the bounds of possibility that fires might originate in this manner, but it is not likely to happen very often. Most of the fires which have burned in this region can be traced to human agencies.

EXTENT OF FIRES

The fire-marked areas of the region comprise 2,754,770 acres, which leaves only 192,350 acres of tracts now or formerly wooded that have not been visited by fire at least once during the past one hundred years. In this estimate are included all tracts which show clearly the presence of fire sometime during the life of the present forest. In some cases the fire marks consist of mere traces around the base of trees or an individual tree more or less burned. In other localities the damage runs from 3 to 5 per cent. In still others the amount of burned timber varies from 10 to 25 per cent of the quantity yet standing, and from these figures it runs up to total loss. It is estimated that the areas badly burned—that is, those on which 50 per cent or more has been destroyed—comprise 715,440 acres, and of this amount there are 213,730 acres, in tracts larger than 80 acres, on which the destruction has been total. If the many small lots of badly burned forest which are scattered throughout the still growing stands were taken into the account, the figures given above would be considerably increased.

The region in which the forest has been most severely burned forms a fairly well-defined belt ranging from 15 to 20 miles in width and stretching diagonally

across the entire region from northwest to southeast. It enters the region near Table Mountain in the basin of North Fork of Feather River and extends across the canyon of that stream to the high country of the Spanish Peak range. From here it takes a southerly course through the central portions of the basin of Middle Fork of Feather River and the upper portions of the basin of South Fork of Feather River and enters the basin of North Fork of Yuba. Here it swings slightly more to the east and passes through the central portions of Middle Fork of Yuba, South Fork of Yuba, head of Bear River, and central portions of North Fork of American River basins, where it again shifts further to the east and enters Middle Fork of American River Basin east of Westville, continuing southward across the Rubicon River and beyond our area. All along the line of this fire belt smaller lines extend in all directions, but chiefly eastward. The damage done on these tracts fully equals, if not surpasses, the loss of timber on all the other areas put together.

EFFECT OF FIRES.

The results of forest fires in this region are fourfold. There is, first, the destruction of the timber by burning or root killing, which everywhere is the primary consequence of timber fires; second, there is suppression of young growth; third, a notable increase in the density and extent of the undergrowth, and fourth, the removal of the less fire-resisting trees and the survival of the species best fitted to withstand fire.

The fire-resisting capacities of the different species of coniferous trees growing in the region vary a good deal. The relative rank of each in this respect, commencing with the one having the lowest, is as follows: White fir, Shasta fir, lodgepole pine, Patton hemlock, red fir, white pine, Digger pine, sugar pine, yellow pine. As the tendency in a forest fire is always toward destruction of the trees less capable of resisting the flames and heat, it might be supposed that after repeated fires none but the most resistant trees would survive. To some extent this happens in the stands of the yellow-pine type, but is so largely counterbalanced by the methods of seed dispersion that the species of trees of higher fire-resisting capacity seldom gain much over those of the lesser. Hence, it is a common thing to find a reforestation after fire in the yellow-pine type consisting of white and red fir in a much higher ratio than that in which the yellow pine is present, owing to the seeds of those two species being light and provided with a large seedwing which insures their wide and rapid dispersion. On the whole, therefore, the composition of the forest is not permanently changed by the destruction of the less fire-resisting trees.

Suppression of the young growth has always been one of the most serious results of fires in this region. The land does not carry more than 35 per cent of the quantity of timber it is capable of supporting. There is no good reason

for believing that the stands which have been cut differed in this respect from those which remain.

The destruction of young growth by fire during the last half century must have been enormous. Let anyone who doubts this examine the sapling stands now springing up in old-growth forests where fire has been kept out during the last twelve or fifteen years. Such stands may be seen on tracts in Mohawk Valley, on areas in the central portions of the basin of West Fork of Feather River, and in the northern portion of Truckee Basin. These sapling stands, composed of yellow pine, red and white fir, and incense cedar, singly or combined, are so dense that a man can with difficulty force his way through. But for the stature of the species composing them they would constitute chaparral. It is granted that such close-set stands could not reach maturity and maintain their present density; but there is ample space almost everywhere in the old and second growth stands, those from 100 to 350 years old, for twice the present volume of timber, and it would have been there but for fires.

An increase in density and extent of brush growth below the 7,300-foot level is here an unfailing consequence of fires. In the yellow-pine type of forest and in the woodland it grows to larger proportions, and here and there, where the timber has been totally destroyed, it forms patches of pure growth. On the areas occupied by the Shasta-fir type, situated below the 7,000-foot level in the central district, extensive and excessively dense brush growths follow the destruction of the timber by fire. These brush-covered tracts, constituting a true chaparral, are characteristic features of all the badly burned region throughout the district. The brush chiefly consists of manzanita (*Arctostaphylos patula*), scrub oak, chinquapin, wild cherry, and species of *Ceanothus*. It grows to a height of from 4 or 5 feet, and is far more dense and uniform than the chaparral which covers the lower slopes of the southern California mountains. Although the growth of chaparral is commonly found in semiarid country, it is found here on tracts belonging to the region having the highest precipitation in this portion of California. There can not be the slightest doubt that every acre of chaparral represents so much ground once forested, denuded by fire, then overgrown with brush. At the head of Slate Creek, and near Howland Flat, in the western portion of Sierra County, chaparral identical with these growths elsewhere in the region is now in process of formation on tracts which were covered with forest to within twenty years ago. The land covered with chaparral comprises 210,740 acres, exclusive of small plots less than 80 acres in extent.

The lack of reforestation and the ascendancy of brush in the partly decimated stands of timber are to be ascribed, in a general way, to soil aridity. Every

fire which lays bare the forest floor causes a more or less deep and lasting soil aridity, owing to greatly increased evaporation and run-off, the effects of which are particularly felt during the growing season or at the time certain species of conifers discharge their seeds.

Above the 7,000-foot level the tendency toward brush growth is much diminished. Above the 7,300-foot level severely destructive fires give rise to open tracts on which grass or weeds take the place of the forest.

GRAZING.

Grazing acts as a destructive agent to the forest by preventing reforestation. The grassy fire glades which abound along the main range of the Sierra and at high altitudes in the central districts of the region were once covered with forest and would again bear timber but for the excessive amount of sheeping to which they are subjected.

MINING.

In most portions of the West mining makes inroads upon the forest by cutting. In this region it acts in another way as well; that is, through hydraulic mining operations. Every acre of forested ground torn up by the hydraulic giants and covered with tailings, or converted into a dumping ground for the debris, is an acre of forest land irretrievably lost. Centuries will pass before the mounds of debris and crumbling bluffs of sand and gravel left by this class of miners will possess much forest cover. These methods of mining are now nearly at a standstill, but should they again be used most of the area within the central and lower portions of the Yuba forks, as well as similar areas in the drainage of North and Middle forks of American River, would become mere gravel heaps, incapable of bearing forest for centuries to come.

REFORESTATION

Reforestation in the region is along two general lines, namely, restocking of burned areas and new growth on logged areas. It differs in composition and development in the different forest types and is more or less influenced by soil and seepage conditions.

REFORESTATION IN THE SHASTA-FIR TYPE.

Reforestation in the type, as a whole, is deficient. None of the chaparral areas show any decided tendency toward a return to forest cover. The badly burned areas of Shasta fir in the North Fork of Yuba Basin are apparently slowly parting with their soil cover by wash of rain and melting snow and becoming more sterile. The same is true of the tracts on and around Bucks Mountain and all the badly burned sections in the basins of the North and Middle forks of American River. The

grassy fire glades in the eastern and trans-Sierran districts utilized for sheep runs are reforesting only in exceptional cases, most of them as yet totally lacking young growth. The trampling of thousands of sheep pastured on these slopes during summer and fall reduces the soil, to a depth of 6 or 8 inches, to the consistency of dust. Rain washes this dust into the creeks and rivers, and heavy winds lift it up and carry it far away. The seeds of the Shasta fir, the chief species of the type, and upon which reforestation chiefly depends, are largely shed in July and are trampled into the ground and destroyed. All seedling trees on the sheep runs are either cut off below the ground by the sharp hoofs of the animals or uprooted and trampled. In these runs, where trees have succeeded in establishing themselves, they are bent and stunted. Nothing whatever except excessive sheep grazing prevents a uniform stand of timber of medium density on these grassy glades, and while sheep are pastured there they never will return to forest cover. If this statement is doubted, let the skeptic examine the small tracts dotting the slopes here and there at high elevations where formerly sheep grazed, but no longer do so. There are many such plots, varying from 1 acre to 3 or 4 acres, scattered along the ridges from Webber Peak to the Rubicon River, on which the grass and weeds have been so thoroughly eaten out that even the sheep have abandoned them. On such tracts, left undisturbed for four or five years, Shasta firs cover the ground to the number of 10,000 to 15,000 trees to the acre. Every grassy fire glade in this region, at elevations above 7,000 feet, will reforest if left undisturbed by sheep and will remain bare while used as sheep runs.

Paucity of reforestation in chaparral tracts is due to soil aridity. Unless there is some sort of low ground cover like grass, weeds, or a layer of humus, the seeds of the Shasta fir, and probably the seeds of other trees belonging to the Shasta-fir type of forest, stand a very slight chance of germination. If they fall in the open, or on bare sandy or gravelly soil, they rest on a dry seed bed, where in the middle of the day the temperature in July reaches 120° to 125° F., and where they soon lose their germinating power. If the chaparral is dense the seeds may not reach the ground until they are dried up and their germinating power is gone. But whatever may be the cause, the fact remains that in this region dense chaparral seems to be fatal to a speedy return to forest cover. Eventually these brush growths will be replaced by forest—of that there is no manner of doubt—but it can not be hastened by burning the chaparral. That procedure only delays reforestation and increases the density of the next crop of brush. Chaparral can be replaced by trees only in the regular slow course of nature's methods, or by artificial replanting.

The ascendancy of chaparral on these tracts may be worth explaining. The species of brush composing it are such as are present in small quantities in unburned forests. All of the species have their seeds protected by a hard, bony

covering which prevents them from readily drying up and losing their germinating power. Therefore, when they fall on ground made bare by a forest fire and heated by the hot rays of a California sun, they do not perish, as do the seeds of the conifers, but remain in a quiescent state, ready to start into growth as soon as conditions are favorable. In that way different shrubs soon occupy the ground to the exclusion of tree growth, flourishing and attaining great proportions under the influence of heat and light.

In old, close stands, composed exclusively of Shasta fir, there is no young growth worth mentioning. In the logged stands in the Truckee Basin reforestation is abundant. On the cut-over areas near the head of South Fork of Yuba River it shows a tendency toward pure growths of lodgepole pine. The conditions of the different species of trees in reforestation are described below.

SHASTA FIR

This species generally holds its own in reforestation and is here and there gaining a little. In the upper Yuba Basin it is encroached upon to some extent by lodgepole pine, and in some localities has in recent times lost ground, owing to arid conditions.

LODGEPOLE PINE.

Lodgepole pine is increasing in numbers in the upper Yuba Basin on areas stripped of Shasta fir by loggers. It is also increasing in density around the margins of wet glades in the upper portions of Middle Fork of American River Basin. But on the whole it is losing ground both in reforestation and in the old-growth stands of the species, owing to encroachments of Shasta fir.

WHITE PINE

This species shows no perceptible increase or diminution in reforestation.

PATTON HEMLOCK

This species is increasing in numbers along the highest summits throughout all of its range. On some of the tracts south of Eureka Peak, burned over thirty or forty years ago, it forms 60 to 75 per cent of the new growth. The tree appears to have somewhat the habit of the lowlands hemlock in Oregon and Washington, forming stands of pure growth after fires, where the soil is deep and the seepage particularly abundant.

REFORESTATION IN THE YELLOW-PINE TYPE.

✓ Reforestation in this type of forest is extremely diverse. On the areas where the timber was cut in the early days of placer mining, namely, the western portions of the basins of the Yuba River forks, Bear River, and North Fork of American River, reforestation is exceedingly abundant. In the oldest and best of the stands

the young growth varies from 8 to 12 inches in diameter and 40 to 50 feet in height. The trees are thick set, 1,000 to 3,000 per acre; few show any clear trunk, nearly all being limby from leader to base. None of the tracts carrying these young growths have been placered. The stands are patchy, a few cover 3,000 or 4,000 acres each, but most of them occur on areas of small extent. Yellow pine is the leading species in these new growths, forming 35 to 65 per cent, the balance consisting of red fir and incense cedar. On tracts where the ground was turned up thirty or thirty-five years ago by the old methods of hand mining the growth is scraggy and uneven. The soil was washed away, sharp sand and gravel being left, and the stands show the result in small, gnarled trees, which have barely reached a height of 12 or 15 feet in thirty years. On the débris heaps left behind by the hydraulic miners a few feeble trees are springing up here and there, but most of the heaps are without any tree growth. On the areas logged within recent years restocking is abundant and vigorous provided fire has not swept over the tracts. But in numerous instances the composition of the coming forest varies remarkably from the one which has been logged, the degree of variation depending on the method of logging practiced and especially on the fact whether the cut has been merely selective or exhaustively close.

Reforestation on the logged areas of the type in the trans-Sierran district is abundant where the forest has not been too closely logged. On some of the northern portions of the Truckee Basin, where practically all of the yellow pine seed trees have been cut, reforestation is very deficient or consists of lodgepole pine or white fir.

Restocking of the burned-over areas in the type is slow and scanty where little local seepage exists or where the undergrowth has obtained the ascendancy. On some of the areas between Emigrant Gap and Colfax, logged very closely many years ago, oak occurs in reforestation to the almost total exclusion of coniferous growth.

The yellow pine type, as a whole, is not extending its range through reforestation, but is sustaining some slight losses along its western edge, adjoining the woodlands, due to close cutting and to the occupation of the denuded areas by oak and Digger pine. The condition in reforestation of the different species of trees composing the type is given in detail below.

YELLOW PINE

The stand of the species in the reforestation on the logged areas in the basin of North Fork of Feather River is good. In the western portions the saplings vary from 3 to 6 inches in diameter at the base and from 20 to 40 feet in height. The percentage of the tree varies from 20 to 60 per cent of the young growth. Apparently the coming forests on these tracts will contain a larger proportion of yellow pine than the one cut off. On the logged areas at

the head of Middle Fork Basin, south of Sierra Valley, the yellow pine forms about 5 per cent of the reforestation against 25 to 30 per cent in the original forest. This is due to close cutting of the species on these tracts and the sparing of incense cedar and white fir, which species together now form 95 per cent of the young growth. Throughout the unlogged portions of this basin there is comparatively little change. In sections protected from fire during the past twelve or fifteen years, like the Mohawk Valley, the yellow pine is gaining in numbers. In the western and logged portions of the basins of the Yuba River forks the young yellow pine is of vigorous growth where the ground has not been placered. Where the forest was cut forty-five or fifty years ago the growth has reached dimensions from 6 to 12 inches in basal diameter and 40 to 50 feet in height. The stands are close set, and the proportion of yellow pine varies from 35 to 65 per cent. On the débris heaps left after placer mining the growth is thin, scraggy, and scattering.

In the central portions of these basins the tree is hardly maintaining itself on the logged tracts, owing to close cutting of the seed trees.

In Bear River Basin and in the basins of North and Middle forks of American River there is a loss all along the western borders where the yellow pine type touches the Digger pine areas, due, as in the basins north, to exhaustive cutting of the seed trees of the species. Yellow pine is abundant in the restockings on the logged areas in the central portion of Bear River Basin; it is deficient in the central areas of the basins of both the North and Middle forks of American River, here giving way in some places to oak, in others to white fir and incense cedar, all depending on the methods of cutting in vogue.

On the logged areas in the Truckee Basin yellow pine is deficient in reforestation. More white fir and lodgepole pine are springing up on these tracts than formerly existed there. The growth of yellow pine is small, brushy, and scattered. The largest of the saplings are from 4 to 8 inches in diameter at the base and 20 to 30 feet in height. The stem is knotty and limby from leader to base.

Taking the region as a whole, the yellow pine is losing ground on all the logged areas, owing to wasteful and injudicious logging methods, while the average increase on the uncut portions is sufficient to maintain the present proportion.

SUGAR PINE

The belt of greatest density of the sugar pine in this region is the strip 12 to 15 miles wide which stretches diagonally across from northwest to southeast and which is more particularly mentioned elsewhere in this report. In this belt the original average percentage of sugar pine was, approximately, 20 to 25 per cent. Much of the area has been logged for its sugar pine; some of it very closely, other portions merely in a selective manner.

Where the logging has been selective, the species as it appears in reforestation has not suffered any very decided diminution, but where the cut has been close or exhaustive a great change has taken place. The tracts most closely logged comprise the western parts of the basins of Feather, Yuba, and Bear rivers, and North and Middle forks of American River. On most of these tracts the proportion of sugar pine in the reforestations does not amount to 1 per cent, and under the most favorable conditions to not more than 4 per cent, and with the cutting of the remaining seed trees constantly going on there is not the least probability of any decided alteration in these proportions in the future. On the areas cut over thirty-five or forty years ago the sugar pine has reached nearly the same dimensions as the yellow pine, namely, 6 to 12 inches in basal diameter and 40 to 50 feet in height.

Along the areas contiguous to the woodlands the sugar pine has been losing ground during many years, the species having receded eastward about 10 miles since cutting began. Old stumps of sugar pine standing among Digger pine and oak, where now not a sapling or seedling of the species is to be found, show a more extensive westward range within recent times. On the unlogged sugar-pine tracts stretching eastward in the Middle Fork of Feather River Basin and in the central areas of the Middle Fork of American River Basin the reproduction of sugar pine in the old growth keeps pace with the loss through natural causes.

Along the western and northern shores of Lake Tahoe there formerly existed a narrow belt of heavy forest having sugar pine as one of its component trees. At the present time a few scattered trees of the species still remain, but most of them were long ago cut out. The proportion of young sugar pine in the reforestation on these closely logged tracts is insignificant.

To sum up the condition of the sugar pine in the region examined, the tree is losing ground at a rapid rate on all the areas logged, and while total extinction is not threatened, yet its proportion in the reforestation throughout such tracts, situated within the chief range of its growth, is so greatly reduced that in place of its former ratio of 20 to 25 per cent the coming forest will contain only 2 or 3 per cent at the most, while on the unlogged tracts it is maintaining its present ratio. The deficiency of sugar pine in the reforestation is due to one general cause, and that is wasteful and unscientific logging methods—everything capable of yielding immediate profit being cut, without the slightest provision for sparing a sufficient number of seed trees to restock the cut-over areas.

RED FIR

This species is abundant and vigorous in all reforestation of the yellow-pine type, whether after logging or fires. In reforestation on the gravel heaps thrown up by the placer miners its growth is thin and scattered, but is more abundant than

that of the yellow pine. In the sapling stands in the Yuba Basin, logged twenty to forty years ago, the tree has reached dimensions varying from 6 to 12 inches in basal diameter and 30 to 60 feet in height. The species is not losing ground anywhere in the region examined, but, on the contrary, is gaining. In the forest arising on the logged tracts the species will show an increase varying from 15 to 30 per cent over the ratio in the forest as it existed before cutting began. There is also a slight increase apparent in the percentage of the tree in the sapling growth which is coming up in the aged stands.

WHITE FIR

White fir is increasing its ratio in the restockings, partly at the expense of the yellow pine, partly as an offset to a lessened percentage of sugar pine. On the Pacific side of the main range there is a steady increase of the species, both in reforestation on the logged areas and on the tracts denuded by fire. In the Truckee Basin it is largely replacing the yellow pine on the logged areas, and in the coming forest will amount to 60 to 75 per cent of the growth, against 25 to 40 per cent in the original uncut stands. Its increase throughout the region examined is due to exhaustive logging of yellow and sugar pine and sparing of white fir.

INCENSE CEDAR

The proportion of incense cedar in the region is increasing throughout the reforestation on the western side of the Sierra. The tree is rarely cut, as its lumber is practically valueless owing to worm holes. For this reason an abnormally large number of seed trees remain on the cut-over areas, and the result is a great increase in the proportion of the species. The increase is at the expense of yellow and sugar pine and, in isolated localities, red and white fir. Incense cedar is a more copious producer of seed than any other species of tree in the yellow-pine type, hence its rapid increase on logged tracts is not surprising. In the forest south of Sierra Valley, where most of the yellow pine has been cut out, the crop of incense cedar now springing up forms 40 to 65 per cent of the young growth, while in the forest before cutting it barely constituted 8 or 10 per cent. This instance is an extreme case, but substantial gains in the percentage of the tree are shown throughout its range. The species comes in tardily on burned-over tracts until a growth of white or red fir or yellow pine has established itself.

Incense cedar makes a rapid diametrical growth, but lengthens slowly. Tracts cut over thirty or forty years ago show saplings of the species 8 to 14 inches in diameter at the base and 25 to 35 feet in height.

REFORESTATION IN THE WOODLAND OR DIGGER-PINE TYPE.

In the restocking of the woodland there are but few changes to note. These consist of a temporary increase in the proportion of the different species of oak at

the expense of the Digger pine and a steady elimination of the few yellow and sugar pines and red firs in the higher parts

FUTURE OF THE FOREST

The future of the forest will depend on two factors—the length of time the present forest will yield mill timber and the composition and general aspect of the growth to follow

If we suppose that the present conditions of cutting, grazing, fires, etc., will continue in the future as in the past thirty-five or forty years, it is not a very difficult matter to predict with tolerable accuracy the future of the forest at the end of the present century. First, as to the timber supply. In the Truckee Basin it will probably last twenty years longer; in the accessible areas of the upper portions of Middle Fork of Feather River Basin, twenty-five or thirty years if transportation to outside markets is provided; if not, it will last indefinitely. In the accessible portions of the central and western areas of the Feather River Basin the forest, under the present system of selective cutting, will supply yellow and sugar pine fifteen or twenty years longer, while the red and white fir rejected by the logger will of course last indefinitely unless cheap transportation becomes available, when a decade would suffice to exterminate most of it. The forest in the accessible unlogged areas in the Yuba Basin will last twenty or twenty-five years. In the Bear River Basin the remains still standing, after exhaustive logging of the yellow and sugar pine, will furnish an inferior kind of mill timber for twenty or twenty-five years longer, while the mill timber in the basins of the Middle and North forks of American River, being difficult of access, may be counted to yield a supply for the next thirty-five or fifty years. A great deal—in fact, most—of the uncut Shasta-fir forests are so difficult of access that it is improbable that the ax will make any inroads in them during the current century

If the present rate of cutting and grazing is continued, the general condition of the forests at the end of the century, or even fifty years hence, will be about as follows: The Truckee and Long Valley basins will have been wholly denuded of large timber, and in its place will have come a sapling growth, heavy and close set in some places, open, under sized, and brushy in others. Most of it will consist of white fir, for the yellow pine which has given the present forest its chief value will form a comparatively small percentage of it. The old forest of the west slope of the Sierra, where accessible, will have been cut away, and the young growth will consist largely of red and white fir and incense cedar. It will be small and generally worthless, because the system of cutting the sapling trees for poles which now prevails in the region adjacent to Grass Valley and Nevada City will most likely have been extended to the accessible forested areas eastward. The sheep runs in the high portions of the Sierra will

be extended at the expense of the forest, because to keep up the grazing possibilities of that region will require the extermination of the Shasta fir. The chaparral areas will be brush covered, very much as they are, because they will be burned now and then so as to furnish fresh browse for the sheep, and the burnings will serve only to increase the density of the next stand of chaparral. The arborescent growth will increase in the woodlands, and the stands of Digget pine and oak will become much more dense.

DETAILED DESCRIPTIONS OF DRAINAGE BASINS.

BASIN OF NORTH FORK OF FEATHER RIVER

TOPOGRAPHY.

The drainage basin of the North Fork of Feather River is the largest of the basins which collectively constitute the Feather River system. The Feather River system, so far as it comes within the limits of this examination, consists of portions of the drainage basins of the West and North forks and all of the Middle and South forks. The North, Middle, and South forks unite within the limits of the region examined; the West Fork enters the main Feather River beyond. Most of the basin of the North Fork lies north of and is not included within the area covered by the present examination. The region examined comprises 447,840 acres, and consists of the tracts in the northern portion of the Bidwell Bar quadrangle adjacent to and draining directly into the main North Fork Canyon at its junction with Middle Fork of Feather River; also of the northern portions of the Downieville and Sierraville quadrangles, which are drained by southern and eastern tributaries of the North Fork. There is here added to the North Fork areas examined the tracts draining into West Fork of Feather River situated within the boundaries of the Bidwell Bar quadrangle, amounting to 27,000 acres. The North Fork enters the area of Bidwell Bar quadrangle at the northern margin, about midway between the eastern and western boundaries. It is sunk in a deep, remarkably precipitous canyon. From where it enters the Bidwell Bar quadrangle to a point known as Big Ripples, about 6 miles above its junction with Middle Fork of Feather River, the canyon varies from 2,000 to 5,000 feet in depth. The greatest width at the top rarely exceeds 2 miles, while the bottom is seldom more than one-fourth mile wide, more often only the width of the stream, 150 to 175 feet. The slopes are exceedingly rocky, the middle and lower portions frequently falling away in almost perpendicular escarpments. The canyon is extremely difficult to cross, only two or three localities being known above Big Bend that are passable for animals, although footmen can cross in a number of places. Below Big Ripples the canyon walls rapidly recede, and the gorge widens correspondingly at the bottom. In its course

through the Bidwell Bar quadrangle the canyon is only moderately tortuous, except at one place where it makes a turn known as Big Bend. Here it curves eastward around Big Bend Mountain with a magnificent return swing to the west. The curve is over 12 miles in length, and at its western end the river has gained only 3 miles in a direct line from the point where it first made a turn eastward. The river is a fairly rapid stream of moderate volume. Its width at Big Bar Crossing, about halfway between its entrance into the Bidwell Bar quadrangle and its point of junction with Middle Fork of Feather River, was in July about 100 feet; its depth was from 3 to 5 feet on the rapids below the bar. Below Big Ripples the stream is less rapid and considerably deeper. The channel abounds in boulder-strewn rapids, detached fragments of rock which project above the surface here and there in the smoother portions, and occasionally ledges jutting from the canyon walls. Now and then occur stretches of smooth, deep water between the rapids.

The northwestern portion of the basin included in the Bidwell Bar quadrangle consists of steep, rocky ridges, some with broad, nearly level summits, as Bucks Mountain and the central and northern portions of the Spanish Peak Range, and some with occasional rocky prominences. Below French Creek the ridges rapidly become lower and lose the rugged character they have in the upper and higher portions of the basin, finally merging into the easy and irregular lines of the foothill country. West of the river the basin is not nearly so broken and rough as east of the stream. The northern tracts here consist of a glaciated granite region, somewhat plateau-like in character. The central and southern portions comprise low ridges and shallow canyons, the whole with easy rolling contours. Although the drainage basin of the river within the Bidwell Bar quadrangle contains a considerable number of creeks and streams of varying size, it adds comparatively little to the volume of the river, most of which is derived from the region south and southwest of Lassen Peak. The creeks entering the river from the west are small and unimportant, excepting Pine Creek, which has a drainage basin of 24,000 acres and draws its water supply from the high and glaciated regions around Table Mountain and Campbells Lakes. The eastern tributaries are larger. The most important are French Creek, with a drainage basin of about 22,000 acres; Grizzly Creek, with a drainage basin of 12,000 acres; and Bucks Creek, with a basin comprising about 40,000 acres.

The portion of the basin in the Downieville quadrangle consists of a central depression—American Valley, which is a widening of the Spanish Creek Valley—together with numerous smaller canyons, creeks, and flats. On the east, American Valley is hemmed in by the Grizzly Mountains, a north-south range having its northern end situated beyond the boundary of the quadrangle, while on the south rocky and rather precipitous ridges and spurs, having for their central point

Clermont Hill, separate the basin from that of the Middle Fork of Feather River. Grizzly Mountains consist of a comparatively narrow ridge, rocky and steep near the summit, the western spurs having long, easy descents, the eastern short and abrupt. This range is noteworthy because it is one of the chief ridges which stand as a barrier against the westward extension of aridity sweeping in from the Nevada deserts.

The drainage of this portion of the basin is discharged northward through Spanish Creek. This is a small stream, at least during the summer season; it drains a considerable area of high country, and, from the appearance of its banks, is subject to freshets during the spring breakups.

The area draining into the North Fork from the region mapped on the Sierraville sheet consists, in its topographical features, of the broad depressions known as Red Clover Valley and Dixie Valley. They are expansions in the canyons or valleys of small creeks with similar names and are hemmed in on the east and west by short, steep, and rocky mountain ranges paralleling the main range of the Sierra.

The mean altitude of the basin is about 5,500 feet. The eastern area possesses the greatest elevations. Bucks Mountain, Mount Pleasant, and a few other unnamed peaks in that part of the basin are each over 7,000 feet in height, while the mean level outside of the immediate slopes to the main canyon is somewhat less than 5,000 feet. The plateau west of the river, of which Table Mountain forms the culminating point with an altitude of 6,200 feet, has a mean elevation of about 5,100 feet. South of Bear Ranch Hill and Flea Valley the altitude rapidly falls and varies between 2,500 and 3,000 feet, while the foothill country near the junction of North and Middle forks has a mean elevation of rather less than 1,500 feet. The altitude of the valley of the main canyon varies from 500 feet at Big Ripples to 2,500 feet where the river leaves the Bidwell Bar quadrangle. In the central portion the Grizzly Mountains reach elevations of 7,800 feet, while east of Dixie Valley the inclosing ranges rise to altitudes of 8,300 feet.

SOIL.

Most of the rocks in the northern portion of the basin consist of granites, or rocks belonging to that series. In some places the granites are capped with lava of comparatively recent date. Practically all the areas which lie above the 4,500-foot level show marks of extensive glaciation. Vast quantities of coarse sand and gravel, with some heavy boulder drift, the result of glacial erosion, cover much of the country above the 4,000-foot level and form the subsoil of the region. On top of this lies a stratum, commonly thin except in hollows and basins, of more finely comminuted rock débris mixed with humus and other soil-forming material. In the southern part of the basin, where schistose rocks occur, a fine, red, dust-like soil, common at low altitudes in portions of the western slope of the Sierra, prevails.

Many of the higher elevations in the basin contain areas of naked rock, tracts denuded by glacial wear, upon which no soil has yet effected a lodgment. The region around the head of Pine Creek, Snows mine, and Little Kimsheew Creek contains many of these bare-rock areas, and the eastern slopes of Spanish Peak Range present a magnificent example of glacial erosion. Table Mountain, in the same region, is a basaltic outflow with slopes of rough bare talus. West of the river, Bucks Mountain comprises much bare, rocky ground and rough boulder-strewn canyons and slopes. The soil, even where apparently thin and gravelly, seems to possess considerable fertility, at least as regards the production of forest.

MINING.

The mining operations in the basin are limited mostly to placers. A small amount of quartz mining is carried on in French Creek Basin. On the west side of the river most of the placers are south of Table Mountain and Campbells Lakes and at the heads of the streams that are tributary to Kimsheew and Rock creeks. There is more or less placer mining all along the bars in the bottom of the main canyon. The placers in the Spanish Creek drainage were formerly extensively worked both by hand and hydraulic mining, and enormous holes have been torn in the Pleistocene or glacial gravel ridges. On the east of the river, in the basin of French Creek and near the junction of the North and Middle forks, a small amount of placer mining is carried on. The latter locality has been a noted placer ground from early days.

AGRICULTURAL LAND.

The agricultural areas in the basin chiefly consist of the level tracts in the Spanish Creek drainage, such as Meadow Valley, American Valley, and Thompson Valley. These tracts are situated at elevations between 3,000 and 4,000 feet and have a mean temperature high enough to insure comparative or complete freedom from summer frosts. Grain, fruit, and hay are the products. Elsewhere in the basin the country is either too broken, the slopes are too steep, the valleys have little or no bottom, and the altitude is such that summer frosts are of too frequent occurrence. However, in most of the larger canyons and valleys south of Flea Valley west of the river and of Big Bar Hill east of the stream, scattered clearings occur, some in the bottoms where the valleys widen a little, some on small terraces along the ridges or on their flat summits. The clearings are generally small, varying from 1 to 5 acres in extent. A little hay and small quantities of garden truck and fruit are raised. In the wooded area near the junction of the North and Middle forks considerable land might be put under cultivation if water for irrigation could be supplied. The total of the larger agricultural areas in the basin is 9,520 acres.

PASTURE

The accessible portions of the basin are utilized throughout for cattle and sheep pasture. The region has been closely pastured during many years and the native herbage on the drier slopes has long since been eaten out. In place of the original grass growth at the lower elevations have come large quantities of wild oats and coarse weeds. Scattered bunches of grass still exist throughout the forest and with the browse furnished by oak saplings and shrubs of various kinds constitute the chief items of forage at the lower and middle elevations. Above the 5,000-foot level in the glaciated areas south of Table Mountain and north of Flea Valley are numerous small glades at the heads of streams, bearing thick swards of grass, mountain sedges, and various species of rush. These meadows are closely pastured during the summer season. Similar glades, but more numerous, exist on the summits and slopes of Bucks Mountain. At the head of Bucks Creek are large areas of meadow land, in favorable years producing hay, in dry years merely utilized for pasture. In French Creek Basin there are few naturally grassy tracts, but the forest is open and the ground bears a sparse and scattered grass growth. The foothill region of the basin, openly timbered or merely wooded, has long since been eaten out by sheep and cattle and produces only wild oats and flea and tar weeds. The fenced lands situated in Red Clover and Dixie valleys are excellent pasture grounds. The ridges adjacent to these valleys are sheeped over each season and in consequence all young growth is exterminated on the sheep runs. The chaparral-covered tracts produce no pasturage. The naturally timberless grassy pasture lands in the basin are estimated to contain 15,420 acres. If the small scattered glades, an acre or two in extent, were included, the acreage would probably reach double the above amount, but these small openings are more naturally parts of the forested areas than pasture lands.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

Both classes of timber lands are represented in the basin. Together they comprise a total of 384,060 acres, divided as follows:

<i>Forest and wooded area in North Fork Feather River Basin</i>	
	Acres
Forested	370,160
Wooded	13,900
Total	384,060

The foothill country in the southern portion, generally situated at elevations below 2,000 feet, constitutes the wooded area. It carries scattered stands of various

species of oaks mixed with Digger pine, and above 1,500 feet small amounts of yellow pine. The forested regions begin at or near the 2,000-foot level and extend to the summit of the highest ridges, provided soil and moisture conditions there permit the growth of forest. Below the 5,000-foot contour the forest is of the yellow-pine type and contains the chief lumber-producing trees—yellow pine, sugar pine, and red and white fir, with small percentages of incense cedar. Between 5,300 and 7,000 feet, in the western and central portions of the basin, the forest gradually changes to the Shasta-fir type, composed largely of Shasta fir and in some places of white pine, while sugar pine, red fir, and white fir disappear or are greatly reduced in relative proportions.

CHARACTER OF FOREST

The aspect of the forest in the basin varies a good deal according to the altitude, the species composing it, and the amount of fire and cutting to which it has been subjected. The glaciated area in the northwest corner of the basin, with Snows mine as a central point, as a rule carries a very thin and scattering forest. Most of the timber is composed of Shasta fir, with yellow pine and white fir in the canyons. The forest occurs in thin lines and scattered groups of trees standing isolated in dense chaparral, or in heavier, compact bodies of small extent in sheltered hollows in the canyons or along wet and marshy margins of various small glades near the heads of creeks. The heaviest stands of forest are in the middle areas of North Valley Creek bottoms. These tracts, although situated at considerable altitude and adjacent to the thinly forested region around Snows mine and Table Mountain, carry stands of medium density composed of yellow pine, sugar pine, red and white fir. From Kimsheew Creek south the forest is of the yellow-pine type. Except where it has been cut and logged, the timber is above the average in density of stand, running from 10,000 to 25,000 feet B. M. per acre. It is rather open in character, but somewhat uneven in stand, owing to numerous outcrops of bare rock. The trees are from medium size to large, stand well apart, and the stands have comparatively little undergrowth. South of Big Bend Mountain the country is thinly forested, gradually thinning out into the wooded region of the foothills.

The canyon of North Fork of Feather River carries a thin stand of forest throughout. From its junction with the Middle Fork to Island Bar the timber consists of scattered stands of oak and Digger pine, with a small percentage of yellow pine. Above Island Bar, the west side of the canyon, where not too rocky, supports a sparse growth of oak and yellow pine, with heavier stands of oak, yellow and sugar pine, red and white fir, incense cedar, and madroña in the breaks of the small lateral canyons. On the east side of the canyon the forest is disposed in much the same manner, but the stands are usually heavier, especially

in the side canyons. The average stand of timber of merchantable size for the entire canyon below 2,000 feet is about 1,000 feet B. M. per acre, local or Truckee practice, or about 1,500 feet B. M., estimated by Michigan practice. In general, the canyon below 2,500 feet is a region of arid or subarid tendencies, due to steepness of slope and consequent rapid run-off, and also to the great summer heat caused by its north-and-south situation and deeply sunken position below the summit of the inclosing ridges. East of the canyon all the areas included under the general designations of Bucks Mountains and Spanish Peak Range are thinly and scatteringly forested. The summits and higher slopes of the ridges bear stands largely composed of Shasta fir, often of nearly pure growth, with a small proportion of yellow pine, much of which is of the big-cone or Jeffrey type. In the canyons occur stands of medium density made up of the common species which form the yellow-pine type of forest, the yellow pine always largely predominating where the forest has not been logged. From Bear Ranch Hill to Big Bar Hill, extending southeastward to French Creek, lies a heavy block of forest, the heaviest in the basin. It is of the yellow-pine type, but contains an unusually large proportion of sugar pine, amounting, on the area immediately south of Bear Ranch Hill, to 15 per cent of the total arborescent growth, or to 40 per cent of the mill timber. Both the yellow and sugar pine in this heavy block of timber are of exceptionally large size and of old growth. Much of the sugar pine runs above 5 feet basal diameter, with clear trunks 40 to 60 feet in height. The trees stand well apart and are set in the midst of a rather close and low old growth of different species of oak. Much of the tract will readily cut 50,000 feet B. M. per acre by Michigan standard, and not much less by the Truckee practice, owing to the uniformly large size of the yellow and sugar pine. This area of heavy timber extends to the southern slopes of Big Bar Hill, where it thins out and is largely replaced by red and white fir, which, together with smaller percentages of yellow and sugar pine, form the principal lumber trees throughout French Creek Basin. South of French Creek the areas comprised within the drainage of Mosquito and Berry creeks, together with the summits and slopes of Bloomer Hill, carry thin mixed stands of the common lumber trees which form the yellow-pine type, much mixed with low-growing oak.

The lower and middle of the western slopes of Grizzly Mountains and in general all of the Spring Garden Creek drainage bear good stands of excellent timber, consisting of yellow and sugar pine, red and white fir, incense cedar, and oak. The stands are open and the timber is of large size, often running 20,000 feet B. M. per acre. The upper slopes and summits of Grizzly Mountains carry thin,

scattered stands of yellow pine with now and then a sugar pine and a large quantity of white and Shasta fir, the trees of all these species being much reduced in size owing to altitude. On the slopes of Clermont Hill, south of American Valley, the forest is thin and scattered, and is composed largely of small red fir, being set on rocky ground among great masses of undergrowth.

The portion of the basin situated east of Grizzly Mountains carries in most places a thin forest composed largely of yellow pine and white fir. The stands are open and irregular, owing to the extremely rocky nature of the ground on most of the slopes. In the valleys, open, park-like stands of lodgepole pine fringe the meadows and glades.

The merchantable timber in the basin is mostly an old growth, varying in age from 175 to 350 years. The large yellow and sugar pine, 3 feet or over in diameter, is rarely less than 200 years of age. The red and white firs of similar dimensions are somewhat younger, but there is very little prime merchantable forest less than 175 years of age.

The percentage of unsoundness in the different lumber trees is subject to a good deal of variation. In stands of the Shasta-fir type the proportion is high, often reaching 40 per cent. The causes which have operated to bring this about are mostly of two kinds—fire damage and injuries received by the trees while in the sapling state due to the crushing effects of great snow masses. The Shasta fir does not resist fire very well and succumbs easily or is badly damaged even by a comparatively light surface fire. If not killed outright, rot is generally induced in some portion of the trunk where the fire burned through the protecting bark. The crushing effect of snow on the trees of this species while in the sapling stage causes the formation of curves or knees in the trunk near the base of the tree. With age these knees expand greatly and form the peculiar, characteristic swelled butts which disfigure the otherwise symmetrical, columnar trunk of this species. The swelled butts, often extending from 5 to 6 feet or more above the ground, constitute defective portions and detract that much from the merchantable timber volume of the clear trunk. There are comparatively few defects in the yellow and sugar pine and red fir, most of them being due to fire scars and confined to the basal portions of the trunks. The white fir is prone to decay at the center, about 15 per cent being defective from this cause. The incense cedar of the basin is either rotten at the core or is honeycombed with great numbers of longitudinal wormholes. Owing to this peculiarity the tree is practically valueless for commercial purposes. Most of the large oak in the basin, oak with trunks large enough to make sizable saw logs, is hollow. The Digger pine has been utilized in some places for mill-timber purposes, but as a rule the tree branches comparatively close to the ground and the clear trunk is too short for mill use.

LUMBERING

Out of the 370,160 acres of forest land in the basin, 114,200 acres, or nearly 31 per cent, has been logged, cut, and culled. This amount represents very closely the amount of land cut over for commercial purposes. It does not represent the irregular cutting and culling for domestic purposes, placer mining, and local building uses, nor the amount of ground cut over in the woodlands. These classes of cuttings extend all over the basin, and collectively comprise perhaps 7,000 acres more. The acreage cut over for commercial purposes represents, with the exception of a few thousand acres south of Bear Ranch Hill, the region comparatively easy of access for lumbering operations. The area uncut and uncultured consists either of private holdings accessible, but whose owners have not yet seen fit to convert their forest into lumber, or of tracts situated in rocky, inaccessible canyons, or on the slopes and summits of high and steep ridges.

The cutting both east and west of the river has been, to a great extent, selective—that is to say, the timber of the best and most desirable kinds has been cut off, leaving the balance to be logged at some future time. In some places west of the river, as at Big Bend Mountain, the cutting has been nearly uniform, taking all kinds and converting them either into lumber or fuel. The cutting has been governed wholly by the outside demand and the cost of transportation. The demand at the point of manufacture has been trifling. The only methods of bringing the lumber cut in the basin to market is by wagon over hilly roads, involving in some cases a haul of 40 miles. The only kind of lumber capable of standing the high cost of this method of transportation has been the clearest and choicest sugar and yellow pine. The cutting has therefore chiefly been confined to these species, and the red and white fir have remained uncut.

West of the river logging operations for mill purposes have extended northward from the foothill region to a point 4 or 5 miles above Old Defiance mill. Between this point and the headwaters of Kimschew Creek the region is difficult of access and little, if any, cutting has been done. From Kimschew northward the cutting has been limited to miners' use. East of the river lumbering operations begin a mile or two south of Hart's mill, and have continued northward on nearly all accessible areas that carried stands of yellow and sugar pine of prime quality. The only tract that has escaped the cutting and culling process is the block of heavy sugar pine a few miles south of Bear Ranch Hill. The northern limit of the cutting east of the river is near Buckeye, where the Shasta-fir type of forest begins. The selective method of logging as here practiced is an exceedingly wasteful one, more than one-half of each tree

being rejected. However, owing to the fact that much of the cutting has been rigidly confined to clear stuff, there is still standing fully one-half of the forest. There are only one or two sawmills in operation in the basin at the present time. The most extensive concern is located at the head of Chino Creek, cutting the heavy sugar and yellow pine on the southern slopes of Big Bar Hill. The lumber is hauled by wagon to the nearest railroad point—Oroville.

A great deal of cutting has been done by shake makers. The same wasteful methods practiced elsewhere in the West by this class of timber butchers are in vogue here. Numbers of sugar pine are felled and rejected because they are uneven in grain and fiber, hence difficult to split, while of the trees found suitable only a few cuts near the butt end of the log are used.

The amount of standing merchantable timber in the basin in M feet B. M. is as follows.

Amount of timber in North Fork of Feather River Basin

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	1,280,000	1,000,000
Sugar pine	850,000	695,000
Shasta fir	156,000	115,000
Red fir	458,000	343,000
White fir	175,000	110,000
Total	2,919,000	2,263,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland—(1) From junction with Middle Fork of Feather River northward 4 miles. Woodland, no merchantable mill timber; oak, mostly evergreen species; small Digger pine, scattered yellow pine of small size, suitable only for fuel.

Grade 2—less than 2,000 feet B. M. per acre.—(1) Canyon of North Fork of Feather River. Thin, open, scattered growth of yellow pine, oak, Digger pine to near Island Bar; red fir, incense cedar, and small quantities of sugar pine in openings of side ravines along the upper portion of canyon; all of poor quality. (2) Table Mountain region: Thin, scattered groups and lines of Shasta and white fir, with occasional trees of yellow pine, all of poor quality. (3) Bucks Mountain region. Thin, open, scattered stands, chiefly composed of Shasta and white fir, with a small percentage of Jeffrey pine, all of poor quality. (4) French and Berry Creek drainage. Mixed stands of yellow-pine type; thin, open growth owing to rocky soil; the yellow and sugar pine closely culled and cut. (5) Region of Red

Clover and Dixie Creek drainage: Yellow pine and white fir, the former predominating at elevations below 6,000 feet, the latter above this altitude; at the highest summit small quantities of white pine; growth very thin and scattering, owing to rocky soil; very difficult of access.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) Big Bend Mountain: Yellow pine of inferior quality, best cut long ago, red fir of small size, white fir, incense cedar, and oak. (2) Concow Creek region: Mixed forest, cut and culled, here and there open stands of large-sized sugar pine and yellow pine; much dense sapling growth of yellow pine and extensive oak copses. (3) Kimsheew Creek region. Mixed forest, largely yellow pine, some of sugar pine; some red and white fir; Shasta fir on higher areas; stands thin and open; difficult of access. (4) Basin of French Creek and south to Hart's mill. Mixed forest of yellow-pine type; stands originally thin, owing to rocky soil; much cut and culled; small quantities of yellow pine, but forest throughout mostly composed of red and white fir, with large quantities of low oaks, mostly California black oak. (5) Region north of Bear Ranch Hill. Open, scattered stands or thin lines of trees in dense chaparral, composed chiefly of Shasta and white fir; some yellow pine and red fir at lower elevations; all of poor quality. (6) Region around American Valley: North of the valley, yellow pine and red fir, with small quantities of sugar pine, white fir, and incense cedar; south of the valley, largely red fir of small growth set in dense brush. (7) Region around Red Clover Valley: Yellow pine 20 to 25 per cent, balance white fir, occasionally a sugar pine, some incense cedar; all on rocky ground in heavy brush, difficult of access. (8) Region around Dixie Valley: Thin stands of yellow pine, much white fir, white pine at highest elevations; stands set on rocky ground, difficult of access; timber generally of poor quality.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Concow Creek and North Valley region. Mixed forest, yellow and sugar pine, red and white fir, cut and culled in the Concow Creek areas; fair quality, but difficult of access in the North Valley region. (2) French Creek Basin: Mixed forest, best yellow pine, mostly culled, largely composed of red and white fir in the eastern part; remaining timber generally of fair quality. (3) Bucks Creek Valley: Mostly Shasta fir, scattered yellow pine, and white fir, medium quality; not difficult of access from Buck's ranch. (4) Region around Edmanton: Chiefly close stands of slender growth red fir, 10 to 12 per cent yellow pine, sugar pine, and incense cedar. (5) Western slopes of Grizzly Mountains: Good stands, averaging 9,000 feet per acre, of excellent quality yellow pine, some large red fir, and 3 to 4 per cent sugar pine; growth generally open, except along the bottoms of creeks, where heavy brush growths have followed fires and 15 to 20 per cent of the standing red fir has been damaged.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Rock, Kimshew, and Pine Creek regions: Mixed forest of yellow-pine type, large size, old-growth yellow and sugar pine, red and white fir of medium dimensions, mostly of prime quality; not difficult of access. (2) Break Neck, Fish, and Last Chance creeks Sugar pine of small size, but thick set, scattered yellow pine of large dimensions, small red and white fir, and along the higher levels Shasta fir; timber throughout below medium quality and difficult of access. (3) Berry Creek Basin. Chiefly red and white fir of small size, incense cedar, and oak; most of the yellow and sugar pine cut long ago. (4) Big Bar Hill: Large and fine growth of yellow and sugar pine, some red and white fir; the yellow and sugar pine now in process of cutting. (5) Gold Lake region: Largely red and white fir, some of large size, small percentage of yellow and sugar pine; the larger proportion of these species logged off long ago. (6) Spring Garden Creek drainage. Yellow and sugar pine of large dimensions, the former constituting about 35 per cent, the latter 10 to 15 per cent of the stands; red fir 2 to 3 feet in diameter; incense cedar and small-growth oak; heavy stands averaging about 21,000 feet B. M. per acre; some portions readily accessible, the higher portions more difficult.

Grade 6—over 25,000 feet B. M. per acre.—(1) Region between Bear Ranch Hill and Big Bar Hill: Large heavy growth of yellow and sugar pine, red and white fir of medium dimensions; much oak, largely California black oak; incense cedar. A fine body of timber, damaged by surface fires in the eastern portion; not very difficult of access from Walker Plain

FIRES

Almost the entire basin, both wooded and forested, exhibits plain evidence of having been overrun by fires, chiefly within comparatively recent times. It is estimated that out of a total of 422,900 acres, woodland and forest, only 42,620 acres are wholly free from the marks of fire. The tracts that have escaped are such as, by reason of rocky or exceptionally wet environments, were surrounded by natural fire breaks.

The amount of damage inflicted on the forest by fire has varied in different localities. It has been vastly greater throughout the stands of Shasta-fir type than in the yellow pine or in the mixed or woodland areas, owing to the small resistance offered by the Shasta fir to fire. Also the litter in the Shasta-fir stand is on the whole greater than elsewhere and has supplied the material for a more intense fire and wider destruction.

The severest and most extensive fires west of the river have burned in the region around Table Mountain, while east of the stream the area situated on and in proximity to Bucks Mountain has suffered in a high degree. The burned region west of the river corresponds exactly to the extent of the auriferous areas

where mining has been carried on since 1850. The tracts more severely burned east of the river are not situated in a very rich mineral region, but connect directly with burned tracts adjoining the placer grounds east of Spanish Peak. On its face the evidence would seem to warrant the conclusion that the fires which have ravaged the basin most extensively followed in the steps of miners and prospectors of the early days. The correctness of this conclusion is further strengthened by the fact that the big burns throughout the country examined lie contiguous or very close to much of the richest mineral ground.

South of the area in the North Fork Basin mentioned above fires have left their marks almost everywhere, but the destruction has not been great, probably not over 5 per cent of the total volume of merchantable timber having been burned. Most of the very destructive fires occurred many years ago. Those of later years have not done much damage. Small fires burn every season in many portions of the basin, but are not permitted to spread very far. The most extensive fire within recent years in the yellow-pine areas burned in the northern portion of French Creek Basin, killing much oak, but not many conifers. It is said that cattlemen set this fire in 1897 or 1898.

Results of fires in the woodlands have been the killing out of much underbrush and small quantities of oak and Digger pine. The destruction of the brush has been of doubtful advantage, since it usually springs up more vigorous than ever after a fire. In the yellow-pine type of forest the fires have scared or deeply scarred, near the base of the trunk, much of the yellow and sugar pine, as well as the red fir, besides destroying much young oak and sapling and seedling conifers. In the forest of Shasta-fir type 70 per cent of the timber has been destroyed, chiefly by old fires, while the remainder is much damaged and weakened.

REPRODUCTION

Reproduction of the woodland growth is poor and deficient as regards the coniferous species. The different varieties of oak, on the contrary, maintain vigorous and spreading stands when not limited by the ax. In the areas of the yellow-pine type, where the fires are kept down, the cut-over tracts are densely restocking with a young growth composed of the same species that grew there before the cutting. In this restocking yellow pine predominates, while sugar pine is much below the percentage of the species as it existed in the original unlogged forest. Selective cutting, wasteful as the practice is, has given rise to a heavy young growth in this particular region. In the Shasta-fir type reproduction is poor, solely owing to the great fires that have prevailed there, as the Shasta fir is an abundant seeder. In the chaparral-covered tracts there is a very slight restocking, chiefly along the margins where the brush joins the forest, and the

young growth is almost exclusively Shasta fir. Reproduction on worked-out placer grounds is poor. In such places the soil and humus have been washed away and only coarse gravel, bowlders, and bare bed rock remain. The pasturing of cattle in the basin does not appear to interfere with the reproduction of the forest, while the grazing of sheep is almost prohibitive of restocking.

CHAPARRAL.

The chaparral-covered tracts comprise 38,840 acres and occur almost everywhere except in the eastern portion of the basin. Chaparral in the woodland areas is merely a scattering undergrowth—clumps of bushes here and there mostly ceanothus (*Ceanothus cuneatus*). Elsewhere a brush growth close enough to be called chaparral is invariably a sequel to the total destruction of the forest on any area below the highest subalpine elevations. There are many such chaparral tracts throughout the yellow-pine type of forest, both east and west of the river, but most of them are small, rarely exceeding 5 to 10 acres. In the areas occupied by the Shasta-fir type of forest occur the main chaparral belts. Within the basin the tracts covered with this sort of growth amount to 38,840 acres, situated partly in the region around Table Mountain and partly on the summits and slopes of Bucks Mountain. The region of the denser chaparral in these localities lies between 5,000 and 6,200 feet. The shrubs composing it consist chiefly of manzanita (*Arctostaphylos patula*), ceanothus (*Ceanothus velutinus*), together with service berry, scrub oak, and chinquapin. In the yellow-pine type the chaparral is mostly composed of *Arctostaphylos glauca* and *Ceanothus integrifolius*. In some places the chaparral has been badly burned within recent years. Especially is this the case on the tracts south of Snow's mine. Fire, however, does not usually destroy it; in a little while the brush springs up as thick as ever and shows little sign of giving way to forest cover.

BASIN OF MIDDLE FORK OF FEATHER RIVER.

TOPOGRAPHY.

The largest drainage basin within the region covered by this examination is that of Middle Fork of Feather River, with an area of 778,540 acres. The ultimate heads of the stream lie in the main backbone of the Sierra, in the spurs and ridges which surround the level depression known as Sierra Valley. Through this flat, dry and sandy in some places, swampy in others, meander the various small streams which form the heads of the fork. At the northwest corner of the valley, near Kirby, the river breaks through the easterly spurs of Grizzly Mountains and emerges into a canyon of shallow depth. From Kirby to Bells Bar the course of the river is through a valley not at all canyon like except

here and there for short distances. At Bells Bar the river enters the canyon—a stupendous gorge from 1,500 to 3,000 feet in depth. In its upper portion this canyon is cut through the great granite axis which enters the region in the northwest corner of Bidwell Bar quadrangle near Snow's mine, and which continues southward with many high summits and deep gorges and joins the main Sierra at Donner Pass. The canyon of the Middle Fork continues to within a few miles of its junction with North Fork of Feather River, widening out and becoming less gorge like where it enters the foothill country. The slopes, while steep throughout the entire length of the canyon, scarcely present the sharp declivities characteristic of the canyon of North Fork of Feather River. But like that, the canyon of Middle Fork has no bottom lands below Bells Bar except sand and gravel bars at the openings of lateral canyons.

The general drainage basin of the stream consists mostly of very mountainous and broken areas with the exception of the level Sierra Valley, Grizzly Valley, and other smaller flats bordering the various tributary streams. The rockiest areas of the basin, although not the most elevated, are situated in the central portions and consist of the granite axis already alluded to. The regions north of Sierra Valley are also notably rough, while the tracts north of the river and west of Grizzly Mountains present the easiest slopes of any of the mountainous portions of the basin.

The eastern portion of the basin is formed by the main range of the Sierra Nevada and adjacent spurs and flanking ridges. The main range directly east of Sierra Valley consists of a comparatively narrow ridge 2 to 8 miles in diameter, reckoning from the valley as a base. It rises with steep slopes both on the eastern and western declivities, and culminates in a narrow crest dotted with low peaks and broken, rocky combs. At Beckwith Pass the range breaks down, the ridges become thin, rocky spurs, and at the point in the pass where the wagon road from Sierra Valley passes east into Long Valley there is a clear cut through the range within 250 or 300 feet of the Sierra Valley level, with a low, rocky, granite spur rising to the north and a few large, loose boulders on the south to mark the crest line of the Sierra Nevada. North of Beckwith Pass the main range rises rapidly. Its eastern face is steep, its western front is less so, and its crest consists of rocky eminences and narrow combs, a few rising to 8,000 feet. On the west, north of the Sierra Valley, the range is flanked by two north-and-south ranges having a more or less pronounced parallelism to the main range, the three ranges being separated from one another by valleys of varying width. One of these flanking ridges, the Dixie Mountains, the first to the west of the main divide, is remarkable as presenting the longest slope to the east instead of the west, a reversal of the ordinary mode of slope in these mountains. South of Beckwith Pass to the head of Sardine Valley the same general features prevail which characterize it north of the pass. At Sardine Valley the range swings abruptly west a distance of 18 miles, its steep slope facing northward on Sierra Valley, its long slope descending to Truckee Basin.

The central portion of the basin is formed in part of southerly spurs from Grizzly Mountains, the most westerly of the ranges which parallel the main range north of Beckwith Pass, in part of the summits and eastern declivities of the range which separates the headwaters of North Fork of Yuba River from the upper tributaries of Middle Fork of Feather River. The main portions and outlying spurs of Grizzly Mountains, although steep and precipitous in many places, have a general profile of moderate degree of slope. The North Fork of Yuba divide, on the contrary, is excessively steep and rocky. It has been subjected to extensive glaciation. Its eastern declivities, fronting in part on Mohawk Valley, in part on the Middle Fork, rise sharply and are cut at frequent intervals by deep gorges. Its crest, mostly very narrow, is studded with rocky peaks rising to elevations standing between 7,000 and 8,000 feet, and flanked by a series of lakes and ponds situated in amphitheaters of glacial origin. These lakes, while not very large, constitute, nevertheless, important natural reservoirs in the drainage system of the basin.

The western portion of the Middle Fork Basin is formed by the canyon of the stream and its inclosing divides, which separate it on the one hand from the basin of the North Fork of Feather River, on the other from that of South Fork of Feather River. These divides consist of two ridges which in a general way may be classed as plateaus paralleling the canyon. They are extensively cut into by numerous tributaries of the river, but the canyons are not very deeply eroded, and the general altitude of the whole varies but little below 4,500 or above 5,500 feet. The foothill country, of which only a small tract is contained within the basin of the Middle Fork, has an elevation of 1,000 to 2,000 feet, and consists of steep, rounded ridges with a trend somewhat parallel to the canyon of the river.

The mean altitude of the basin is rather high. Excluding the canyon areas it probably does not fall much below 5,500 feet. Most of the larger flats, including Sierra Valley, are situated at altitudes of 5,000 to 5,500 feet, while numerous points on the main range south of Beckwith Pass reach elevations of 8,000 to 8,500 feet.

SOIL.

Over the greater portion of the basin the soil has had its origin in the silt and debris ground out of the adjacent rocks by glacial action. Above 5,000 feet glaciation seems to have prevailed pretty uniformly throughout the region. Hence on the slopes above this altitude the soil is formed largely of comminuted rock debris, gravel, boulders, and the like, more or less mixed with mold—accumulations from ages of plant growth. At elevations above 7,000 feet in the central regions and in the areas north of Sierra Valley the soil on the more exposed slopes and summits consists chiefly of coarse gravel, while boulders of various size are abundantly strewn over

the surface. Much of the high western slope of Dixie Mountain, the summits of peaks and ridges bordering Mohawk Valley on the west, as well as the western slopes of Penman Peak and the region around Grizzly Peak and Mount Jackson, have a very thin gravelly soil or frequently none at all, the bed rock showing over large areas. Almost all of the large valley flats in the eastern and central portions have at some past time constituted the bottoms of lakes. Such flats have, in process of time, become covered with great accumulations of soil-forming material swept in from the surrounding mountain sides. In the western area of the basin schistose rocks prevail, and, when not overlain by the gravelly glacial detritus from the central and eastern portions, the common fine, soft, red soil prevails.

MINING.

Mining, both quartz and placer, is carried on at several localities in the basin. Granite Basin, Onion Valley, Johnsville, and Plumas Eureka are all well-known placer grounds worked during many years. At Johnsville and here and there along the eastern side of Mohawk Valley quartz mining is carried on. In the eastern section of the basin there is little if any mining done at the present time.

AGRICULTURAL LAND.

The western portion of the Middle Fork drainage contains small tracts of agricultural lands, all situated along the summit of the divide between North and Middle forks of Feather River. They consist of small clearings in the forest, and produce hay, fruit, and vegetables. On the north side these agricultural clearings end at Buckeye; south of the river they cease near Lumpkin. In the central area of the basin the agricultural tracts lie along Mohawk Creek and below the junction of that stream with the Middle Fork, in the valley of the latter stream. These lands are subject to summer frosts, and are mostly utilized for the production of hay. The largest area of lands under cultivation and, in general, the area most suitable for agricultural purposes, is in Sierra Valley. This tract, an ancient lake bottom drained wholly dry, except a narrow strip in the western portion, is utilized for agriculture where water for irrigation is procurable. Some portions, as the northern, are subject to summer frosts and are largely devoted to hay production; other areas, as the western, southern, and tracts in the eastern, are either wholly free or much less subject to frosts during the growing season, and are in use for purposes of general agriculture. The area actually under cultivation is but a fraction of the entire cultivatable tract. Lack of water for irrigation appears to be the chief reason for this condition.

The lands actually under cultivation or cultivatable under irrigation facilities, exclusive of possible clearings, are estimated to cover 99,950 acres of the basin.

PASTURE.

The only tracts not utilized for pasturing cattle and sheep are the chaparral sections and the cultivated portions producing something else than hay or grain. As soon as the season permits sheep and cattle are started for the western and central areas of the basin from the Sacramento Valley, while from the east come large bands of sheep from Nevada. Below 5,000 feet natural grass and forage are scanty. Above that altitude there is a sparse growth of grass and weeds throughout the yellow-pine and Shasta-fir forests, while in the latter, where lodgepole pine prevails, tracts occur with a fair sward of grass and sedge. All through the high portions of the central regions are numerous glades and grassy margins at the heads of streams or fringing lakes and ponds. Such places are invariably closely pastured, and when fall comes their herbage has been eaten down as close as cattle and sheep can possibly bite it.

The largest naturally nontimbered and nonwooded pasture tracts are Grizzly Valley and lateral offshoots, Last Chance Valley, and the arid or semiarid slopes of the range east of Sierra Valley. Grizzly Valley is mostly a semiarid flat between timbered ridges. In the upper portion it is thinly forested with stands of lodgepole pine alternating with glades; in the central and eastern portions it is entirely devoid of timber, except along the margins next to the ridges. The soil is deep and rich, strongly alkaline, and supports an abundant growth of sagebrush (*Artemisia tridentata*) with here and there sedgy or grassy spots. Several small flats extend along the creeks short distances back from Grizzly Valley among the ridges. They have mostly the nature of glades. Last Chance Valley is a low flat at the junction of several creeks forming Last Chance Creek. Portions of it, under fence, are heavily grassed and serve for dairy pastures. Other portions, on higher and drier land, bear sagebrush and a thin scattering grass growth. The pasture areas east of Sierra Valley consist of spurs and slopes of the main range, devoid of timber because of arid climatic conditions, covered with sagebrush and purshia, in some places with the wild almond (*Prunus andersonii*) of the Nevada deserts, at higher elevations with scrubby mountain mahogany and aspen. In former years these tracts doubtless supported a good growth of grass, but excessive grazing, especially by sheep, has long since killed most of it, and the same holds good of all the pasture area in the basin not under fence. Along the main range of the Sierra north and south of Beckwith Pass are numerous small glades and aspen groves, all with a little grass in summer, and all closely pastured. Along the western side of Sierra Valley, partly at valley level, partly on the summit of the divide against North Fork of Yuba River, are scattered small nonforested tracts, at the lower levels too dry to support stands of forest, at the higher elevations too wet

and glade like. Without exception they are closely sheepled off or pastured by cattle during the season. Mohawk Valley is a notable pasture tract, but is mostly under fence and cultivation. It is not largely utilized as pasture until late in the season, when the hay crop has been cut. The pasture area of the basin, that is, the tracts naturally devoid of timber and noncultivable, comprise in the aggregate 90,140 acres.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

Most of the basin is essentially a forest region. Some of it is thinly covered with scattered stands due to rocky soil, climatic or soil aridity, or to destruction by fire and ax; but a very considerable proportion supports extensive and heavy stands of mill timber. The tracts classed as wooded occupy only a very inconsiderable acreage. The total amount of woodland and forest in the basin is 534,600 acres, distributed in the following proportions:

Forest and wooded areas in Middle Fork Feather River Basin

	Acres
Forested	532, 000
Wooded	2, 600
Total	534, 600

The small amount of foothill country situated at the junction of the Middle Fork with North Fork of Feather River forms the wooded part. It is covered with a thin and sparse growth of Digger pine, oak, mostly evergreen species, and, here and there in the canyons above 1,000 feet, low and scattered yellow pines. The wooded region is situated almost wholly below 2,000 feet, but does not extend up the main canyon along this level beyond the point where the canyon leaves the foothill country. The forested region begins a little above the 2,000-foot contour with stands of yellow pine, which are considerably mixed with small oak and Digger pine. At an elevation of 2,500 feet the Digger pine thins out, and on the ridges disappears completely at 3,200 feet, while its altitudinal limit in the main canyon of the river scarcely extends above 2,500 feet. The bulk of the lumber-producing forest in the basin is situated between 4,000 and 7,000 feet. It is quite unequally divided, however, within these altitudinal limits in different parts of the basin. In the central and western areas the yellow-pine type of forest, which here, as elsewhere in the region under examination, contains most of the mill timber, is situated mostly between the 3,000 and 5,200 foot contour lines. In the east-central and throughout the eastern area of the basin there is a notable rise in the altitudinal position of the type, until in the region of the main range north, south, and east of Sierra Valley the yellow-pine forest lies between the 5,000 and 6,800 foot contour lines. In the west-central portion of the basin the Shasta fir forest begins immediately above that of the yellow

pine and ascends to the highest elevations. In the eastern section the pure Shasta-fir type is lacking, being represented by the white and lodgepole pines. The white pine reaches the summits of the highest peaks of the main range, and forms in some places almost exclusively the only coniferous growth there.

CHARACTER OF FOREST

Owing to decided climatic differences between the western, central, and eastern portions of the basin, there is considerable variation in the aspect and character of the forest. In the eastern section north of Sierra Valley the forest suffers from lack of moisture. It lies contiguous to the Nevada deserts and comes in direct contact with them, not only on the eastern side of the range but also on the western. At Beckwith Pass the arid region of western Nevada sweeps across the main range of the Sierra in a space about 8 miles wide. It extends all over Sierra Valley and follows many of the creeks north thereof far back among the mountains. The result is that those mountains are covered with a thin stand of timber, the red fir and sugar pine of the western area of the basin being wholly lacking, while yellow pine, white fir, and incense cedar constitute the forest of the yellow-pine type. On the slopes of the main range below 7,000 feet east of Last Chance Valley the forest is composed of the following trees in the proportions given:

<i>Composition of forest east of Last Chance Valley below 7,000 feet</i>	
	Per cent
Yellow pine.....	72
White fir.....	25
Lodgepole pine.....	3

Above 7,000 feet yellow pine and white fir thin out. The composition of the forest is then as follows:

<i>Composition of forest east of Last Chance Valley above 7,000 feet</i>	
	Per cent
Yellow pine.....	15
Lodgepole pine.....	10
White pine.....	40
White fir.....	35

There are scattered trees of incense cedar at the lower elevations, and western juniper, mountain mahogany, and aspen at the upper. As the Sierra forest does not in this latitude extend east beyond the immediate slopes of the main divide, the foregoing examples are illustrative of its average composition where it adjoins the Nevada deserts. The stands of mill timber on these tracts are thin, most of them averaging less than 4,000 feet B. M. per acre. The region above the 6,500-foot level, corresponding in a general way to the region of the Shasta fir

forest in the central portion of the basin, is studded with aspen thickets. The aspen at these elevations is often a mere shrub, forming thickets quite as low, dense, and intertangled as the manzanita does in the central portion of the basin. Sometimes, however, it reaches the stature of a tree and is then 20 to 50 feet in height, with dimensions at the base up to 20 inches. In such cases the aspen forms compact groves, always around the margins of swampy depressions, while as a shrub it spreads over the open subalpine slopes in dense, impenetrable masses. The white-pine stands are generally patchy, a heavy belt or fringe of the species alternating with aspen thickets or close growths of mountain mahogany, which in this latitude is mostly of low, scraggy stature, occasionally reaching the dimensions of a tree.

West of Last Chance Valley on Dixie Mountains and on the various ranges between them and Grizzly Mountains the forest is of the same general type as on the main range. Along the valleys, where the bottoms are wet, fringes of lodgepole pine form the lowest forest belt; higher stands of yellow pine, with some incense cedar and white fir, come in. Above this there is a gradual increase in the proportions of white fir and a smaller amount of yellow pine, finally ending with stands of white pine and white fir, with a trifling percentage of yellow pine, the whole mixed with scrub aspen, manzanita, mountain mahogany, and various species of *ceanothus*.

East of Sierra Valley lies a strip about 8 miles wide, covering the main range on either side of Beckwith Pass, almost totally devoid of arborescent growth save for a chance juniper here and there, and overgrown with sagebrush. The forest begins again about 6 miles south of the pass and is practically of the same appearance and composition as that farther north thereof at the lower elevations, being composed of 80 per cent yellow pine, 19 to 20 per cent white fir; at the upper altitudes 75 to 80 per cent white fir, 10 to 15 per cent yellow pine; the balance being aspen, mountain mahogany, and white pine. The stands of mill timber between 5,000 and 7,000 feet are thin, averaging 1,500 to 1,800 feet B. M. per acre. Above 7,000 feet they are heavier, averaging 3,500 to 4,000 feet B. M. per acre. The crest of the main ridge is rocky and the forest patchy, wide stretches of mountain mahogany, scrub-aspen thickets, and sagebrush-covered slopes alternating with stands of timber. At the head of the canyon of Smith Neck Creek, a stream flowing north and losing itself in the levels of Sierra Valley, the main range turns west at right angles. With this turn comes a great change in the density of the forest on the Middle Fork slopes. From the head of Smith Neck Creek to the North Fork of Yuba Divide these slopes have a northern exposure and bear, except where logged, heavy stands of timber. The composition of the forest in this portion of the basin does not differ materially from that on the main range north of Beckwith Pass at similar altitudes, but much of the mill timber occurs in heavier stands, some of it averaging 15,000 to 20,000 feet B. M. per acre.

In the portion of the basin near North Fork of Yuba Divide, Shasta fir comes in along the higher slopes and summits, with an occasional sugar pine at lower levels. A typical composition for the forest here is as follows:

Composition of forest in Middle Fork of Feather River Basin near North Fork of Yuba Divide

SHASTA-FIR TYPE	
	Per cent
Shasta fir	70
Yellow pine	8
Lodgepole pine	1
White fir	20
White pine	1

YELLOW-PINE TYPE	
Yellow pine	45
Lodgepole pine	1
White fir	50
Incense cedar	30

Except where logged the stand of mill timber is good, averaging about 15,000 feet B. M. per acre.

As a rule, the forests in the eastern part of the basin have normally little litter or undergrowth, except where fire has destroyed the timber or along the rocky slopes flanking the crest lines of the highest ridges. Where logging operations have been carried on, as on the mountains south of Sierraville, there are great accumulations of tree tops and rejected portions of saw logs. Of humus, such as we know it in the forests of northern Oregon, Washington, and Idaho, there is none. Either the forest floor consists of bare, coarse gravel or sand, or there is a very thin cover of decaying pine needles, while in some localities the ground is closely carpeted with broad mats of the creeping *ceanothus* (*Ceanothus prostratus*).

The central portion of the Middle-Fork Basin may be considered as beginning west of Sierra Valley, and mostly consists of the tracts found in the Downieville quadrangle. In general the region is one of high precipitation, and the forest types are more ample in the number of species composing them as well as better developed and differentiated.

Going west from Sierra Valley a series of ridges and spurs belonging to the southern extension of Grizzly Mountains are found; most of them are under 6,000 feet in altitude, but some attain elevations of 7,000 feet. The influence of the arid or semiarid climatic conditions existing in Sierra Valley is readily observable throughout the tracts in question in the almost complete absence of forests of the Shasta-fir type, moderate stands of yellow pine, and large areas of sparsely timbered slopes, but it is also clearly to be seen that the humid conditions of the central portion of Middle Fork Basin exert considerable force in shaping the

composition and aspect of the forest on these tracts. In a general sense these mountains constitute a transition ground between the arid or semiarid eastern portion and the humid area of the western and central Middle Fork Basin. The yellow-pine forest is here reenforced by red fir and sugar pine, two species absent from the eastern section of the basins. The red fir hugs the slopes and canyons of the Mohawk Valley side of the mountains, scarcely extending into the tracts draining east to Sierra Valley. Here it is mostly of small size, 20 to 22 inches in diameter at the base and 80 to 95 feet high, the greater portion falling below these dimensions and much resembling the red fir as it occurs in the State of Montana adjacent to semiarid regions. The sugar pine attains considerable size, 2 to 4 feet in diameter and 80 to 100 feet in height. It is nowhere abundant, scattered trees occurring here and there. It follows the ridges and valleys eastward and reaches the slope fronting on Sierra Valley through the gaps at the head of Little Valley. Yellow pine, white fir, and incense cedar form the bulk of the forest. The yellow pine occurs in very large quantities. The old growth averages from 22 to 36 inches in basal diameter, 80 to 120 feet in height, with clear trunks 20 to 35 feet in length. The white fir is abundant, especially in the canyons. It varies from 2 to 5 feet in diameter and 10 to 150 feet in height. A typical example of the composition of the yellow-pine forest on these mountains is as follows:

Composition of forest in central portion of Middle Fork of Feather River Basin

	Per cent
Yellow pine	75
Lodgepole pine	1
Red fir	3
White fir	18
Incense cedar	3
Sugar pine	Occasional trees

The Shasta-fir type of forest occurs only on the very summit of a few of the highest peaks, Grizzly Peak, Penman Peak, and Mount Jackson being the most noteworthy. It consists of a few thin, scattered stands of Shasta fir much mixed with white fir and occasional yellow pines.

The yellow pine on these tracts is mostly an old growth; that is, the greater percentage of suitable size for mill timber is over 150 years of age. It is generally sound and of fair quality. The other species average less than 150 years in age, owing to frequent fires and low fire-resisting capacity, and throughout are more or less defective from rot and gum cracks. Below 5,500 feet the forest is open; there is little undergrowth and only small quantities of litter, except where logging operations have been carried on, while humus is almost absent. On the areas above 5,500 feet the undergrowth rapidly increases in density until at 6,500

to 7,000 feet the forest is in most places set in thick masses of brush consisting of *Ceanothus velutinus*, *C. cordulatus*, and *C. integerrimus*.

West of Mohawk Valley the mountains reach greater elevations, have a greater rainfall, and, so far as regards the composition of the forest, show none of the arid aspects characteristic of the eastern portion of the basin. Much of the region is situated above the 6,500-foot level, with steep, precipitous ridges and slopes. All the higher, broken, and mountainous areas, comprising fully two-thirds, fall within the altitudinal range limits of the Shasta fir and bear forest of this type.

The yellow-pine forest is confined to the lower elevations—usually below the 5,600-foot level—and to slopes facing on the larger valleys.

The Shasta-fir forest is here of typical composition. Its chief species is Shasta fir. In smaller percentages occur white fir, white pine, lodgepole pine, Patton hemlock, and, on the warmer and drier slopes, limited quantities of yellow pine. Owing to numerous bare, rocky patches, small lakes, ponds, wet glades, and extensive burns, the forest is much interrupted. Most of the lakes, ponds, and glades are surrounded by fringes of lodgepole pine. Some tracts, like Church Meadows, bear open stands of lodgepole pine, distributed with tolerable uniformity over considerable areas of what appears to have been not long ago wet and marshy glades. The crests of the highest ridges and peaks—such as Haskell Peak, Mount Elwell, Eureka Peak, and Bunker Hill—and northern rocky slopes bear thin, mixed stands of Patton hemlock, white pine, and Shasta fir. In some localities, especially on the ridges between Eureka Peak and Bunker Hill and on the western slopes leading to Haskell Peak, 80 to 90 per cent of the forest consists of Patton hemlock. Often, in sheltered hollows and saddles along the 7,000 to 7,500 foot level, Shasta fir forms very dense and nearly pure stands. Such stands sometimes run 50,000 feet B. M. in merchantable mill timber per acre. There is a great deal of morainic material deposited at high elevations, the mountains here having been subjected to much glacial erosion. Some of these morainic deposits consist of coarse boulder drift, as on the east side of Gold Lake and at the head of most of the canyons entering Mohawk Valley from the west, and bear close stands of brushy lodgepole pine and small, stunted white pine and Shasta fir. All through the Nelson Creek and Onion Valley drainage the country is broken and rocky, and bears generally light stands of forest. Fires have greatly thinned them, but the conditions of soil and slope have always been inimical to heavy forests on these areas.

The Shasta-fir forest here occurs in open stands of medium and heavy growth. Where the stands are thin, undergrowth is plentiful. The sapling stands of Shasta fir and lodgepole pine are always close set and occasionally form very dense thickets. The timber is mostly of poor quality. Heavy, nearly pure stands of Shasta fir are

exceptional and are found only in regions which have not been visited by fires for a century or two. Elsewhere, chiefly owing to fires, 30 to 50 per cent of the timber is unsound, cracked, broken, or rotten at the core. The bulk of the type averages about 3,500 feet B. M. per acre.

The yellow-pine type follows closely the course of the larger valleys. The best and heaviest stands of timber occur on the slopes fronting Mohawk Valley on the west and in the main canyon of Middle Fork between Crescent Hill and Cromberg. The stands on the Mohawk Valley slopes are excellent. On the valley levels the forest consists of yellow pine to the extent of 95 per cent. Along the foot of the slopes, and extending 800 to 900 feet in altitude, the timber is a mixed growth of yellow pine, sugar pine, white and red fir, with a small proportion of incense cedar. It is an old growth, much of the yellow and sugar pine with basal diameters of 3 to 5 feet, 100 to 150 feet in height, and 30 to 60 feet clear trunks, while the red and white fir is commonly of smaller diameters. These tracts have an average capacity of 22,000 feet B. M. per acre. Below Mohawk Valley the yellow-pine forest decreases in density and the timber is not so large, few of the heavier stands averaging above 20,000 feet B. M. per acre. The timber is generally sound. The forest contains only a moderate amount of undergrowth if we except the sapling stands, which in some portions of Mohawk Valley are exceedingly thick. West of Mohawk Valley, in the Nelson and Onion creeks drainage, the yellow-pine forest follows up the valleys of the lateral feeders, but it is in most places of little commercial value, having been widely ravaged by fire in recent years. The litter in forests of this type is light outside of logged areas. There is no humus except a very thin layer of pine needles; the forest floor is bare sandy or gravelly soil, or is covered with broad, close mats of the creeping ceanothus (*Ceanothus prostratus*).

The western portion of the basin comprises the area of the Bidwell Bar quadrangle. The gorge of the Middle Fork bisects it from northeast to southwest, bounded on either side by ridges, most of which fall below 5,000 feet. With the exception of small areas situated near Dogwood Peak, Frankln Hill, Mount Ararat, and Grizzly Hill, which reach the altitudinal levels of the Shasta fir, the region lies within the limits of the yellow-pine type of forest and is covered with stands of this character.

The tracts bearing the Shasta-fir type are rocky and barren throughout. The stands, composed of Shasta fir, white fir, and on Grizzly Hill of white pine also, are thin and stunted, mostly set in thick chaparral and of little commercial value. Successive fires have damaged the growing portions from 25 to 50 per cent.

The yellow-pine type of forest covers the ridges inclosing the gorge, together with the flanking basins, from Dogwood Peak, on the south side of the river, and

from near Crescent Hill to the beginning of the wooded areas, about 6 miles northeast of Bidwell Bar. The ridges, although rocky where they break off to the main canyon and here and there on the steeper slopes of the lateral gorges, are commonly provided with deep soil and capable of bearing heavy stands of timber.

From Dogwood Peak to Franklin Hill the forest is open on the drier slopes and of medium density, averaging in the best stands about 6,000 feet B. M. per acre. In the bottoms of the numerous small canyons the stand is heavier, averaging about 9,000 feet B. M., and is much mixed with underbrush. The timber is composed of yellow pine, 40 to 60 per cent; sugar pine, 15 to 30 per cent; white fir, 6 to 15 per cent; red fir, 2 to 3 per cent. Here and there occur small flats covered with lodgepole pine, with occasional trees of yellow pine and sugar pine. From Franklin Hill west the stands greatly increase in density. The maximum is reached in the upper basin of Fall River, and in the region around Lava Top, Wagner, and Lumpkin, where many of the stands average 50,000 feet B. M. per acre and large tracts carry from 20,000 to 35,000 feet B. M. per acre. The forest here is rather thickset, especially on the wetter slopes and flats. Yellow pine forms 40 to 60 per cent; sugar pine, 40 to 75 per cent; red fir, 30 to 45 per cent; white fir, 12 to 30 per cent. In addition, there are considerable quantities of oak and incense cedar. This belt of timber is of good quality as regards the pine which it contains, but much of the fir, red and white, has suffered severe damage from fire within recent years. A few miles west of Lumpkin the forest rapidly begins to thin out. The stands are composed largely of small timber, left over from past cuttings, and have been extensively thinned by the ravages of repeated fires. In much of this section the timber is set in thick brush, which has, as elsewhere, increased enormously as a sequel to the fires. At Kanaka Peak the yellow pine begins to thin out, giving way to Digger pine and oak, while 4 or 5 miles farther west the yellow pine ceases entirely and the woodland begins.

The gorge of the Middle Fork is thinly forested throughout. Large portions of its slope are too rocky, or else have a soil too shallow to support much arborescent growth. But the thin stands of timber, especially on the northern exposures of the canyon declivities above the point where Cascade Creek enters, are largely due to fires and the consequent development of a dense chaparral. The greater portion of the timber in the gorge has no commercial value, being mostly small or else situated where access to it is impossible.

North of the gorge the forest is thinner than on the ridges south, partly due to logging operations, but more to fires. From Mount Ararat west to Buckeye the forest occurs in more or less isolated stands surrounded by chaparral. The

timber is of medium quality and runs about 12,000 feet B. M. per acre for the best, with 5,000 to 7,000 feet B. M. as an average. From Buckeye south to where the woodland areas begin, most of the yellow pine has been cut, and the stands are composed of red and white fir to the extent of 65 to 70 per cent. A large percentage of the fir has been damaged by recent fires, and nearly all of it stands in thick growths of underbrush.

The woodland areas of the basin carry oak and digger pine. A typical composition is as follows:

Species found on woodland areas in Middle Fork of Feather River Basin.

	Per cent
Digger pine.....	30
Oak.....	70

In some localities these proportions are reversed. The stands are generally open, but sometimes they are heavily covered with large clumps of *Ceanothus cuneatus*, the species of shrub which constitutes most of the undergrowth in the woodland region. The oak and digger pine have a commercial fuel value. The small quantity of digger pine suitable for mill-timber purposes has long since been logged off.

LUMBERING

The logged, cut, and culled areas in the Middle Fork Basin amount to 102,490 acres, or nearly 20 per cent, out of a total of 532,000 acres. A portion of this has been logged for lumber and exported, but a considerable quantity has been cut to supply local demands for fuel, lumber, and mine timber.

Beginning with the western portion of the basin, the region logged for export purposes begins where the woodland merges into forest, and continues on the north side of the river to Buckeye, on the south side to Fall River. The cutting has been selective, the clearer yellow pine and sugar pine being cut, while the less desirable of these two species, as well as the white and red fir, have been rejected. The cutting has followed the accessible portions of the main dividing ridges, and has ceased at the points specified owing to difficulties in transportation. The lumber manufactured has been hauled to the nearest railroad point in the Sacramento Valley. About 50 per cent of the merchantable timber has been cut. At the present time logging operations are suspended on these tracts. There still remains much choice yellow and sugar pine comparatively easy of access; north of the river this is owing to the almost complete exhaustion of the accessible yellow and sugar pine; south of the river, to unknown causes. Between the points mentioned and Mohawk Valley the cutting has been wholly

to supply local demands, especially for fuel. Most of this cutting has been confined to Onion Valley, a mining camp, and the adjacent region. Proceeding eastward from Onion Valley, the next cutting is at the Four Hills mine, a short distance west of Bunker Hill. The cutting here is for mill-timber purposes. The alpine hemlock and Shasta fir are the two species cut, none other being obtainable. As timber is rather scarce in this locality, all portions of the tree that can be made use of are worked up, a most remarkable circumstance in this portion of California, where wasteful methods of handling timber are the rule. Part of this cut area laps over on the basin of North Fork of Yuba River, part on that of the Middle Fork in Mohawk Valley. The mine is situated almost exactly on the summit of the Yuba-Feather River divide, hence the cutting on either side of the divide. The next cutting has been on the slopes facing Mohawk Valley on the west, from Smith Lake to a point a mile or two north, beyond Squirrel Creek. Part of this cutting has been for the purpose of supplying mine timbers and fuel to the mining camps at Johnsville, Plumas, Eureka, and Little Jamison, and part has been for export. On the areas where the timber has been cut for use of the miners the cut has been 95 per cent of the standing timber, and all kinds have been taken. Where the logging has been for export, selective cutting has been the rule, and the standard followed has not greatly varied from that in vogue in the western part of the basin. At the present time there is only one mill cutting in the Mohawk Valley. It is located near Squirrel Creek, and the product is hauled at great expense to the terminus of the railroad on Willow Creek, about 2 miles south of Otis ranch.

From Otis ranch, following the line of the railroad east, there is a continuous line of cutting for a mile or two on either side of the road as far as Sierra Valley. North of Sierra Valley there has been a good deal of cutting for domestic purposes at scattered points as far as the main divide. Along the west side of the valley the heavy cutting commences a few miles north of Little Valley, thence southward, following the northern slopes of the main range, to a point about 6 miles east of Sierraville, about 80 per cent of the accessible yellow pine, together with considerable quantities of white fir, have been cut out.

The most valuable tract of mill timber in the Middle Fork Basin still remains almost untouched by the logger. This is the timber in Mohawk Valley and on adjacent slopes. As but a few miles intervene between the present terminus of the railroad near Willow Creek and Mohawk Valley, and no serious obstacles prevent its extension into that region, it is a foregone conclusion that a few years more will see the last of the hitherto uncultured, heavily timbered areas in the Middle Fork Basin as wastefully logged as the others have been.

The amount of standing merchantable timber in the basin in thousand feet B. M. is as follows:

Amount of merchantable timber in Middle Fork of Feather River Basin.

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine.....	2,364,600	1,637,000
Sugar pine.....	600,000	525,000
Shasta fir.....	910,000	572,000
Red fir.....	700,000	380,000
White fir.....	494,400	304,000
White pine.....	60,000	31,100
Patton hemlock.....	20,600	1,300
Total.....	5,149,600	3,450,400

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—(1) From junction with North Fork of Feather River northwestward 3 miles: Woodland with scattered oak and Digger pine of small size; culled and cut for fuel during many years; no mill timber.

Grade 2—less than 2,000 feet B. M. per acre—(1) Canyon of Middle Fork of Feather River to mouth of Dogwood Creek. Thin growth of yellow pine, sugar pine, red and white fir, incense cedar; poor quality of timber, owing to rocky soil and successive fires; mostly inaccessible on account of the gorge-like character of the canyon (2) Region around Mount Ararat: Scattered stands of white and Shasta fir, small quantities of red fir and yellow pine in canyons; all of poor quality and damaged by fire; difficult of access, owing to deep, rocky canyons; the whole growing in dense chaparral. (3) Onion Valley: Thin stands of yellow pine, white and red fir, and incense cedar in the bottom of canyons; on northern slopes of ridges scattered stands of Shasta and white fir set in dense chaparral; on the southern slopes sparse growth of yellow pine, white and Shasta fir, and, near the head of the valley, low, stunted white pine. (4) Middle Fork of Feather River Canyon, above and below English Bar: Yellow and sugar pine, red and white fir; thin stands, owing to rocky slopes. (5) Upper Nelson Creek: On the ridges Shasta and white fir with some white pine at the highest elevation, small quantities of yellow pine and red fir in canyons, all of poor quality and generally small size; set in dense chaparral and difficult of access. (6) Region around Johnsville and Eureka Peak. Cut and culled areas formerly bearing stands of Shasta and white fir and yellow pine; at the highest elevations thin stands of

small-sized Shasta fir, white fir, alpine hemlock, and white pine; forest much broken by tracts of bare rock and brush growth; all of poor quality and difficult of access. (7) Region around Mount Jackson and Grizzly Peak. Chiefly white fir, some small and stunted yellow pine, occasional bunches of Shasta fir, all in thick chaparral; difficult of access and much damaged by repeated fires. (8) Region north of Sierra Valley. Yellow pine and white fir of medium quality, thin and scattered in growth, owing to rocky soil; on the highest ridges white pine short of trunk, but with basal diameters up to 40 inches; mostly difficult of access. (9) Region south of Sierraville: Thin stands of white fir, the yellow pine cut off, large quantities of incense cedar, generally unfit for mill-timber purposes. (10) Main range east of Smith Neck Canyon. Scattered growth of small, short yellow pine, white fir, and, at the summits of the ridges, white pine, all in dense chaparral, mountain mahogany, and scrub aspen; practically impossible of access.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) Area north of Middle Fork Canyon from head of Canyon Creek to Marble Creek: Yellow pine and sugar pine of fair quality in the more difficult portions; mostly cut off where readily accessible; the remainder chiefly red and white fir, some incense cedar, and medium-sized oak with a fuel value; in the northern portions near Marble Creek Shasta fir of poor quality in heavy chaparral. (2) Granite Basin. Yellow pine, sugar pine, red and white fir at the lower levels; Shasta fir and white pine on Grizzly Hill slopes; stands thin, owing to rocky soil and slopes. (3) From Kanaka Peak to Franklin Hill. Yellow and sugar pine, red and white fir, incense cedar, and, in the southern portions, considerable oak. Below Cascade Creek most of the best yellow and sugar pine has been culled out. Timber is of fair quality; the northern area, situated chiefly along the breaks of the Middle Fork Gorge, is difficult of access. (4) Region around Franklin Hill: Sugar pine, yellow pine, white and Shasta fir, small quantities of red fir, timber of fair quality; mixed forest, here and there with stands of lodgepole pine or broken by chaparral growths or rocky areas. (5) Lower Onion Valley and slopes of Middle Fork Canyon in this vicinity: Yellow pine, red and white fir, small quantities of sugar pine; timber of medium quality set in thick chaparral or on steep rocky slopes, and practically inaccessible. (6) Upper Onion Valley: Chiefly Shasta fir, some white fir, and scattered yellow pine, all of small growth and mostly in thick chaparral; much damaged by past fires and difficult of access. (7) Nelson Creek drainage. In the lower portion of the basin yellow and sugar pine, red and white fir, incense cedar; and oak; fair in quality; thin stands, in part due to past fires, in part to rocky slopes; in the upper portion mostly Shasta and white fir, scattered yellow pine; at the highest altitudes white pine and Patton hemlock in small quantities. (8) Mohawk Valley drainage: Chiefly yellow pine and white

fir, the former of good quality; stands thin, owing to rocky slopes; below Bungalow, largely small-growth red fir with here and there large-sized yellow pine interspersed. (9) Grizzly Creek drainage. Mostly yellow pine and white fir, occasional sugar pines and red firs, some incense cedar, and here and there at the highest altitudes small stands and scattered trees of white pine and Shasta fir; yellow pine of good quality, thin in stand, owing to rocky slopes and arid climatic tendencies. (10) Sierra Valley region: Northern portion, yellow pine and white fir with white pine above 7,000 feet; fair quality; thin stands, due to rocky slopes; southern portion, yellow pine and white fir, white pine along the crest of main range, west of Sierraville chiefly white fir, the yellow pine having been logged off, forest below 6,500 feet generally accessible for logging operations; at higher elevations the timber is difficult to reach, due to steepness and the rocky character of the slopes.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Region around Bald Rock ranch: Yellow pine, red and white fir, the pine largely logged; the remaining stands chiefly red and white fir, incense cedar, and large quantities of oak. (2) Granite Basin. On the higher areas Shasta and white fir, on the lower levels yellow and sugar pine, red and white fir; difficult of access, timber of medium quality. (3) Region around Lumpkin: Chiefly red and white fir; fair quality, damaged to the extent of 10 to 15 per cent by recent fire; yellow and sugar pine scattered in the fir stands; the greater proportion of the two species logged off. (4) Region around Franklin Hill. Chiefly yellow and sugar pine, red and white fir in lesser quantities; timber of fair quality and size; forest broken by patches of chaparral. (5) Upper Onion Creek and Nelson Creek region. Chiefly Shasta fir of poor quality and small size, but in thick stands set in chaparral on steep slopes or in hollows and saddles of ridges; small quantities of white fir, and at the highest summits scattered trees of white pine and Patton hemlock. (6) Mohawk Valley drainage. In the lower and central areas good stands of yellow and sugar pine, red and white fir; generally of excellent quality and not especially difficult of access, in the upper portion of the valley Shasta and white fir on the northern declivities, yellow pine, red fir, and white fir on the southern, with here and there a sugar pine; timber smaller and not so easily logged as in the central and southern areas of the valley. (7) Regions around Sierra Valley: North and west of the valley, chiefly yellow pine and white fir, the yellow pine of good quality and easy of access; in the southern area, yellow pine at elevations between 5,000 and 6,200 feet; above that Shasta and white fir of rather poor quality, owing to fire.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Region between Bald Rock Ranch and Brush Creek. Chiefly red and white fir in heavy stands and of fair quality, although in some places damaged by recent fires, yellow and sugar pine

in small proportions, the entire tract having been logged and the better grades of these species cut off. (2) Granite Basin. Yellow and sugar pine, with a few heavy stands of Shasta and white fir in the higher areas. (3) Region around Lumpkin and north to Franklin Hill: Mixed forest of good quality, yellow and sugar pine, red and white fir, incense cedar and oak; near Lumpkin, chiefly red and white fir, the best of the yellow and sugar pine having been logged off some years ago. (4) Mohawk Valley region. Mixed forest of good proportions, fine quality, and easy of access; yellow pine as the chief species, large sugar pine, medium-growth red and white fir; in the upper portion of the valley, on northern slopes, chiefly Shasta fir. (5) Region south and west of Sierra Valley: Yellow pine of good quality and dimensions, at the lower levels mixed with poor quality white fir; at higher altitudes, Shasta and white fir, with occasional sugar pines on the tracts west of the valley.

Grade 6—over 25,000 feet B. M. per acre.—(1) Region in and about Upper Fall River Basin: Heavy stands of yellow pine, with large-size sugar pine 4 to 6 feet in diameter; large-size red and white fir in canyon bottoms; forest comparatively easy of access, and of excellent quality. (2) Mohawk Valley drainage: Below the 6,000-foot level, heavy stands chiefly of yellow pine, with 10 to 15 per cent of sugar pine along the 5,500-foot level, and red and white fir of medium size; above the 6,000-foot level, scattered yellow pine, but chiefly Shasta fir, in very heavy and thickset stands, with varying percentages of white fir below the 7,000-foot contour line.

FIRES

In the entire basin of Middle Fork of Feather River there are less than 20,000 acres which show no marks of having been swept by fire, as may be seen by the following table:

Classification of lands in Middle Fork of Feather River Basin

	Acres
Forested.....	532,000
Wooded.....	2,600
Chaparral.....	51,850
Total.....	586,450
Fire marked.....	567,760
Total not fire marked.....	18,690
Total.....	586,450

Of the fire-marked areas, 163,100 acres are classed as badly burned, including the pure chaparral growths shown on the classification maps. The tracts not fire marked consist of wet, grassy glades, or of rocky slopes, where fires could not readily run; in some places, of old placer diggings.

The same amount of damage has been done here as in the basin of North

Fork of Feather River. The greatest damage is in the regions of the Shasta fir, less in the yellow-pine forest, and least in the woodland areas. Hence the tracts most badly burned are in the central portion of the basin above the 5,500-foot contour line. They are, however, by no means confined to that or to higher elevations, since many of the areas on which destruction has been nearly total are situated along the lowest levels in the Middle Fork gorge.

Going eastward in the basin from the junction of North and Middle forks, we find recent burns as well as some of older origin throughout all of the heavily timbered sections both north and south of the river gorge. The damage has not been very extensive, probably not over 5 per cent of the original stand of timber. The red and white fir has suffered the most, the yellow pine the least. Here and there a sugar pine has been burned at the base and lies prostrate, while on occasional small spots varying in size from 3 to 50 square rods the timber has been consumed, and brush has taken the place of the forest. Near Cammel Peak, south, and Mount Ararat, north of the gorge, the Shasta-fir forest begins, and with it come the great destructive burns which disfigure such a large proportion of the forest in the basin. Throughout the area in the central sections of the basin west of Mohawk Valley, on the summits of the ridges, in the canyon bottoms, and on the intermediate slopes the forest is a series of isolated stands separated by extensive chaparral-covered tracts, or it consists of thin lines of scattered trees set in the midst of dense brush, the invariable sequel of the destruction of the forest at these elevations. The tracts that have suffered most are situated in the region around Dogwood Peak, in Onion Valley, on the northern slopes of Pilot Peak, and all through the upper portion of the Nelson Creek Basin. All of the region here mentioned abounds in wide stretches, slopes, and summits evenly covered with the brush growth that comes after fire, and with very few trees remaining to break the monotony of the chaparral. In the lower portions of Mohawk Valley, northeast of Eureka Peak, and in the upper areas north of Haskell peak are extensive burns. They are situated on the backbone and slopes of points of spurs, the forest in the canyons on either side having escaped destruction. This situation imparts a peculiar aspect to the region when one views it from some eminence where the eye is enabled to take in some miles of mountain slope at once. In the Mohawk Valley bottoms the damage has not been very great, owing to the large proportion of yellow pine, which forms the bulk of the forest. East of Mohawk Valley the timber on all the peaks and higher ridges has been badly burned. The summit of Penman Peak and the high ridges connecting it with Mount Jackson and Grizzly Peak have been nearly stripped of forest, and carry enormously dense brush growth in its stead. Along the higher slopes of the Grizzly Creek drainage basin are found thin stands of forest set in heavy brush, but in general the damage here has not been very extensive, owing to the prevalence of yellow pine as the leading

species of trees in the forest. It is impossible to estimate accurately the quantity of timber consumed by fire in the central area of the Middle Fork Basin, but it can be stated that this region does not now carry over 35 per cent of the stand of timber it is capable of carrying, and that the deficiency is wholly due to forest fires, a great majority of which have occurred since 1850.

In the eastern portion of the basin the forest is quite as uniformly fire-marked as in the central or western portions, but owing to the fire-resisting quality of the yellow pine, which here constitutes the largest percentage of the timber, the damage has not been great, probably not more than 6 or 8 per cent. Most of the severe burns are at high altitudes, where white fir and white pine of low fire-resisting capacity largely replace the yellow pine found in the forests of the lower levels.

The fires which have so extensively decimated the forest in the region under consideration are in most cases due to human agency. Possibly some have been caused by lightning, but lightning as an agency in the starting of forest fires is probably here, as elsewhere in the West, a convenient scapegoat upon which to throw the sins of the careless or maliciously inclined hunter, prospector, or sheepman, to whose presence most of the fires can be ascribed. All of the fires that came under my personal observation in the central and eastern areas during the time that this examination was in progress had been set by sheepmen. The fires along the main divide of the Sierra, north of Beckwith Pass, found burning in July, followed exactly the movements and progress of the sheep camps. The same condition existed on the summits and slopes of Gizzly Mountains. Around Franklin Hill large tracts of chaparral and adjoining forest were burned during the summer and fall, and the burns were invariably in proximity to sheep camps. In former years prospectors and miners doubtless were responsible for many of the fires, but in late years sheepmen are the leading agents.

REPRODUCTION

Restocking of logged or burned-over areas is progressing here along the same lines as in the basin of North Fork of Feather River. In the woodland region the Digger pine is apparently declining, while the oak is increasing. On the logged tracts in the western portion of the basin there is abundant restocking with the same species that made up the former stands, but yellow pine and red fir contribute on the whole a larger proportion of the young forest growth than they did in the original old growth, while sugar pine is noticeably much below its former numbers. The relative scarcity of the sugar pine is probably owing to the more exhaustive cutting and culling of the latter species than the two former. Restocking of the burned tracts of Shasta fir in the central areas is excessively poor and deficient. I found no tract where the forest was successfully displacing the brush. On the contrary, the chaparral evidently was becoming

denser and spreading farther into the forested areas. In old, unburned, pure-growth stands of Shasta fir reproduction is almost lacking. These stands are always very close set, and the dense shade or conditions of soil humidity are inimical to seedling or sapling growth in such places. In Mohawk Valley, and in general throughout the eastern area, where the forest is protected from fire, reproduction is abundant. Especially is this the case in the yellow-pine stands in Mohawk Valley. In most portions of the valley bottom of that stream no fires have run in the past twelve or fifteen years. The result is dense sapling growth of yellow pine and white fir, chiefly the former species, in the old-growth stands. On the logged tracts south of Sierra Valley restocking is abundant, consisting largely of white fir and incense cedar, with the latter species greatly predominating. In logging these tracts the yellow pine was almost wholly cut out and the incense cedar and white fir left. Owing to the great seed-producing capacity of the incense cedar it is the leading species in the restocking process, and the coming forests on these tracts will be practically valueless as a source of mill timber.

CHAPARRAL

Bush-covered tracts occur everywhere in the basin, but chaparral proper is found only where the forest has been destroyed by fire. In the woodland tracts it is present merely in the form of scattered clumps of bushes among the Digger pine and oak, and consists almost wholly of *Ceanothus cuneatus* and the California bearberry (*Rhamnus californica*). In yellow-pine forests the brush is chiefly a thin undergrowth scattered among the growing trees, except on ground where the forest has been wholly or partially destroyed by fire, when it forms true chaparral. At the lower elevations, 2,500 to 3,500 feet, the brush consists chiefly of a species of manzanita (*Arctostaphylos glauca*); at the higher altitudes it consists of various species of ceanothus, service berry, chinquapin, scrub oak, and the like.

It is in the Shasta-fir type of forests where the most extensive and destructive burns have occurred that the typical chaparral occurs. From Franklin Hill to the levels of Mohawk Valley the mountains are dotted like a checkerboard with these close and uniform growths of brush. The species which compose them are generally the same that form the brush stands in the basin of North Fork of Feather River, manzanita (*Arctostaphylos patula*), chinquapin, scrub oak, service berry, and various species of ceanothus prevailing. Above the 7,000-foot contour line the chaparral is never very dense and consists almost wholly of a spinescent species of ceanothus (*Ceanothus cordulatus*). In the eastern portion of the basin there is but little of the typical chaparral. Its place is taken by dense masses of mountain mahogany and young aspens, partly occupying burned-over areas, partly growing on ground too rocky and sterile to support forest.

BASIN OF SOUTH FORK OF FEATHER RIVER

TOPOGRAPHY.

The basin of the South Fork of Feather River has a smaller area than that of any other of the various main forks that constitute the Feather River system. The extent of country drained by the stream is estimated at 91,240 acres. The stream heads on the western slopes of Pilot Peak, an eminence situated at the head of one of the branches of Nelson Creek, a tributary of Middle Fork of Feather River. No portion of its drainage originates in very high ridges, and most of its course is through a region rarely exceeding 5,500 feet in altitude. It flows in a canyon that is of inconsiderable depth and has slopes of moderate declivity, and that therefore presents a sharp contrast to the deep gorges that form the canyons of the Middle and North forks of Feather River. In the upper portion of its course—from Pilot Peak to Little Grass Valley—the canyon is narrow and shallow, the greatest depth being 400 or 500 feet. At Little Grass Valley the canyon widens into a grassy or sparsely timbered flat, which continues for a mile or two, when the canyon walls contract and continue without further widening to the point of junction with Middle Fork of Feather River, $1\frac{1}{2}$ miles above Bidwell Bar. In the deepest portions the canyon rarely exceeds 1,000 feet in depth.

The drainage area of the stream consists wholly of the slopes of the divides which separate it from Middle Fork of Feather River on the north and from North Fork of Yuba on the south. From Little Grass Valley westward the northern ridge has somewhat the aspect of a plateau region not very deeply cut by lateral canyons. On the south the river is paralleled by a peculiar narrow ridge, called the Mooreville Ridge, which is separated from the main divide by Lost Creek. The main ridge south of Lost Creek is very similar in contour to the ridge north of the river—the Middle Fork of South Fork of Feather River Divide. The highest point in the South Fork drainage is Pilot Peak, with an altitude of 7,500 feet; the lowest, situated in the canyon bottom at the junction with the South Fork, has an elevation of 500 feet.

SOIL.

The upper areas of the basin, from Pilot Peak to a point just west of Cammel Peak, north of the river, and Lexington Hill, south of the stream, show evidences of glaciation or of having been more or less covered with glacial débris ground out elsewhere, and much of the soil is in consequence composed of gravel and sand, with a liberal sprinkling of bowlders and admixture of humus and mold—derived from ages of forest growth—as a top dressing. West of the two points designated the soil changes to the fine, brick-red material commonly prevailing below the

4,500-foot level in this region. There is not a great deal of bare rock exposure in the basin. The slopes of Pilot Peak consist in some places of rock devoid of soil covering, and below Little Grass Valley there are occasional exposures of basaltic rocks with no soil.

MINING.

Placer diggings exist in many localities along the tributaries of the river. They are little worked at the present time. Quartz discoveries have been made in several localities, but none are developed to shipping capacities, and the work so far is merely of a prospective character.

AGRICULTURAL LAND.

The agricultural lands in the basin are situated on the ridges forming the divides which separate the South Fork from the Middle Fork of Feather River and North Fork of Yuba River. They consist of lands won from the forest by clearing, and are generally located at the head of small lateral tributaries of the river. Most of them are situated on the divide between the river and the North Fork of Yuba and west of Lexington Hill. Above this point the region is subject to recurring summer frosts and is therefore too cold for agricultural operations. The lands under cultivation comprise in the aggregate 2,040 acres. The products are fruit, vegetables, and hay.

PASTURE.

All the accessible portions of the basin are used for pasturing sheep and cattle. The sheep runs are situated in the upper areas of the basin from Cammel Peak and Lexington Hill west. The pasture tracts, all under fence, are situated in Little Grass Valley and consist of a series of wet, marshy glades producing the ordinary coarse grass and sedge of these mountains. They comprise an area of 560 acres. The pasture throughout the forest is thin and poor. Most of it has long since been eaten out by cattle or destroyed by excessive sheepling. In the upper portions of the basin there are extensive stands of open lodgepole pine with a sparse turf of grass covering the forest floor. This is sheepled off closely each season, and the sheepmen commonly endeavor to increase the pasture by burning some portions of the brush and timber in this region each year.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE.

Most of the basin is forested, but the proportion of woodland, though small, is larger than in the North Fork or Middle Fork basins, being 8 per cent against

less than 4 per cent in the North Fork and 5 per cent in the Middle Fork. The acreage of forest and woodland is as follows:

Forest and woodland in South Fork Feather River Basin

	Acres
Forested	71,740
Wooded	9,200
Total	80,940

The wooded areas stretch from the junction of the Middle Fork of Feather River eastward along the canyon for a distance of 8 or 9 miles and are generally situated below the 1,800-foot level. The lower 2 miles of this distance lies wholly within the foothill country; the balance stretches into the forested regions proper, but carries the woodland type of trees owing to semiarid conditions of the canyon slopes, due chiefly to rapid drainage and rocky soil. The arborescent growth of the woodland areas consists of Digger pine and various species of oak. It is thin and scattered, and along the upper limits is mixed with a little yellow pine, the species occurring mostly as isolated trees set in the oak and Digger pine. At altitudes of 1,800 to 2,000 feet the Digger pine thins out and yellow pine with red fir takes its place, other species of oak, mostly California black oak, come in, and at 3,200 feet the Digger pine disappears. From 2,000 feet to the highest altitudes (7,500 feet at Pilot Hill) the basin is forested, but the bulk of the merchantable timber grows between the 3,000-foot and 5,000-foot contour lines. It is noteworthy that the upper limit of merchantable timber is about 300 feet higher than in the basin of the North and Middle forks of Feather River along the same meridian, the densities in each locality being equal. The cause for this rise is to be found in the long eastward sweep of the foothill region in the main Yuba Basin.

Most of the basin carries the yellow-pine type of forest, the Shasta fir being limited, south of the river, to portions of the region east of Lexington Hill, while north of the stream the lower end of Little Grass Valley nearly reaches the limit of its westward range in the basin.

CHARACTER OF FOREST

With the exception of the small acreages in the upper basin which carry forests of the Shasta-fir type, and the woodland tracts at the western termination of the canyon, there is little variation in the forest except such as is due to logging operations and to fire. Portions of it differ considerably, however, in the proportions of the different species from the corresponding type in the other

Feather River basins. The composition of a block of forest of the yellow-pine type lying between Lexington Hill and Strawberry Valley is as follows:

Composition of forest of yellow-pine type between Lexington Hill and Strawberry Valley

	Per cent
Yellow pine	10
Sugar pine.....	20
Red fir	17
White fir.....	40
Incense cedar.....	10
Oak.....	3

As the greater proportion of the merchantable timber in the basin is contained in this stretch of forest the above example is nearly typical of the general composition of the bulk of the forest here. The comparatively low percentage of yellow pine in South Fork Basin is in striking contrast to the proportion in which the species occurs elsewhere in the basins of the forks of Feather River at similar elevations. It is not clear whether this is due to some peculiarity of soil or to greater soil humidity, but probably to the latter.

The central portion of the basin carries the heaviest stands of timber. The trees are moderately close set. Much of the red and white fir is of small diametrical dimensions, averaging 20 to 24 inches, but of considerable height, often reaching 150 to 180 feet. The yellow pine and sugar pine each reach 2 to 6 feet in diameter and 120 to 180 feet in height. The merchantable timber varies from 25,000 to 45,000 feet B. M. per acre for the heaviest stands and 5,000 to 12,000 feet for those of medium density, where logging operations have been carried on. Undergrowth on these tracts is exceptionally dense. Usually the yellow-pine forest at middle elevations is open, but here is a uniform, dense mass of brush growth, consisting chiefly of ceanothus. In the western areas of the basin the forest is thin, as it has been closely and repeatedly logged. The remains consist mostly of yellow pine and red fir of small dimensions, the better class running about 5,000 feet B. M. per acre.

The eastern area of the basin carries a forest composed partly of the yellow-pine type, partly of Shasta fir. The former follows the main valley of the stream and occasionally branches out into the side canyons. On the summit of the ridges, on the middle and higher portions of the slopes, and in the more humid situations in the valleys the Shasta-fir type prevails. The yellow-pine type here consists chiefly of yellow pine and white fir, but along the southern slopes of the main South Fork Canyon, as far up as 3 or 4 miles east of Grass Valley Hill, there are occasional sugar pines, short and stocky, 3 to 5 feet in diameter and 50 to 75 feet in height, mixed with yellow pine, lodgepole pine, and now and then a Shasta fir. In the main canyon bottom, from the lower end

of Little Grass Valley up, the forest is largely made up of lodgepole pine, appearing as open groves and fringes along the stream and wet or marshy flats mixed with Shasta and white fir and occasional yellow pines. In the canyon heading on the northern slopes of Bald Mountain there are a few heavy stands of forest, composed in some places of thick-set sugar pine of large and medium dimensions; in other localities are nearly pure-growth stands of Shasta fir averaging 45,000 to 50,000 feet B. M. per acre. Along the northern slopes of the South Fork Canyon from a point 3 miles east of Bald Mountain to the head of the canyon at Pilot Peak the forest is patchy, thin scattered groups and lines of Shasta and white fir alternating with dense stands of nearly pure-growth Shasta fir. In general, the forest in the eastern part of the basin is of poor quality. Oft-repeated fires are the cause. At least 35 per cent of the standing timber is more or less defective from rot caused by scarring or burning. Almost everywhere the undergrowth is exceedingly dense and great numbers of fallen trees have made a large amount of litter.

LUMBERING.

The timber has been more or less systematically logged and culled in the basin on 44,350 acres. Part of this is situated in the forested portions, part in the areas classed as woodland. As the forest and woodland together amount to 80,940 acres, the cut areas comprise 55.4 per cent of these tracts.

The most extensive logging operations in the basin have been carried on in the western portion. The woodland areas were cut over in early days, because they were adjacent to the placer mines at Bidwell Bar and above. As the demand for lumber increased, logging operations were extended eastward as far as the lumber could be profitably hauled to the chief points of distribution in the Sacramento Valley. As elsewhere in the Feather River Basin, much of the logging has been selective, but the practice has been, on the whole, much more elastic than in either the North or Middle Fork regions; that is, some red and white fir has been cut, at least on the ridges south of the river, and yellow and sugar pine of smaller dimensions has been taken. North of the river the basin has been logged to Knownothing Creek, and the cutting has varied from 50 to 90 per cent of the available merchantable timber. Below Mooretown the practice has been rather broad—yellow pine, sugar pine, and white and red fir down to 20 inches at the base being taken. Above Mooretown the cutting has been more closely selective. South of the river the chief cutting has been west of Strawberry Valley. Some red and white fir has been taken, together with most of the yellow and sugar pine which grew on these tracts. The cutting in the main canyon has been largely for fuel, in a lesser degree for placer mining. Above the localities where the main logging operations cease there has been cutting at many points for fuel, shakes, etc., but the total is small, not exceeding 1 per cent in the

aggregate. Cutting in the eastern portions of the basin has been limited to timber for fuel and shakes, and nearly all of it has been on the tracts contiguous to Onion Valley or to the mining regions near Gibsonville. Most of the cutting near this latter place has been for fuel, a quartz mill located $1\frac{1}{2}$ or 2 miles south of Gibsonville drawing most of its cord wood from the ridges adjacent on the east to Little Grass Valley.

The amount of standing merchantable timber in the basin in M feet B. M. is as follows:

Amount of mill timber in South Fork of Feather River Basin

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	250,000	200,000
Sugar pine	185,000	155,000
Shasta fir	200,000	87,000
Red fir	200,000	150,000
White fir	110,000	76,000
Total	945,000	668,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—(1) From junction with Middle Fork of Feather River eastward 9 miles. Small thin groups and lines of oak and Digger pine, all of small size, culled many years ago for fuel; no mill timber.

Grade 2—less than 2,000 feet B. M. per acre.—(1) From near Stringtown to Kanaka Peak: Chiefly oak and Digger pine of small size; here and there yellow pines rarely exceeding 18 inches basal diameter and 50 to 60 feet in height. (2) Canyon of South Fork of Feather River: Yellow pine, sugar pine, red fir of small size occurring in scattered bunches or as isolated trees, the whole of little commercial value and difficult of access, average stand about 1,800 feet B. M. per acre Michigan practice. (3) Ridges and bottom lands of main canyon adjacent on the east to Little Grass Valley: Scattered stands of Shasta and white fir growing mostly on the ridges and surrounded by heavy chaparral; lodgepole pine on the bottom lands generally of small, slender growth, with here and there a few yellow pines and white firs, difficult of access except from the Gibsonville side; a large percentage defective, owing to rot and fire scars.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) From Stringtown to region around Mooretown: In the western portion, small quantities of undersized yellow pine, culls left over from previous cuttings, occurring in scattered bunches on the crests of northern slopes of the ridges, barely averaging 2,000 feet B. M. per acre,

much mixed with oak and Digger pine; in the eastern section small yellow pine and red fir, also closely cut and culled. (2) From Powell Creek to Clipper Mill (area south of the river). Yellow pine and red fir, in the eastern portion mixed with white fir, all of small size, the large trees having been long ago logged off. (3) Main Canyon of South Fork of Feather River. Yellow pine, sugar pine, red and white fir of medium size and quality; thin stands owing to rocky soil; difficult of access. (4) Region adjoining Little Grass Valley on the north. Scattered yellow pine, sugar pine of low, stocky growth, some white and Shasta fir; all set in close lodgepole pine stands or dispersed in small bunches among heavy chaparral growth; much of it defective owing to rot; difficult of access except from the Gibsonville side.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Region between lower end of Little Grass Valley and head of South Fork of Feather River: Chiefly white and Shasta fir of small size, in close stands on the northern slopes of the ridges near the canyon bottoms, or in open stands of larger growth, surrounded by areas of chaparral or rocky, nonforested tracts; on the southern slopes and in the valley bottoms yellow and sugar pine mostly mixed with lodgepole pine; all of poor quality owing to damage from fire and generally difficult of access; average capacity about 5,500 feet B. M. per acre. (2) Region between American House and Clipper Mill, including Mooreville Ridge: Large quantities of red and white fir, small percentages of yellow pine and sugar pine, except on Mooreville Ridge; all of fair quality and size; stands comparatively open; average capacity of the tract, excluding Mooreville Ridge, 9,000 feet B. M. per acre, on the latter 6,000 feet B. M. per acre; comparatively easy of access. (3) Region around Mooretown, Lumpkin, and Quartz Hill: In the two first-named localities chiefly red and white fir, most of the yellow and sugar pine long since cut out; in the last-named locality yellow and sugar pine of medium size and quality mixed with small percentages of white and red fir of slender growth and large proportions of oak; most of the tract comparatively easy of access.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Region directly south of Lumpkin. Chiefly red and white fir of large size, 2 to 4 feet in diameter, 100 to 150 feet in height, often in close stands, but more generally of open growth; small quantities of yellow and sugar pine, the larger proportion of these two species logged off long ago; the red and white fir considerably damaged by extensive surface fires of recent origin; much undergrowth; easy of access. (2) Region between Lexington Hill and Clipper Mill: From Lexington Hill to American House largely Shasta and white fir in close set stands, the trees of medium dimensions; farther west, yellow and sugar pine, large quantities of red and white fir, all fairly well preserved; considerable undergrowth; readily accessible. (3) Tracts adjoining Little Grass Valley on the west. Mostly Shasta fir of tall growth and long clear trunks, 18 to 24 inches in diameter at the base, 90 to 120 feet in height with

clear trunks 40 to 80 feet in length, mostly in thickset stands; at the lower elevations mixed with white fir and occasionally with yellow and sugar pines

Grade 6—over 25,000 feet B. M. per acre.—(1) Areas south of the river and west of Lexington Hill: Heavy forest, composed chiefly of red and white fir with 15 to 20 per cent sugar pine of large size; yellow pine in comparatively small quantities, ranging from 10 to 15 per cent, large in size and of good quality; readily accessible; average capacity, 35,000 to 45,000 feet B. M. per acre. (2) Tract between Bald Mountain and Little Grass Valley: Heavy, close stands of large Shasta fir 3 to 5 feet in diameter at the base mixed with some white fir, and fringed on the northeast by a small block of old-growth sugar pine, yellow pine, and white fir.

FIRES

Much of the area in the basin is fire marked, and on nearly 20 per cent the forest is badly burned; that is, over 50 per cent of the timber on the tracts classed as badly burned has been destroyed, as is shown in the following table:

Classification of lands in South Fork of Feather River Basin

	Acres
Forest, woodland, and chaparral.....	88,640
Fire marked.....	70,000
Badly burned.....	15,000

Deducting from the areas badly burned the tracts classed as chaparral—areas originally forested and totally denuded by fire—amounting to 7,700 acres, there remain 7,300 acres, all situated on the forested tracts of the basin upon which 50 to 90 per cent of the timber has been burned. This estimate of 7,300 acres is, however, in reality too low and represents only the conspicuous areas of the larger burns. Throughout the forested region there are many spots, 3 to 10 square rods in extent, burned clean of timber not accounted for, except as they lower the average stand of mill timber upon the tracts where they exist. If all such places were taken into account, the amount of badly burned forest in South Fork of Feather River Basin would probably swell to two or three times the figures above given.

The regions in the basins which have suffered most from fire are situated in the eastern portion, and are closely bounded by the range limits of the Shasta fir. Considerable damage has been done in the central regions as well, owing to the presence of large percentages of red and white fir, and the relatively small proportion of the more fire-resisting yellow and sugar pines. The woodland tracts in the western sections have suffered comparatively little.

Northeast of Stringtown, on the divides north of the river, fire-marked timber is everywhere distinct. Many of the fires in the woodlands occurred so long ago that the marks of them are not very distinct. Beyond Kanaka Peak, where much of the damage is of recent origin, the effect of the fires is more conspicuous. In the

region around Lumpkin fires have burned through most of the heavy forest existing there. A large amount of white and red fir has been destroyed—partly consumed, partly fire killed, and still standing. Northeast of Lumpkin, in an area extending to the head of Fall Creek, the basin of the South Fork shows, by the uniform thinning of the forest and the abundance of chaparral, ample evidence of widespread fires. Near the point where Fall River heads in the ridges inclosing the South Fork Canyon, Shasta fir appears, and with it the especially big and destructive burns of the basin. Everywhere on ridge and slope one sees long lines and broad swaths of chaparral, invariably marking areas formerly covered with forest. The standing timber is uniformly thin and shows plenty of fire scars and sears, while the underbrush has developed abnormally. Chaparral and thin, fire-seared stands of trees alternate with small, scattered blocks of fire-killed forest throughout the Upper South Fork Basin on both sides of the river. South of the river fires in the yellow-pine forests have not been so abundant nor so widespread as north of the stream, but enough have burned there to clearly leave their impress. Near Lexington Hill the Shasta fir forest begins, and burned tracts follow exactly as on the north side of the river—chaparral, thin broken stands of timber, burned trees still standing, and litter composed of fallen fire-killed trees or trees simply broken off near the top. Yet, throughout the region examined, the quantity of litter derived from partly burned trees is remarkably small and wholly out of proportion to the amount killed by fires. The quantity of timber destroyed in the stands of Shasta-fir type, assuming that the chaparral-covered tracts bore a forest of the same density as that which remains, may roughly be computed at 60 to 65 per cent of the volume now standing, while the loss in the yellow-pine type is probably about 8 per cent.

REPRODUCTION

Reproduction in the woodland tracts is slow as regards the Digger pine, while the different species of oak springing partly from the root where burned or cut, and producing an abundance of acorns, are increasing.

Throughout the central region reproduction is moderate, the heavy underbrush, which has come as a sequel to the numerous surface fires, preventing much seedling growth. What young growth there is consists largely of white fir. In the eastern portion young growth is everywhere scanty, partly by reason of excessive sheeping and the trampling out of seedlings, and in part owing to the ascendancy gained by the chaparral, which here, as elsewhere, successfully resists all encroachments by the surrounding forest. A great deal of the young growth in the eastern portion consists of lodgepole pine which, in localities with plenty of seepage, sometimes wholly replaces the former forest of Shasta and white fir when destroyed by fire. Elsewhere on these areas, where forest and chaparral struggle for possession of the ground, Shasta fir is the chief species in the coming forest.

CHAPARRAL

The brush growths in the South Fork Basin do not materially differ from those in the other valleys of the Feather River drainage. In the woodlands it exists as scattered clumps chiefly composed of manzanita (*Arctostaphylos glauca*) and *Ceanothus cuneatus*. Where the woodlands join the forest most of the brush growth consists of the manzanita. In the central area species of ceanothus form most of the underbrush, while in the higher eastern portions 80 per cent of the chaparral consists of a single species of manzanita (*Arctostaphylos patula*).

BASIN OF NORTH FORK OF YUBA RIVER.

TOPOGRAPHY.

The basin of the North Fork of Yuba River, draining an area of approximately 304,530 acres, is the largest basin of the Yuba River system. The Yuba River system consists of three chief branches—the North, Middle, and South forks—all uniting in the foothill region and forming Yuba River. The entire area drained by the several forks and most of the foothill country tributary to Yuba River are included within the limits of the present examination and comprise in round numbers about 1,038,000 acres.

The North Fork of Yuba River heads in the main Sierra. The elevation of the range at the head of the stream is 8,000 feet. The chief heads of the North Fork of Yuba River are situated in the broken and glaciated region of the granite area north of its main canyon. Numerous streams rise here and, flowing southward, enter the fork at various places. Their main and lateral canyons are narrow, with steep rocky slopes, and display evident signs of extensive glaciation.

Like the main branches of the Feather River system, those forming the Yuba system lie in deep, narrow canyons, sometimes even gorge-like. The canyon of the North Fork becomes a gorge about 4 miles above Sierra City, and continues to within 12 or 14 miles of the junction with Middle Fork of Yuba. At the point where the gorge begins the canyon floor is sunk 2,700 feet below the summit of the inclosing divide on the south, while at its end the depth is about 1,500 feet, though the canyon walls are not so uniformly steep and abrupt as those of the Feather River. The northern slope is long, and only the last 1,000 or 1,500 feet presents very deep descents. The declivities of the southern slope, on the other hand, are abrupt throughout. The distance from the canyon bottom to the summit of this divide is frequently not more than 3 miles in a direct line, giving, in some instances, a fall to the small creeks which head in it of 600 to 900 feet per mile. There are no bottom lands in the main canyon, except a tract of a few score acres near Downieville, and the bed of the main river as well as the channels of the larger tributaries are boulder-strewn throughout.

Topographically, North Fork of Yuba Basin consists of two parts, an eastern and a western, divided along fairly well-defined natural lines. In a general way, the eastern portion north of the river comprises the area situated east of Slate Creek, while south of the river it consists of the district to the east of Woodhull Creek. These divisions are not alone topographical, they also mark in a broad way the boundaries of the forest types of the basin. The eastern portion of the basin is the larger, comprising considerably over half of the entire area. Most of it is situated north of the main canyon. Its shape is peculiar, resembling a half oval with the river flowing along the rectilinear base line of the figure.

Excluding the area of the main canyon, the district has a mean elevation of nearly 6,000 feet. One point, Sierra Buttes, attains a height of 8,600 feet, while numerous other peaks and ridges in this part of the basin rise to elevations between 7,000 and 8,000 feet. The region is remarkably rough and broken, especially north of the main canyon. It abounds in narrow canyons and gorges, and the divides separating them are steep and rocky. The western portion of the basin consists of broad ridges of low relief cut by many streams sunk in narrow canyons or valleys.

SOIL

All of the eastern half of the basin has been subjected to extensive glaciation and the soil consists largely of sand and gravel with plenty of bowlders, mixed on the surface with a light dressing of mold. In hollows that have received the washings of humus from adjacent hillsides the layer of mold sometimes reaches 18 inches to 2 feet in depth, but throughout most of the district coarse, sandy or gravelly soil is the rule. At the heads of Slate Creek and the West, Middle, and East forks of the North Fork of Yuba large tracts have no soil covering at all, the bare rock crops out and only here and there in the crevices and hollows is found a depth of soil sufficient to support vegetation. Large areas along the upper and middle portions of Slate Creek, the region around Poker Flat, and that adjacent to Canyon Creek are covered with small rock débris, waterworn and rounded, transported from the slopes of the mountains by ice. Where these deposits have not been upturned by the placer miners the soil covering is a few inches in thickness. All the lower declivities of the main canyon are thinly soiled. Along the upper slopes there are in many places vast deposits of drift gravel and bowlders covered with soil 12 to 14 inches in depth, above which project rocky combs and ridges, bare or with thin soil. Throughout the high and elevated tracts surrounding Sierra Buttes, Deadman Peak, and Haskell Peak the basin abounds in bare, rocky expanses, gravel- and bowlder-strewn ridges, and moraines of coarse bowlder drift, with here and there, where the summits of the ridges broaden or small flats occur at the heads of

the streams, circumscribed tracts covered with soil a foot or two in depth. The western portion has generally a deeper and more generous soil. It consists mostly of the typical fine, red material referred to as occurring in similar situations in the basin of the forks of Feather River. The rocks on a large tract of this district are overlain with heavy deposits of silt, sand, and coarse gravel, on which rests a top layer of the red soil which varies from a few inches to 3 feet and in some places even to 10 feet in depth.

MINING.

All the basins of the Yuba forks are old mining districts, none more so than the North Fork region. Placer gold occurs in most of its canyons and gulches and has been mined since early days. The district included within the Canyon and Slate Creek drainage has been extensively worked by all the methods in use by the placer miner. The hills and flats have been torn in all directions by hydraulic mining and most of the stream channels are choked with deposits of *débris* washed in from the placers. Quartz mining has been carried on at numerous localities, especially in the district adjacent to Sierra Buttes. At the present time only a few of these mines are in operation and none on a large scale. The western areas of the basin have been extensively mined, mostly for their placer deposits. Since the enactment of the Camminetti law and the consequent general suspension of the hydraulic method of placer mining, the district has lost its importance as a mining region and but few claims are being worked. Most of the gulches in this portion of the basin contain great quantities of the "slickens"—placer *débris*—gradually working down into the main canyon, and the hills and bluffs created by the hydraulic giants are slowly adding to the descending *débris*, while acquiring a permanent and stable slope.

AGRICULTURAL LAND.

The eastern area of the basin contains no agricultural land, except about a hundred acres in the bottom of the main canyon near Downieville and 50 or 60 acres more in the region north of that town. At Sierra City, and at various places throughout the region below the 5,000-foot level, are small patches—an acre or so, adjoining some miner's claim or cabin where a little hay or vegetables were raised—barely enough for the owner's use. In the western section of the basin are numerous small agricultural holdings, all occupying ground formerly covered with forest. The area of agricultural ground in the basin—that is, the land actually cleared of timber and in tillage—comprises in the aggregate nearly 10 sections, or 6,280 acres.

PASTURE.

The entire area of the basin, wherever accessible, is used as pasture grounds for cattle and sheep. Cattle roam throughout the region; sheep are confined

chiefly to the eastern and more mountainous tracts. The western portion has long ago parted with most of its native pasturage, except on lands under fence. In the eastern portion there exist small glades at the heads of the streams, rocky stretches with thin stands of Shasta fir, and here and there open, park-like bodies of lodgepole pine. In these situations grow a little grass and coarse weeds, which are closely pastured by cattle and sheep during the season. In a general way it may be said that except where fenced, in one or two localities southwest of Eureka Peak and at the head of the South Fork of North Fork of Yuba, the natural pasturage of the basin is thoroughly eaten out. These pasture lands are estimated to comprise, in the aggregate, 400 acres.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

Most of the land in the basin is classed as forested, being situated within the region where the yellow-pine or Shasta-fir types constitute the forest, and comprises 230,850 acres, or nearly 76 per cent of the area of the basin.

The forest begins with stands of the yellow-pine type at the point where the North and Middle forks of Yuba River come together. It is of the same general character on both sides of the river. In the main canyon this type extends to Sierra City, following the canyon of North Fork of North Fork of Yuba River nearly to its head, and that of South Fork of North Fork of Yuba River into Hay Press and Tehuantepec valleys. Along the main canyon the type extends up all of the slopes and lateral gorges, generally ceasing at about 5,500 feet. Above these altitudes the Shasta-fir forest sets in and covers all the ridges and peaks, except where fire has destroyed it. By far the greater proportion of the basin, owing to its position at or above the 6,000-foot contour line, bears this type of forest. The acreage of the two forest types represented in the basin is as follows:

<i>Area of yellow-pine and Shasta-fir types in North Fork of Yuba Basin.</i>	
	Acres
Yellow-pine type	65,000
Shasta-fir type	165,850
Total	230,850

CHARACTER OF FOREST.

South of the river, in the western portion of the basin, the yellow-pine forest is mixed with red fir, oak, incense cedar, and, occasionally, small quantities of white fir. It is mostly a reforestation after close and exhaustive cutting, and is therefore largely composed of young growth 20 to 40 years old. There is comparatively little large timber, except along the steep breaks to the canyons, too difficult of

access to loggers. The young growth is in thickset stands with little underbrush. Here and there it is broken by placer diggings, or by hillsides formerly nearly deforested by fires and now covered with a close growth of manzanita (*Arctostaphylos glauca*). In scattered patches of old or middle-aged stands, or in young growth where the stands are thin, oak of various species is mixed with the coniferous growth in small percentages.

At the lower levels in the main canyon of the North Fork the forest of the yellow-pine type is thin and scattering, as a rule. On the northern declivities in sheltered hollows, on the less steeply descending slopes, and at the opening of side canyons are bodies of timber composed of medium close stands, made up of yellow pine, red fir, incense cedar, occasional sugar pines, and small quantities of white fir, all of short and slender growth, owing to low ratio of soil humidity, caused by rapid run-off and generally thin and sterile soil. On the canyon slopes with southern exposures the forest is very thin, and consists chiefly of yellow pine and oak of small size throughout. There is very little sugar pine in the yellow-pine type south of the river, either of old or of sapling growth.

North of the river the yellow-pine forest is of medium density where logged, and heavy where uncut. On the logged tracts, owing to the selective cutting practice that has prevailed, a large percentage of the yellow and sugar pine has been cut out and the white and red fir left. On the uncut tracts the forest is of the same average composition that characterizes the stands on the adjacent South Fork of Feather River area—that is, chiefly red and white fir, with yellow and sugar pine, varying from 8 to 20 per cent, and small quantities of oak and incense cedar. The yellow-pine forest, as it follows up the lateral canyons which branch off in a northerly direction from the main gorge in the eastern area of the basin, is mostly thin and small. The larger proportion consists of red fir, here and there white fir, incense cedar, and oak, generally set in thick underbrush, the result of many and severe fires.

The Shasta-fir forest north of the river begins east of Slate Creek at 5,500 feet elevation. At higher altitudes, and in the central portion of the drainage of this stream, it spreads out to the tracts west of the creek. It is of poor quality throughout, and, as a rule, extremely patchy, owing to extensive fires and to the sterile and rocky character of the soil. Here and there, as on the western slope of the ridges near Saddleback Mountain, on the ridges trending southward from the divide near Gold Lake, and on various small, isolated tracts in the same or adjacent regions, are pure stands of Shasta fir of considerable density, which occasionally average 20,000 feet B. M. per acre. At the heads of the basin in the main Sierra are several blocks of heavy forest. For some reason they have not been largely invaded by fires, and their situation at a high altitude has so far

preserved them from loggers. The best of these stands will yield 22,000 feet B. M. per acre, while those of lesser capacity will average from 5,000 to 8,000 feet B. M. per acre. South of the river the Shasta-fir forest begins east of Woodhull Creek, keeping rather closely to the summit and higher slopes of the divide. It is of medium density, with here and there heavier blocks having a capacity of 7,000 to 9,000 feet B. M. per acre, but easterly, along the crest of the divide, it is broken and patchy, owing to burns. From Keystone Mountain east for a distance of nearly 6 miles it consists of scattered groups and stands in dense chaparral or glades. Beyond this it merges into the heavier and more even stands along the main divide of the Sierra at the head of the basin.

The composition of the Shasta-fir forest in the basin is tolerably uniform throughout. Shasta fir is the prevailing tree, in pure stands 100 to 175 feet in height, but rarely over 3 feet in diameter above the basal swell and more often but 24 to 30 inches. In open stands the tree is stocky, often having a diameter of 4 to 5 feet with a height of 80 to 90 feet. Mixed with the Shasta fir is white fir in varying proportions. In some of the heavy blocks of forest near Saddleback Mountain the white fir proportion is as high as 65 to 75 per cent, but usually it is below 25 per cent; commonly the tree does not ascend above 6,500 to 6,800 feet. Throughout nearly all of the Shasta-fir forest in the basin yellow pine is found, and at the lowest altitudinal limits of the type its proportion in some instances may reach 8 or 10 per cent. At the higher elevations there are only occasional trees to be found, and above the 7,000-foot level the species commonly ceases altogether. Throughout the basin, tipping the summits of the highest peaks and fringing the crest of the ridges above the 7,300-foot level, one meets small quantities of Patton hemlock, while almost uniformly from the 6,000-foot level to the highest summits north of the river and at its heads in the Sierra main divide, white pine, in proportions varying from 2 to 5 per cent, is seen. All of the glades and marshy places at elevations above 6,000 feet are fringed with lodgepole pine. Sometimes the species occurs in nearly pure stands; more frequently the tree is dispersed among stands of white pine, Shasta, and white fir. A typical composition of the Shasta-fir forest at the head of the basin is as follows:

Composition of Shasta-fir forest at head of South Fork of Yuba Basin.

	Per cent
Shasta fir	63
White fir.....	32
Yellow pine	1
White pine.....	3
Lodgepole pine.....	1

LUMBERING.

The areas on which timber has been systematically logged, or cut and culled for other purposes, comprise 131,420 acres, or 56.6 per cent of the forested tracts of the basin. The larger proportion of the timber has been cut for mill purposes, but a considerable portion has been converted into fuel. Beginning with the area north of the river in the western part of the basin, the cutting has proceeded along the crest and higher and more inaccessible slopes of the divide against South Fork of Feather River. The cutting has largely been selective, the yellow and sugar pine being taken, while most of the red and white fir remains. East of Slate Creek the cutting has kept pace with the mining camps along the central and upper drainage of this stream, extending northward into Onion Valley in Middle Fork of Feather River drainage, while the eastern point rests at Rattlesnake Peak. A great deal of the timber cut from these tracts has been used in the rough logs for cabins, for mining, and fuel. Here a feature in logging presented itself which was seen elsewhere in only a few places in the region examined. It consisted in logging the dead timber standing in the chaparral and in cutting the sapling growth which was slowly endeavoring to replace the brush. This system of cutting was observed around Gibsonville, Howland Flat, and several other places in that vicinity. Having burned the forest and being hemmed in by ridges and canyons not easy to cross, the miners, perforce, had to use the dead timber as far as it would go. After having used up the dead timber and finding a sapling growth slowly creeping into the chaparral, and needing fuel, they are cutting this small growth, not averaging 3 inches in basal diameter, thereby destroying all chance of reforestation in this locality. This extraordinarily close cutting foreshadows conditions sure to come in other localities, both in California and elsewhere in the timbered regions of the West, when the present forest shall have been laid low. The slopes on both sides of the main canyon have been logged throughout wherever accessible. Much has been cut to supply the mines at Sierra City and elsewhere in that region; much has been converted into fuel. Between Downieville and Bassetts on the North Fork of North Fork of Yuba River, and for a distance of 5 or 6 miles below Downieville, all the accessible timber on the canyon slopes below the 5,200-foot level has practically been cut off, while north of Bassetts the cutting has been carried up to the 7,000-foot level and 50 to 60 per cent of the timber taken.

On the areas south of the river, in the western portion of the basin, nearly all of the mill timber has been cut off. There is still remaining considerable fuel stuff and occasional blocks of timber of small dimensions, which, on a pinch, could be used for mill purposes. In the eastern districts the Shasta-fir forest along the divide between the North and Middle forks of Yuba has been logged

as far east as Milton Creek. Some of the timber has been used locally in the working of various mines situated on and near the summit of the divide, much of it has been skidded into the North Fork Canyon and used in the mines at Sierra City and adjacent districts. The cut on these tracts varies from 35 to 45 per cent. The merchantable timber yet standing in the basin in M feet B. M. is as follows:

Amount of merchantable timber in North Fork of Yuba Basin

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	110,000	80,000
Sugar pine.....	106,000	68,000
Shasta fir	450,000	295,000
Red fir	350,000	280,000
White fir	575,000	396,000
White pine	11,500	10,000
Patton hemlock.....	2,000
Total.....	1,604,500	1,129,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 2—less than 2,000 feet B. M. per acre.—(1) Main Canyon of North Fork of Yuba: Scattered yellow pine, sugar pine, red and white fir, all of small size, closely culled where accessible; some few small bunches of good timber on northern slopes, but mostly of small size and unfit for mill timber. (2) Central regions of Canyon and Slate creeks: Occasional yellow and sugar pine, red and white fir of small and slender growth, Shasta fir, all of inferior quality, damaged by fire to the extent of 60 to 70 per cent. (3) Upper Slate and Canyon creeks drainage: Region around Gibsonville, Howland Flat, Port Wine, and Morristown, scattered Shasta fir in dense chaparral, thin lines of same species with small quantities of white fir in the canyons, worthless for anything but fuel; Poker Flat, bunches and scattered trees of Shasta and white fir in chaparral and on barren rocky slopes with an average of 1,000 feet B. M. per acre. (4) Goodyears Creek drainage: In the lower area, yellow and sugar pine, red and white fir, incense cedar and oak scattered as single trees, thin lines or small groups in dense chaparral; in the upper area, Shasta and white fir of small size disposed in similar manner in chaparral or on barren rocky slopes, largely defective owing to damage by fires. (5) Upper areas of West Fork of North Fork, Middle Fork of North Fork and East Fork of North Fork of Yuba River: Scattered Shasta fir with small amount of white fir at the lowest elevations, occasional yellow pines throughout, white pine and small quantities of alpine

hemlock on the highest summits; 40 to 45 per cent of the timber defective owing to rot and fire scars. (6) Region north of Sierra Buttes: Shasta and white fir of small size and little value, occasional yellow pines stunted and gnarled in growth, white pine to the extent of 3 per cent, scattered trees of alpine hemlock at the highest elevations. (7) Region around Table Mountain: Shasta fir along crest of the divide, on the slopes mixed with white fir; all in dense chaparral or on rocky sterile soil; damaged by fire to the extent of 60 per cent. (8) From junction with Middle Fork of Yuba to Mountain House: Scattered yellow pine, slender growth red fir, occasional sugar pines, incense cedar and oak, all of inferior quality, the entire region having been closely logged many years ago.

Grade 3—2,000 to 5,000 feet B. M. per acre.—Areas west and north of river: (1) From junction with Middle Fork Yuba to Woodville Creek: Small quantities of yellow pine, but mostly red fir of slender growth; 90 per cent logged; set in thick stands of different species of oak; timber poor in quality. (2) From Woodville Creek to Canyon Creek: White and red fir to the extent of 70 per cent, incense cedar, small bunches of yellow pine and scattered sugar pine, the two latter species having been mostly logged off. (3) Slate and Canyon creeks drainage: In the lower portions yellow pine, sugar pine, white fir of medium quality but thin of stand owing to fires and rocky ground, red fir of slender growth; in the upper areas white and Shasta fir almost exclusively, much damaged by fire and extremely difficult of access. (4) North and northeast of Downieville: Below the 5,400-foot level, mixed forest of yellow-pine type, small yellow pine, scattered sugar pine of small growth, white and red fir of small size, with oak and incense cedar; above the 5,400-foot contour line, larger proportion of white and Shasta fir; at 6,000-feet and over, 80 per cent Shasta fir, white fir to elevations of 6,800 feet, white pine and occasional trees of Patton hemlock; timber poor throughout, 35 to 40 per cent defective, owing to damage by fire. (5) Drainage of South Fork of North Fork and North Fork of North Fork of Yuba River; tracts on the west slope of the main divide of the Sierra: Shasta fir to the extent of 60 to 75 per cent; white fir, 15 to 30 per cent at the lowest elevations; red fir and occasional sugar pines of medium dimensions; yellow pine scattered or in small bunches along the highest summits; white pine to the extent of 3 to 5 per cent; forest growing on rocky slopes, mostly with dense underbrush, difficult of access. (6) Ridges south of Downieville: White and red fir at the lowest altitudes, stocky yellow pines at the higher levels; white and Shasta fir, all in thick chaparral and damaged by fire to the extent of 15 to 20 per cent; all difficult of access. (7) From Mountain House to junction with Middle Fork of Yuba: Almost exclusively red fir of slender growth, set in places difficult of access; scattered trees of yellow pine, and in the western portion rarely a sugar pine; all mixed with oak and incense cedar and closely culled during many years.

Grade 4—5,000 to 10,000 feet B. M. per acre.—West and north of the river—(1) From junction with Middle Fork of Yuba to Woodville Creek: Small blocks of forest chiefly in ravines, 85 per cent red fir, balance yellow pine, all set in close stands of oak. (2) From Woodville Creek to Canyon Creek: In the western portions, small blocks of timber, chiefly red and white fir, remaining after logging; in the eastern area good stands of red and white fir, some yellow and sugar pine of large size, incense cedar and oak; all mixed with dense undergrowth and in rather open stands, average capacity between 8,000 to 9,000 feet B. M. per acre; readily accessible from South Fork of Feather River—North Fork of Yuba divide. (3) From Canyon Creek to Goodyears Creek: Forest of yellow-pine type with white and red fir of slender growth as chief species, and scattered yellow pine, with occasional sugar pine; timber of medium quality and in thin stands, owing to fires and rocky ground. (4) Basin north of Downieville: From 60 to 80 per cent Shasta fir, balance chiefly white fir, with scattered yellow pine, all much mixed with heavy undergrowth; fire damage from 20 to 60 per cent; region very difficult of access owing to deep, precipitous canyons. (5) Head of basin in the Sierra main divide: From 60 to 80 per cent Shasta fir, white fir, yellow pine as occasional trees, white pine at the highest summits; timber fair in quality, but in thin stands owing to rocky ground. (6) Area south of Downieville: Red and white fir as chief species, scattered yellow pine, occasional sugar pine; small blocks of medium heavy forest, usually in deep ravines or on flats high up on the ridges where access is difficult; timber of good quality.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Middle portion of Slate Creek drainage: Small quantities of Shasta fir, large percentages of white and red fir, 10 to 25 per cent of yellow and sugar pine; timber of good quality, most of it readily accessible; average capacity about 20,000 feet B. M. per acre. (2) Area west of Saddleback Mountain: A block of heavy, fairly well-preserved white and Shasta fir, 40 to 65 per cent of the former species, 35 to 60 per cent of the latter; extremely difficult of access; average stand 25,000 feet B. M. per acre. (3) Area northwest of Sierra Buttes: Shasta fir, 90 per cent; an occasional white fir, white pine, and Patton hemlock; damaged by fire to the extent of 10 to 15 per cent; medium growth in thick stands and very difficult of access. (4) Head of the basin in the Sierra main divide: Shasta fir, 60 to 70 per cent; white fir, 18 to 20 per cent; small quantities of yellow pine; 2 to 3 per cent of white pine on the higher ridges; timber of medium quality in close stands averaging 20,000 feet per acre. The Shasta fir in this block of timber runs from 2 to 5 feet in diameter and up to 100 feet in height, with clear trunks 35 to 55 feet in length. The tract is difficult of access owing to high position and depth of surrounding canyons.

FIRES

None of the region included in this examination has been so extensively scorched by fire as the basin of North Fork of Yuba River. Some of the basins, as, for example, that of Middle Fork of Feather River, show a relatively larger percentage of fire-marked forest, but none so large a proportion of badly burned. The forested areas and those covered with chaparral comprise 295,450 acres, of which 264,750 acres show distinct marks of having been visited by more or less severe fires within the life of the present forest. The area on which the forest has been badly burned—destroyed to the extent of 50 per cent and upward—comprises 131,500 acres, or very nearly 50 per cent of the fire-marked tracts.

Beginning in the western area of the basin north of the river, the timber is found to be fire marked throughout. In the sparsely forested region from the junction with Middle Fork of Yuba River to Woodville Creek the damage has not been extensive, here and there red firs have been scorched or killed and, occasionally, a few oaks and yellow pines burned up, the damage in the aggregate probably falling below 2 per cent. From Woodville Creek eastward to Canyon Creek, surface fires of moderate intensity have run through most of the heavy timber, destroying perhaps 4 to 6 per cent and leaving behind wide patches of heavy underbrush to mark their paths. East of Canyon Creek, beginning with the Shasta-fir forest, come the great burns of the basin. Throughout all of the central and upper areas of Slate and Canyon creeks, Goodyears Creek, and eastward to a line drawn south from Church Meadows to the junction of South Fork of North Fork of Yuba River and Milton Creek, the entire region is dotted with great tracts of burned forest. These burns are a direct continuation of the burned areas in the basins of the North and Middle forks of Feather River, and follow closely the course of the high granite uplift cutting through the region from northwest to southeast. The only reason for the exceptional fierceness and destructiveness of the fires here is that the Shasta-fir forest originally contained more inflammable humus and litter than the yellow-pine forests at lower altitudes and, hence, furnished the material for hotter fires. The amount of damage in this district varies considerably. On many large areas the forest has been entirely wiped out, in others only partially burned. Where the destruction has been complete it is impossible to state with any degree of accuracy the amount of forest destroyed, but the assumption that the heaviest forest grew on the tracts where the fiercest fires raged has, at least, a fair degree of reason for its acceptance. If such has been the case then fire has wiped out, since the American occupation of California, at least 90 per cent of the timber at that time standing in these districts.

As one travels east in this portion of the basin, the western edge of the large and destructive burns are met near Lexington Hill and Union Hill. Here the yellow-pine type of forest joins that of the Shasta fir, and the fires burning in the

latter have spread into the regions of the former, destroying especially the white and red firs. The forest shows the work of the fire in thin stands and numerous patches of dense brush without timber, covering 4 to 50 square rods of ground. Coming into the Shasta-fir forest, chaparral-covered hillsides appear at frequent intervals. Some are burned entirely clear of forest, not a tree remaining, only a uniform and level-topped mass of manzanita, chinquapin, scrub oak, and ceanothi, showing where forest once grew. In other places, as in the region around Gibsonville, single trees, thin lines, small groups, or scattered stands rise from the mass of chaparral. In other localities, as around Howland Flat, and between this point and Poker Flat, as well as on the divides around Fir Top Mountain, Saddleback Mountain, and Deadwood Peak, much of the fire-killed timber still stands in the midst of chaparral. In the scorched or partially burned stands the remaining trees are scarred by the fires, many lie prostrate, some are still standing, and everywhere are trees in various stages of decay due to damage received in the fires. Along the higher summits in this part of the basin half-burned tracts of forest alternate with the characteristic chaparral. At the highest elevations the burned tracts are either wholly bare of vegetation, save for a few coarse weeds, or they are covered with dense thickets of a spinescent species of ceanothus (*Ceanothus cordulatus*), or, rarely, bear a young growth of forest, restocking after the fires. Toward the head of the basin the fires have not been so widespread or destructive. Some tracts have entirely escaped, but other portions, particularly the frontage of spurs abutting on the larger canyons, have been entirely stripped of timber and now bear broad patches of brush instead.

The southerly extension of this line of burns crosses the main canyon of North Fork of Yuba River south of Sierra Buttes. Thence, ascending the divide between North and Middle forks of Yuba, it closely follows the range of the Shasta fir westward, having destroyed every vestige of forest in some places, in others sparing small groups or stands and leaving the crest of the ridge, with many of its slopes, dotted with broad expanses of chaparral. In the interval between the destruction of the forest and the ascendancy of the brush, much of the soil on the denuded hillsides in this region of the basin has slid into the canyons, together with quantities of gravel and loose boulders.

The damage traceable to fires has, apparently, not been very great south of the river in the yellow-pine type of forest, but as nearly all of the old timber has been cut in this district and much of the area turned up by the placer miners or converted into agricultural land, the amount of forest destroyed by fire can not be ascertained. Beyond small tracts burned over by light surface fires in the region east of Woodville Creek, the eastern slopes of Oregon Hills, and here and there throughout the yellow-pine areas south of the river, there have been no forest fires in the basin within the past three or four years. Several chaparral hillsides near

Lexington were burned over during the past summer, the fires presumably spreading south from tracts fired by sheepmen on the ridges between Middle and South Fork of Feather River canyons.

REPRODUCTION.

Restocking in the basin is evidently a matter requiring long periods of time, at least in the Shasta-fir type of forest. Throughout all of the badly burned districts south of Downieville there is not even a fair beginning. As elsewhere in these portions of California, where the chaparral covering as a sequence to fires has once obtained a firm foothold, centuries will probably be required before the restocking process succeeds in fully covering such tracts with forest growth. In some localities, as in the region around Gibsonville, exceptions occur. On this particular area Shasta fir was observed to spring up abundantly in dense brush stands of *Ceanothus velutinus*, wild cherry, and manzanita, but such cases are rare, and where in this basin the brush growths have once obtained a firm lodgment restocking consists chiefly in a scattered sapling growth around the outer edges of the brush. The young growth consists wholly of the same species that grew there before the fire, Shasta fir being as a rule the leading species; occasionally small stands are found where the Patton hemlock constitutes most of the growth. However, such tracts are rare and occur only on the highest crests, practically above the altitudinal limits of the chaparral.

The logged areas in the western portion of the basin are restocking abundantly, except where the ground has been turned up by the placer miners and the soil washed away from the underlying sharp, unproductive gravel and boulder drift. In such localities there is either no restocking or the young growth is small and scattered; but where the soil has remained undisturbed restocking is dense and luxuriant. The species composing it are yellow pine, red and white fir, incense cedar, and sugar pine. The first-named species is the main component, while the red fir and incense cedar are about equal. As compared with the old forest, yellow pine and incense cedar are present in relatively larger proportion, the red fir about the same and the sugar pine in much lesser ratios.

CHAPARRAL

The chaparral in the North Fork of Yuba Basin does not materially differ in composition or density from that in the Feather River Basin. In the lower areas of the yellow-pine forest, where the timber was removed by fire, the chaparral chiefly consists of manzanita (*Arctostaphylos glauca*). In the upper areas of the same type of forest, where it has been thinned by fire and the undergrowth thereby increased, most of the brush belongs to various species of *Ceanothus*, and collectively are termed "buck brush" by the inhabitants. The species normally belong to the ordinary thin undergrowth which is everywhere present in the

unburned forest of the region, and only appears in masses dense enough to be termed chaparral as a sequel to fires. In the Shasta-fir forest the leading species composing the chaparral are manzanita (*Arctostaphylos patula*), chinquapin, scrub oak, one or two spinescent species of ceanothus, and in some localities dense thickets of wild cherry.

BASIN OF MIDDLE FORK OF YUBA RIVER.

TOPOGRAPHY.

Middle Fork of Yuba River drains a smaller area than any other of the Yuba forks, its basin comprising in round numbers 150,000 acres. It heads in the main divide of the Sierra opposite Little Truckee River. Its source lies at elevations ranging from 7,000 to 8,400 feet, in a region remarkably deficient in water-shedding capacity. The upper portion of its canyon is comparatively shallow; its bottom is a succession of grassy or sparsely timbered, gravelly, and boulder-strewn flats, the southern walls of the canyon rising steeply from the bottom, the northern sloping back in a series of narrow, rocky terraces. The gorge-like portion of the canyon begins a short distance below Milton. Its bottom is here from 1,500 to 2,000 feet below the summits of the inclosing ridges, and the channel is a mere narrow trough between perpendicular or very steep cliffs. Three or 4 miles above Emory Ford the canyon walls recede and the gorge becomes more open, with only here and there steep projections, continuing in this manner to its junction with South Fork of Yuba. The topography of the basin is one of great simplicity. Practically it consists of two narrow parallel ridges inclosing the canyon. The total width of the basin in a direct line from crest to crest of the inclosing divides is, in the eastern portion, from 3 to 4 miles; in the central and western from 4 to 6 miles. Naturally there is not room for the development of a large system of lateral canyons in this narrow space, and in consequence the stream receives few tributaries, only one of which, Oregon Creek, attains any considerable length or importance as a water carrier. This creek bisects longitudinally the divide on the north of the fork from Forest to near its junction with North Fork of Yuba. The next stream in importance is Kanaka Creek, between Oregon Creek and the main canyon of the Middle Fork, cutting the same ridge in much the same manner as Oregon Creek. Both of these streams flow through deep, gorge-like canyons.

SOIL.

The soil in the upper portion of the basin consists chiefly of coarse sand and gravel mixed with boulder drift, and overlain with a thin layer of mold, except in the hollows where deeper deposits have washed in from the surrounding slopes. In general the soil on the slopes in the upper portion of the basin is thin and

unproductive, while on the flats and broad summits of the ridges it attains a fair depth. In the central and western areas the common red soil prevails; on the steep slopes it is thin or altogether lacking; on the border summits of the ridges it is often of great depth, 8 feet or more, resting on deep deposits of sand, gravel, and boulder drift, the so-called "old channel deposits," or directly on the bed rock. Where plentifully supplied with moisture the red soil appears to be excellently adapted to the production of heavy stands of forest.

MINING.

The entire basin, with the exception of small portions along the upper areas, is auriferous and has been extensively mined for many years. All the gravel and boulder drift near the summits of the divides both north and south of the river contains placer gold, and has been extensively worked in numerous localities by the hydraulic method. Since the closing down of these mines the region has lost much of its former importance as a placer mining district. Considerable quartz mining is carried on in the region around Forest Hill and Alleghany City, and some years ago much labor was expended on the quartz leads in English Mountain, near the heads of the basin, without any tangible result.

AGRICULTURAL LAND.

The eastern and central areas of the basin contain no agricultural land, but in the western districts there are numerous small tracts of land devoted to the raising of fruit, mostly apples, small quantities of grain, hay, etc., and to general gardening. These tracts consist wholly of land originally covered with forest. The total area of agricultural land under cultivation in the basin is 6,850 acres. Much land of this class is not very well cleared, old and young trees remaining in most of the fields; considerable areas are cultivated only in the most perfunctory manner. While the western area is generally of low relief, and contains much land having a gentle slope, near the summits of the ridges, the region is not well adapted to agriculture. The red soil can not be stirred very deeply or very often on any sort of slope, no matter how gentle, without risk of gullying and of the ultimate disappearance of all of it into the bottoms of adjoining ravines and canyons.

PASTURE.

The pasture areas of the basin comprise about 1,200 acres and consist of small, grassy flats, through which the river runs in the upper portion of its canyons. All portions of the basin are utilized as pasture ground, the central and eastern portions for cattle and sheep, the western almost wholly for cattle. The eastern districts contain, in addition to the swale lands in the bottom of the main canyon, small glades, open park-like stands of lodgepole pine, and, on the

southern slopes of the canyon, open, sparsely timbered stretches covered with sage brush and scattered tufts of grass. All of the herbage on these tracts that can be consumed by cattle or sheep is very closely pastured off each season. The western area of the basin contains practically no grass outside the inclosures.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE.

Most of the basin consists of lands classed as forested, only the extreme end of the western areas being wooded. The two classes of land comprise 127,230 acres, or, with the chaparral lands once timbered and again capable of producing forest, 141,230 acres, or 96 per cent of the areal extent of the basin. The acreage of the forested and wooded tracts is as follows:

Area of forested and wooded tracts in Middle Fork of Yuba Basin

	Acres.
Forested	124,630
Wooded	2,600
Total	127,230

The wooded tracts of the basin begin at the junction of the Middle Fork with South Fork of Yuba and continue up the river about 4 miles. They include scarcely anything but the direct slopes of the main canyon, though in some places they stretch back short distances from the upper margins of the canyon. The forested tracts begin on top of the bluffs lining the canyon at Rice's Fork and, a short distance up the river, extend downward to the bottom of the canyon, continuing without break to the head of the basin. Both forest types are represented. The yellow-pine type follows the north side of the main canyon, on the slopes facing north, and ends near Milton. Its altitudinal limit is generally 5,500 feet on the northern slopes and summits of the ridges, and 6,000 feet on the southern. Directly above it the Shasta-fir type begins and covers all of the higher slopes and summits. The acreage of the two forest types is approximately as follows:

Acreage of yellow-pine and Shasta-fir types in Middle Fork of Yuba Basin.

	Acres
Yellow pine	97,230
Shasta fir	30,000
Total	127,230

CHARACTER OF FOREST.

The small amount of wooded area may be noticed under this heading. It consists of thin stands or isolated trees, with a fairly uniform distribution of Digger pine, various species of oak, and small yellow pines.

In the western portion of the basin the yellow-pine type begins with scattered yellow pines, here and there a Digger pine, considerable quantities of oak, and, in the ravines leading down to the canyon, red fir of slender growth. At elevations of 2,000 feet the Digger pine thins out and disappears, while incense cedar begins to form a noticeable percentage of the stands. The type is almost wholly a young growth—25 to 45 years old—restocking after close and exhaustive logging during many years. It occurs partly in extremely thick stands, partly in thin and scattered groups, broken by long, broad, bare stretches of *débris* created by hydraulic mining operations, or by brush growths, the result of fires in the young stands. It is occasionally mixed with small stands of middle-aged forest, the remains of the original growth. At Grizzly Ridge, south of the river and near the head of Kanaka Creek, north of the stream, scattered bodies of old forest still remain. The timber in them is only second rate, the best having long since been cut. From Snow Tent to Graniteville most of the timber is old growth. A large amount, fully 55 per cent, is of white fir, the rest is red fir, yellow pine, incense cedar, and sugar pine, named in order of abundance. On the summits of the ridges these stands present an open appearance, except where fires have invaded them, and then they are choked with dense masses of brush and littered with much fallen timber, owing to the large percentage of white fir. On the slopes south of the canyon in the central area thin stands, culled where accessible, alternate with heavier blocks of forest in situations difficult of access, all with heavy growths of underbrush, while near the canyon bottoms, owing to the rocky slopes, the timber is extremely thin, much of it, on the lowest 400 or 500 feet of slope, consisting chiefly of small oak. In the central area north of the river, the old and middle-aged stands are composed chiefly of slender red fir, while yellow pine occurs sparingly here and there.

At the head of Kanaka Creek the yellow-pine forest ceases to be a factor in the timber on the summits and upper slopes of the ridges, being replaced by Shasta fir. Eastward, beyond the head of Kanaka Creek, it is confined to the slopes having a southern exposure and to the bottom lands of the main canyon. The stands from here to the head of the basin are very thin, owing to rocky ground and the extensive burns, and above Milton contain, in addition to the usual species of trees composing the yellow-pine type of forest, a noticeable amount, 2 to 3 per cent, of western juniper. The stands are here mixed with dense patches of undergrowth and in some places are scattered over semiarid slopes—extensions from the dry regions of Truckee River Basin—as evinced by the broad stretches of sage brush which flourish on them. On the sides of the main canyon having northern exposures the yellow-pine type of forest ceases 6 or 8 miles above Graniteville.

With the exception of tracts around Graniteville, the yellow-pine type of forest in the basin is of poor quality, being composed largely of culls of red and white fir, small-sized yellow and sugar pine, incense cedar of no commercial value owing to worm holes, oak of which the larger proportion of old or middle-aged individuals is rotten at the center, and sapling growths not yet advanced beyond the pole stage. In the region around Graniteville the yellow-pine forest consists of blocks of old-growth white fir, yellow and sugar pine, the two latter species forming 10 to 20 per cent of the timber, occasional red firs, and, as it lies contiguous to the lower edge of the Shasta-fir forest, more or less of that species intermixed. This block of timber is of good quality and represents a growth from 150 to 250 years old.

The Shasta-fir forest north of the river, from the head of Kanaka Creek to the ridges just above Milton, is mostly patchy in its distribution. Extensive fires have swept through it, burning up 60 to 70 per cent, damaging the remainder, and filling the stands with dense undergrowth. From Milton to the head of the basin there are continuous close stands of good quality Shasta fir in localities where the slopes are provided with deep soil and plenty of seepage, or open stands where the soil is thin and the bed rock comes close to the surface. At the head of the tributaries which have their rise just south of Webber Peak the forest is broken by basaltic outflows bare of soil and vegetation, or by dry, semiarid slopes covered with a close, low growth of sagebrush.

South of the river and east of Graniteville, the Shasta-fir forest occurs in long, close stands, here and there separated by thin lines of small, scattered groups of trees standing in dense underbrush. On the slopes of the main canyon, extending eastward to a point within 3 miles of English Mountain, the stands are heavy, often of large growth, the Shasta fir reaching dimensions up to 5 feet in diameter at the base. Mixed with the Shasta fir, along the lower level of these slopes, are considerable quantities of large-size white pine, while near the edge of the canyon bottom there is a fringe of park-like lodgepole pine stands which continues beyond English Mountain to the head of the basin, occasionally dotting the grassy levels and wet glades in the upper portion of the basin. On the summit of the ridges between Findley and Pinoli peaks Shasta fir occurs in close and heavy stands, having 75,000 to 100,000 feet B. M. per acre. Such stands occur only in the saddles of the ridges at the head of some stream where the soil is deep and seepage plentiful. The timber in them is from 200 to 275 years old and, singularly enough, has totally escaped being scorched by fire. These heavy blocks of forest cover only small tracts, not more than 20 to 40 acres in any one locality. They are separated by areas where the timber is thin and scattering, owing to rocky soil or fires.

LUMBERING

The lumbering operations have mostly been very simple. The western area has been cut over as fast as the timber was needed or could be marketed, and 95 per cent of the timber has been cut. What remains are largely culls of yellow pine, red and white fir, or occasional small stands of medium quality yellow pine and red fir, situated on steep slopes, difficult of access, or on flat tops of ridges; that belonging to persons who have not seen fit to log it closely is also standing. From Grizzly Ridge to the region around Snow Tent the cut varies from 30 to 75 per cent, the smaller proportion due to the presence of large quantities of white fir, an undesirable species, which has remained uncut. However, it is now being logged. The cutting near Graniteville, in progress at the present time, is necessarily selective. The haul to a market is so long that only sugar and yellow pine can be logged at a profit. North of the river the cut has been 95 per cent as far east as Alleghany. Culls of yellow pine, red and white fir, incense cedar, and oak remain as on the south side of the river. From Alleghany east to American Hill the cutting has largely been to supply the local demand for mine timber, building purposes, and fuel, and has been quite close except in the rocky gorges which abound here. Most of this cutting has been in the Shasta-fir forest. Elsewhere in the basin the Shasta fir has not been logged. The quantity of merchantable mill timber standing in the basin, in M feet B. M., is as follows:

Amount of merchantable mill timber in Middle Fork of Yuba Basin

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	100,000	58,000
Sugar pine	35,000	30,000
Shasta fir	375,000	250,000
Red fir	95,000	45,000
White fir	125,000	75,000
White pine	14,000	2,800
Patton hemlock	500
Total	744,500	460,800

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—From junction with South Fork of Yuba to entrance of North Fork of Yuba: Small size Digger pine and oak, scattered yellow pine, mostly in the sapling stage; much underbrush in creek bottoms and on top of the bluffs bordering the main canyon; very sparse growth of trees on the lower canyon slopes.

Grade 2—less than 2,000 feet B. M. per acre.—(1) From French Corral eastward along main divide south of the river to Relief Hill: Scattered yellow pine and red fir in western area; the same in the eastern section with the addition of white fir and incense cedar; large quantities of oak throughout, easy of access, but consisting chiefly of culls remaining after close logging. (2) From junction with North Fork of Yuba eastward along main divide north of the river to region around Nigger Tent: Timber same as in section 1. (3) Western and central portions of main canyon: Yellow and sugar pine, red and white fir, incense cedar; timber poor in quality and thinly scattered over steep, rocky slopes; large quantities of small-sized gnarled oak on lowest slopes and in canyon bottom. (4) Eastern portion of main canyon: Scattered yellow pine on lowest slopes, growing on rocky ground, and of inferior quality owing to stunted growth and damage by fire; on northern slopes Shasta fir and white pine mixed, in park-like stands of lodgepole pine. (5) Region around English Mountain. Scattered Shasta fir, white pine, occasionally a white fir; all growing on rocky cliffs, difficult of access, and poor in quality; here and there culled.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) From Birchville to Relief Hill: Small blocks of mixed forest, chiefly red fir of slender growth, not so closely culled as the adjoining areas of grade 2. (2) Relief Hill to region around Shands: White fir to the extent of 60 per cent, often of large size, 3 to 4 feet in diameter, 90 to 120 feet in height; small quantities of yellow and sugar pine, mostly logged off where accessible; red fir and incense cedar, small quantities of oak; most comparatively easy of access. (3) Upper portion of basin: On slopes with southern exposures, 5 to 10 per cent yellow pine, balance white and Shasta fir; on slopes with northern exposure and on summits of ridges, 65 to 75 per cent of Shasta fir, white pine, occasionally yellow pines and white fir; timber fair quality; areas difficult of access from outside, but most portions readily accessible locally; stands thin, owing partly to rocky and barren soil, partly to fires. (4) Central and western portions of the basin. Around American Hill and Alleghany, chiefly white and Shasta fir of poor quality, owing to damage by fires and culling of the timber for local use; in the canyons, red fir of slender growth, white fir, and scattered yellow pine, together with large quantities of scrub oak; west of Alleghany, yellow pine, red and white fir, incense cedar, and oak; all culled many years ago.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Grizzly Ridge and eastward to Shands: White fir, 50 to 65 per cent; yellow and sugar pine, 10 to 15 per cent; red fir from 2 to 4 feet in diameter, incense cedar, and oak; timber of medium quality, showing fire marks, and 45 per cent of white fir badly damaged; about 50 per cent readily accessible, balance growing on steep northern slopes and difficult to reach. (2) Region west of Graniteville: 70 to 75 per cent Shasta fir, balance white fir with

scattered yellow and sugar pine, and some red fir along the breaks to the canyons; 25 to 35 per cent of the Shasta fir defective from fire sears. (3) Eastern portion of basin: Chiefly Shasta fir, yellow pine in small scattered bunches or as single trees on slopes with southern exposures, small quantities of white fir, and along the highest summits and on northern slopes, white pine.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Region around Pinoli and Findley peaks: Shasta fir 75 to 90 per cent of large size and generally good quality; white fir, 2 to 30 per cent of white pine; scattered yellow pines of stocky, gnarled growth. (2) Area north of the river from Milton eastward: Chiefly Shasta fir; 5 to 10 per cent yellow pine, white fir, and incense cedar; 10 to 15 per cent damaged by fire.

Grade 6—over 25,000 feet B. M. per acre.—(1) Region around Pinoli Peak. Shasta fir of moderate dimensions, 2 to 4 feet in diameter, 90 to 100 feet in height, with clear trunks 30 to 50 feet in length, set in very close stands of pure growth and not damaged by fire; difficult of access from the outside, but not hard to reach locally.

FIRES

The Middle Fork of Yuba Basin is fire marked throughout nearly all of its forest-covered tracts, as well as in the woodland sections. The only districts which have escaped are rocky slopes, wet glades, and the small areas near Pinoli and Findley peaks carrying the remarkably heavy stands of pure growth Shasta fir alluded to in the description of the grades of timber. The fires have not been nearly so destructive as in the adjoining North Fork of Yuba drainage, the great burns of this and of the Feather River basins having decreased in intensity and destructive force along the north bank of the Middle Fork of Yuba Canyon. The acreage of the burns is as follows.

Burned areas in Middle Fork of Yuba River Basin

	Acres
Fire marked	133,530
Badly burned.....	26,050

As the total area is 141,230 acres, it follows that the fire-marked tracts cover somewhat over 94 per cent, while the badly burned tracts comprise not quite 6 per cent.

In the western area of the basin north of the river the woodlands and forest have been swept by fire throughout, but as the forest is of the yellow-pine type the damage has not been extensive except as regards the white-fir, which has suffered severely, probably 20 to 25 per cent in the aggregate having been destroyed. Near Mountain House, where the Shasta-fir forest sets in, the big burns begin to appear. They are extensions from the fire-swept districts of North Fork of Yuba Basin, having followed the divide westward from opposite Sierra City. These fires burned fiercely along the summit of the divide and down its southern

slopes to the river, continuing eastward to the head of the basin, where they crossed into the Truckee River and South Fork of Yuba drainage, or joined tracts already burned there. East of Milton they were not nearly so destructive, merely burning a narrow lane here and there through the timber, or giving the Shasta fir and lodgepole pine stands a uniform scorching; the damage aggregating 20 to 25 per cent. Around Forest Hill, Mountain House, Alleghany, and generally throughout that neighborhood, the destruction varies from 80 to 100 per cent. The hillsides have been swept bare over large tracts, and are now covered with chaparral. South of the Middle Fork Canyon the region of the yellow-pine forest is fire marked and damaged very much as in the corresponding areas north of the river, to a point just beyond Bloomfield. From here on, eastward to Shands, the timber is composed largely of white fir, probably to the extent of 60 per cent, and long swaths have been burned in all directions through these stands of low fire-resisting capacity. Most of the fires which have burned here are of recent origin, while those north of the river date back to the early mining days. At Graniteville, where the Shasta-fir forest begins, the burns from north of the river come in and extend eastward, having destroyed 30 to 50 per cent of the Shasta and white fir. The destruction, however, has not been so complete as north of the river. While enough has been consumed to open up the originally dense forest stands to heavy chaparral growths, there still remain scattered heavy bodies, small groups and lines of timber extending in all directions through the brush growth. From some cause the older fires seem to have died out before doing much damage in the upper area of the basin south of the river, and most of those which have run through the forest in these districts have been of recent origin, in the majority of instances probably due to sheepmen.

As it is impossible to know at this date the exact condition of the forest destroyed by the larger and older burns in the basin, an attempt to place the aggregate damage due to fires is more or less a matter of guesswork. But assuming a tolerable uniformity in the burned stands of Shasta fir, and taking their average capacity as closely represented by grade 4 in the present classification, there has been destroyed by fire in this type of forest at least 500,000,000 feet B. M. of timber. In the yellow-pine forest the damage has not been so extensive and has been mostly confined to the white fir. Of this species from 40,000,000 to 50,000,000 feet B. M. is an estimate probably under rather than over the true amount of timber burned.

The origin of the older fires is involved in more or less doubt. Probably prospectors and miners are responsible for many; not unlikely sheepmen burned the forest in the early days of their occupancy, just as they now do, only on a larger scale. Fires observed last summer eating into the very heavy stands of Shasta fir in the region of Pinoh and Findley peaks had, in every instance, a sheep camp for their center.

REPRODUCTION

Restocking of burned and logged areas in this basin is proceeding along lines similar to those noted in the North Fork of Yuba Basin. In open unburned stands of Shasta fir there is even balance between old and new growths, enough of the latter springing up to replace the natural decay of the former. In heavy stands of pure growth of this species there is practically no young growth of any kind. Where the type has been badly burned, lodgepole pine often springs up around the margins of glades and streams and forms fringes more or less thickset. Where this kind of forest has been burned so severely that chaparral growths have resulted there is little or no restocking. As a rule, Shasta fir is the prevailing species in reforestation, whether the areas have been logged or burned, just as it is in the unburned forest. The percentage is sometimes higher, because the scattered yellow pine which originally existed in the stands does not again readily come in as a young growth on these tracts; sometimes it is less, owing to an ascendancy of lodgepole pine. There is, in the basin, one marked exception to this rule. It occurs near Alleghany on some of the hillsides deforested partly by fire, partly by the ax. Here restocking consists almost exclusively of oak, probably California black oak, with hardly a conifer and but little brush growth. This example is the only one of its kind observed in all of the region under examination. Restocking in the yellow-pine forest is exceedingly abundant where logging operations removed the original timber. Yellow pine constitutes the principal species. Next in abundance come red fir, incense cedar, white fir, and sugar pine. The percentage of sugar pine is clearly less than in the original growth, due, in large measure, to the more exhaustive cutting of this species, while almost everywhere incense cedar is more plentiful than formerly, owing to the larger number of seed trees left uncut and to the circumstance that no species of trees in this region seed so abundantly as the incense cedar. On the old placer diggings, where hand mining was the method followed, a thin growth of yellow pine and red fir is creeping in. On the débris heaps left by the hydraulic miners much of the ground is not restocking, while some portions are showing a thin and scattered growth, all depending on the time that has elapsed since the miners suspended operations.

On the whole, the yellow-pine forest is restocking with stands relatively much more thickset, but not greatly differing in composition from those logged, while reproduction in the Shasta fir stands falls far short of replacing the waste due to fires and excessive sheeping.

CHAPARRAL

The chaparral in the basin, in its general features, is similar to that in the North Fork of Yuba drainage, and in every instance owes its origin to fires. Where fires have swept through the lower areas of the yellow-pine forest and consumed the

timber, a heavy growth of manzanita (*Arctostaphylos glauca*) has followed as a sequel. In the woodlands fires have given rise to heavier and more extended masses of undergrowth, mostly *Ceanothus cuneatus*. In the upper areas of the yellow-pine forest, especially where white fir constituted the principal species, heavy masses of brush growth composed of species of ceanothus, scrub oak, and manzanita (*Arctostaphylos patula*) form a chaparral cover on the denuded or partially denuded tracts. In the present Shasta-fir forest, and on areas covered by this type anterior to the time of the big burns, the chaparral and undergrowth consist of manzanita (*Arctostaphylos patula*), scrub oak, and ceanothus. When three-quarters of the timber has been burned the chaparral is exceedingly dense; where the damage from fire has been less it forms a heavy undergrowth. At the head of the basin, on the divide against Little Truckee River drainage, chaparral is almost lacking. In its place there is a low, uniform growth of sagebrush with small amounts—one or two species—of *Chrysothamnus*, unmistakably showing the aridity of this part of the basin, notwithstanding the fact that it carries stands of Shasta fir.

BASIN OF SOUTH FORK OF YUBA RIVER

TOPOGRAPHY.

Next after the basin of the North Fork of Yuba in areal dimensions comes that of the South Fork of Yuba, comprising nearly 280,000 acres. The stream rises in the main Sierra, its most southern heads lying in the northern slopes of Mount Lincoln a few miles south of Donner Pass, its northern tributaries taking their rise on the southern slopes of Mount Lola, about 10 miles north of that pass.

Its drainage basin falls into two natural divisions, an eastern and a western, which differ in relief features. The eastern district consists of a high, elevated region formed of the main divide of the Sierra and its direct westerly spurs. All the eastern portion of the basin has been subjected to extensive glacial erosion. Lakes and ponds abound, all situated in hollows scooped out by ice in the granite. Most of these lakes connect with the main South Fork canyon through creeks sunk in deep canyons, and constitute an extensive system of natural reservoirs. Most of the drainage of the eastern district lies north of the main canyon of the South Fork, only a trifling portion entering from the south. The section of the main Sierra which forms the head of the basin is rocky and barren, most of the spurs in the northern areas beginning with broad summits and easy slopes. South of Donner Pass it is different, the northern slopes of Mount Lincoln forming imposing precipices and escarpments. At a distance of 3 or 4 miles from the main range, between Castle Peak and Mount Lola, the wide summits and easy slopes of the spurs change into narrow crests and steep declivities, while the larger canyons contract and become gorge-like in some places, in others

widening and holding small lakes. West of Summit City, and extending to the brink of Canyon Creek, the country is a broad sheet of granitic rock, cut in all directions by a multitude of deep and narrow canyons and gorges. Rising here and there from this area are high peaks and ridges, such as Old Man Mountain, Black Mountain, English Mountain, and others, their sides and summits without arborescent vegetation, precipitous and ragged, torn and gashed by the ice masses which once covered them, in some places a wall of rock rising abruptly a thousand feet or more, in others a slope covered with great blocks of granitic talus and bare of every vestige of vegetation excepting mosses and lichens. This rough granite region crosses the South Fork of Yuba near Cisco Butte, and, continuing in an easterly direction, forms the frowning precipices of Devil Peak, with its southern extremity, Snow Mountain. Excluding the main range, the eastern portion of the drainage basin has a mean elevation of about 7,200 feet. A number of its summits rise to an altitude of 8,400 feet. The main range at the head of the basin has a mean elevation of somewhat over 8,300 feet. Mount Lola reaches 9,170 feet, and Castle Peak 9,140 feet. These peaks, as well as Mount Lincoln, south of Donner Pass, with an altitude of 8,400 feet, carry snow on their northeastern slopes throughout the year.

The western areas of the basin, aside from the canyon system, consist of two ridges which pursue a course nearly parallel to the canyon of the river. The northern ridge forms the divide against the Middle Fork of Yuba; the southern separates the waters of the main Yuba River and Bear River from those of the South Fork of Yuba. The ridge north of the river, from Shands westward, is broad and plateau like, while between Shands and Graniteville, where the ridge leaves the rough granite areas of the eastern part of the basin, it is a mere hogback, sloping sharply down on either side and forming deep canyons. The ridge south of the river is much broader than the northern one, but is so cut into by lateral canyons that its summit is comparatively narrow, rarely exceeding 500 to 600 yards.

The main canyon of the river begins about 1 mile west of Donner Pass, in a grassy flat $2\frac{1}{2}$ miles long and one-half mile wide, called Summit Valley, recently converted into a storage reservoir. Thence west for a distance of 5 miles the valley is narrow with a flat bottom. Beyond this the canyon walls approach each other, and the bottom is covered with huge granite blocks or intersected by rocky ledges stretching from side to side. The gorge of the canyon begins a few miles above Langs, a point about $1\frac{1}{2}$ miles north of Emigrant Gap station. From Langs to the mouth of Canyon Creek the river has cut a narrow chasm 2,000 feet in depth through the granite. The canyon walls stand up in immense, bare, nearly perpendicular cliffs, and the river rushes foaming over masses of huge granite boulders. Below the gorge the river flows in a narrow canyon, like that of the other Yuba

River forks, 1,000 to 1,500 feet in depth. Most of the drainage entering the river from the rocky areas west of Summit City flows through Canyon Creek, a stream sunk in a precipitous gorge, scarcely inferior in depth to that of the main river, having walls 1,000 to 1,800 feet in height all the way from Bowman Lake to its junction with the main river. This canyon and the next one west, that of Poorman Creek, run in parallel directions, only 3 or 4 miles apart, and are remarkable for the great depth they attain in the short distance of 6 to 8 miles from their point of origin.

SOIL.

The eastern area, having been subject to intense glaciation, has a soil consisting of the *débris* ground out of the granites and other rocks of this region. This soil is generally thin and poor, owing to its gravelly character and small proportion of mold. Nearly one-half of this portion of the basin has no soil covering whatever, the naked rock cropping out over large tracts. Areas of this character are prominent in the districts around Summit City, at the head of North Creek, on the slopes of Castle Peak, Mount Lincoln, and Devil Peak, and adjacent to Cascade Lakes. Here, as elsewhere in the region examined, the hollows and larger flats possess a deep soil, representing the accumulations derived from adjoining slopes. The western section of the basin has, on the flats of the ridges, the common red soil of the lower western slopes of the Sierra in this latitude, in some places resting on the bed rock, in other localities overlying deep deposits of gravel, sand, and boulder drift. The lowest slopes of the main canyon are generally rocky, with a very thin soil.

MINING.

The western portion of the basin is noted for its rich and extensive placer deposits, which have been worked since the early days of gold discoveries in California. Since the introduction of hydraulic methods the auriferous gravel beds west of a line drawn north and south through Maybert to a junction with Middle Fork of Yuba have been torn up in all directions by the hydraulic giants. Vast masses of *débris* have resulted. Some of this still lies on the flats and slopes in irregular heaps of coarse gravel, small rocks, or boulders. Much stands up in huge bluffs 50 to 150 feet in height, slowly caving out in the process of acquiring a permanent slope, while the smaller streams are choked with finer *débris* gradually sliding into the main river. The placer deposits that extend east into the Fall Creek Mountains are of small consequence and are mined by hand. Quartz mining is carried on in both the eastern and western parts of the basin. Much work of this kind has been done in the region around Summit City, but has not been productive of permanent or valuable results. There is no mining at the head of the basin on the immediate slopes of the main divide of the Sierra.

AGRICULTURAL LAND.

The eastern portion of the basin contains no agricultural land. In the western portion are tracts cleared of forest and converted into agricultural holdings. They begin west of the small town of Washington. Some of these lands are situated in the bottom of the main canyon and consist of a few acres to each holding, producing vegetables and fruit, but most of the agricultural tracts are located on the flat summits of the divides west of Galbraith. None of the clearings are large except those between North San Juan and French Corral, where tracts containing 60 acres or more are under cultivation. The bulk of the land cleared and cultivated is situated in the district just specified. The total area under cultivation is 9,950 acres. A large percentage of these clearings still bears some timber, single trees and small groups remaining in many of the fields. Much of the land under cultivation is tilled in a slovenly and intermittent manner. Here, as elsewhere, the fine, loose texture of the red soil is a serious drawback to its cultivation on any sort of a slope, owing to its tendency to wash, even with moderate rains.

PASTURE.

All of the basin, wherever accessible, is used as pasture ground for cattle and sheep. The western portion is poorly provided with grass, and, except for local use, is not grazed to any considerable extent. The principal pasture areas are situated in the eastern portion of the basin. The rocky granite regions around Fall Creek Mountains, English Mountain, and Summit City contain many small glades, while grass fringes most of the lakes. This region is closely pastured by cattle and sheep driven in from the Sacramento Valley with the opening of spring. The higher elevations in this district have been extensively burned, and being situated above the line of heavy brush growth, coarse weeds and scattered tufts of grass have replaced the burned timber. This browse is pastured down each summer. From Summit City to the crest of the main range small glades are numerous. Some of them border creeks and ponds; others are fire glades. All such tracts are pastured and trampled over by big bands of sheep each summer, practically every blade of grass large enough to be bitten off being consumed before winter sets in. Some tracts like Summit Valley are under fence, and in some seasons are utilized for hay, in others for pasture.

The natural meadow tracts in the basin not capable of producing forest owing to their marshy character contain about 3,970 acres.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

The wooded tracts in the basin comprise about 4 per cent of the total area, or 11,880 acres, and occur in the western portion from the junction of the river with

Middle Fork of Yuba to the head of Rush Creek; east of French Corral they are limited to the south side of the river and the bottom of its canyon. They are situated below 2,000 feet, but do not cover all areas in the basin having this elevation, their extension and limitation depending on features connected with the annual precipitation.

The forested tracts occupy most of the western, all of the central and eastern portions, and comprise 226,990 acres, or about 84 per cent of the acreage of the basin. None of the region reaches absolute timber line, although a few small tracts situated on the northeastern slopes of Mount Lola, Castle Peak, and Mount Lincoln carry snow throughout the year in the hollows, and have no forest cover, while the ridges adjacent to and above the snow bear thin and scattered stands. As in the other basins of the forks of the Yuba, the forest consists of two types—the yellow-pine and the Shasta-fir type. The acreage of the two types is as follows:

Acreage of yellow-pine and Shasta-fir types in South Fork of Yuba Basin

	Acres
Yellow pine	87,000
Shasta fir.....	139,990

The yellow-pine type forms the forest in the western portion. In the central it generally ceases on the ridges east of Eagle Bird City, but follows up the main canyon of the river to a point a few miles east of Cisco. It also extends up the canyons of North and Rattlesnake creeks to within 3 or 4 miles of the main range and is generally confined to the southern slopes. Its altitudinal limits in the western and central portions of the basin are close to 6,000 feet, while on the slopes with southern exposures fronting on the main canyon and on the above-named creeks it frequently ascends to 7,200 feet.

The Shasta-fir type is the prevailing form of forest in the central and eastern areas above the 5,800-foot contour. It covers all the higher peaks and ridges

CHARACTER OF FOREST

The timber on the wooded tracts consists of oak and Digger pine, with scattered yellow pines of small size, and rarely, in some gully or small side canyon, a red fir or two. Oak forms the bulk of the growth and is largely composed of evergreen species. The timber is small and scattering and is much mixed with clumps of brush, mostly *Ceanothus cuneatus*.

The yellow-pine forest in the western portion, north of the river, begins with interrupted, thickset sapling stands composed of yellow pine to the extent of 75 per cent. These stands are restocking after close logging. Here and there the young stands contain a few medium-sized yellow pines, occasionally scattered groups and ragged, thin lines of the same tree, while red fir and incense cedar dot the areas just beginning to restock. In the sapling stands there is little or no undergrowth, the trees standing so close that they completely choke out all

brush. In the more open tracts, where restocking is just beginning, brush is plentiful, composed of manzanita and species of *ceanothus*. North of the river the very close and exhaustive logging has ceased near Relief Hill. From this point to its junction with the Shasta-fir type on the ridges near Canyon Creek the yellow-pine forest is extremely patchy and uneven in its composition, in some places, as at Relief Hill, consisting of 65 per cent white fir; in others, as on the slopes into Poorman and Canyon creeks, of 15 to 20 per cent yellow pine, 20 to 35 per cent red fir, scattered sugar pine; 10 to 25 per cent is white fir and incense. The forest has been extensively ravaged by fires and is almost everywhere badly choked with underbrush. Up to the 4,500-foot level there are large quantities of oak mixed with it; above that altitude the oak soon thins out and disappears.

In the main canyon the forest is thin, except on the slopes with a northern exposure, where large quantities of white fir give density to the stands. Along the lowest slopes in the canyon the prevailing species are yellow pine and red fir, the latter—short and slender in growth—predominating, owing to the cutting of the larger proportion of the yellow pine.

On the divides south of the river the conditions are very similar to those on the north. Thick-set sapling stands in the western portion alternate with scattered trees of middle age of yellow pine and red fir on the steep canyon slopes, mixed with large quantities of medium or large sized oak. In the central area yellow and sugar pine occur as scattered trees—most of these species having been cut—with large quantities of white and red fir, all set in the thick and close underbrush of *ceanothus*, which is here a characteristic growth on tracts swept by surface fires of moderate intensity. All through the western and central portions of the basin the yellow-pine forest—old and young stands alike—is broken and interrupted by extensive tracts of placer ground formerly worked by hydraulic methods. It is scarcely necessary to state that no large timber remains on the old placer grounds, while along the edge of the bluffs left standing by the miners the timber which has not already been cut is tumbling in as the banks wash out. On the lower slopes of those canyons, which are deeply choked with *débris* from the placers, are stands of timber here and there, partially buried, mostly dead, with the upper portions of the trees projecting above the sand and gravel.

The western limit of the Shasta-fir forest north of the river is marked by the gorge of Canyon Creek. At first it occurs in solid blocks covering tracts of 1,000 or 2,000 acres, usually along the courses of streams where it has escaped the ravages of fire. A few miles east of Canyon Creek the rocky areas characteristic of the region west of Summit City set in, and the stands of Shasta fir become much scattered. Here and there along a canyon, or fringing a small lake, or in a hollow where soil has collected, occur small bodies of the tree, but

over the larger portion of the region the forest appears only as isolated trees in the crevices of hard, naked granite. East of Summit City the ridges are more uniformly covered with soil and the forest becomes moderately dense, increasing to stands with an average of 8,000 feet B. M. in the upper portion of North Creek Basin. In the extreme eastern portion of the basin, on the crest and slopes of the main range from Donner Pass north, the forest is very uneven. Stretches of rocky, barren slopes covered with boulders, or tracts of nearly bare rock where the timber consists of isolated trees, alternate with stands of forest, varying from 2,000 to 6,000 feet B. M.

In the main canyon, from Langs to its head, the forest is thin. It has been logged and culled for firewood throughout. The remainder consists chiefly of lodgepole pine with scattered Shasta fir, now and then a yellow pine, white fir, or incense cedar, in localities too rocky to be reached by the loggers, all mixed with large quantities of underbrush.

South of the river the Shasta-fir forest begins at the head of Bear Valley. It is everywhere thin, having been logged for mill timber and extensively cut for fuel during the years when the locomotives of the Central Pacific Railroad consumed wood. The cutting extends to the head of the main canyon where the forest consists wholly of small, slender Shasta fir with large quantities of lodgepole pine and scattered trees of white pine. The slopes of Mount Lincoln and adjacent areas are very sparsely timbered. Large tracts are rocky with no soil or a soil too thin to support forest growth. Where a more generous soil covering exists the trees are dispersed singly or in small groups over the slopes, or set in heavier stands in the sheltered basins and along the creek canyons. There is very little brush in the forest on the high slopes of the main divide, but the ground, in most places, is covered with a low, uniform growth of sagebrush. The thinness of the stands of timber along the main divide, where not due to rocky ground, is solely owing to fires and to subsequent excessive sheep grazing with attendant trampling and killing of the seedling trees.

The composition of the Shasta-fir type in the basin varies a good deal, largely owing to the operation of a system of selective cutting practiced for many years. In the other basin of the Yuba system, as well as in those of the Feather River system, the selective cutting has been limited to the forests of yellow-pine type, but here, to meet a once heavy local demand for fuel, considerable tracts carrying the Shasta-fir type of forest have been subjected to an exhaustive culling process. In consequence, many of the stands of Shasta fir in the eastern portion of the basin within reach of the wood cutters now consist of 5 to 15 per cent Shasta fir (this kind of fir being the most desirable species for fuel in that particular region), 85 to 95 per cent lodgepole pine, which is not so desirable, and 2 or 3 per cent of white pine.

Where the forest in these districts has not been cut, Shasta fir is the leading species, usually forming 60 to 75 per cent of the stands. In the wet bottoms of Fordyce Creek and around many of the glades, owing to the swampy nature of the ground, there is nearly always a fringe of lodgepole pine, often in pure stands. Along the crests and slopes of the main ridge above elevations of 7,500 feet occur occasional blocks of forest composed of about 75 per cent white pine, or of Patton hemlock in similar proportions. On Castle Peak a few white-bark pines were observed.

The timber at elevations above 7,800 feet is commonly of little value. It is stocky and stunted, limby to near the base, the tops broken and most of the branches pointing in one direction owing to the severe winds to which it is exposed both in summer and winter. As a whole the timber along the high elevations of the main divide is unfit for mill purposes, its only value being for fuel.

LUMBERING.

With the exception of a small tract situated south and east of Graniteville, north of the river, that part of the basin accessible from without has been logged or culled over in a more or less systematic manner. The areas on which the timber remains uncut are, in addition to the exception noted above, the drainage basin of North Creek, tracts situated among the Fall River Mountains, west of Summit City, the upper tributaries of Canyon Creek, and small areas situated along the slopes of the main ridge from Mount Lola southward. These tracts carry forests of Shasta fir and are only locally accessible. The total area logged and culled comprises 165,400 acres.

The cut in the woodlands has been chiefly for fuel. Some Digger pine large enough to yield mill timber doubtless existed in the early days, but has been logged off. North of the river those ridges and valleys not too steep have been logged to the extent of 95 per cent as far east as Relief Hill. From this point eastward the cutting has been selective but not very close, some yellow and sugar pine being left, together with large quantities of red and white fir, the cut on these tracts varying from 30 to 75 per cent. On the south side of the river to Blue Tent, 95 per cent has been cut, only scattered yellow pines and red firs of slender growth remaining. East of Blue Tent the cutting has been selective, but there still remains from 5 to 6 per cent of yellow pine and less than 1 per cent of sugar pine. Here, as on the north side of the river, there is left red and white fir to the extent of nearly 4,000 feet B. M. per acre on an average. There is, also, below the 4,500-foot contour line, large quantities of oak, most of it with only a fuel value, but some of it large and sound enough to be converted into mill timber. Along the main canyon most of the available mill timber has been cut, the remaining stands averaging about 1,200 feet B. M. per acre, while

in proximity to the old mining camps the demand for fuel has made a nearly clean sweep of all timber, large and small.

In the central and eastern areas of the basin the main canyon and its slopes, together with the valleys of the tributary streams, have been logged as far back into the mountains as the broken character of the country would permit, generally from 1 to 2 miles. The larger timber has been converted into saw logs, the smaller into cordwood. The logged tracts parallel the line of the Southern Pacific Railroad (Central Pacific Railroad) as most of the timber was used either in construction work in connection with the road or as fuel for the locomotives. Shasta fir, yellow, white, and large lodgepole pine were taken. The smaller lodgepole pine was rejected and constitutes the bulk of the timber on these tracts. At the present time the cutting here is wholly for fuel and all sorts of timber are being taken. The cut in the central and eastern areas ranges from 8 per cent where the broken character of the country precluded general logging, to 95 per cent on tracts situated in the main canyon and on accessible slopes. The amount of merchantable timber remaining in the basin is as follows:

Amount of merchantable timber in South Fork of Yuba Basin

	Michigan practice	Local prac- tice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine.....	150,000	103,000
Sugar pine.....	40,000	36,000
Shasta fir.....	415,000	260,000
Red fir.....	80,000	30,000
White fir.....	220,000	115,000
White pine.....	15,000
Total.....	920,000	544,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—(1) Small-sized oak and Digger pine, occasionally scattered yellow pine, and rarely a few red firs in the canyons; timber sparse throughout, especially on the lower slopes of the main canyon.

Grade 2—less than 2,000 feet B. M. per acre.—(1) Main canyon to Maybert: Scattered yellow pine and red fir, all of small size; Digger pine on both slopes of the canyon to within a mile or less of Washington; small quantities of white fir in side canyons; all of poor quality and valuable chiefly for fuel. (2) Divides north and south of the river. Yellow-pine type of forest; small yellow pine and red fir; white fir above the 4,000-foot level; incense cedar and large quantities of oak throughout; all logged many years ago; the remaining timber consisting chiefly of

culls of little value except for fuel. (3) Region between Canyon Creek, Summit City, and Signal Peak. Ninety per cent Shasta fir; small quantities of white pine, scattered white fir and yellow pine below 6,800 feet; all poor in quality, growing in small basins or on steep slopes in the crevices of rocks; all inaccessible from outside. (4) Main canyon from Maybert to Summit Valley: Small Shasta fir; scattered yellow pine on inaccessible slopes; large quantities of lodgepole pine of small dimensions, white pine scattered among the other species and at its best not exceeding 2 per cent; very thoroughly logged and culled, the remaining timber of little value except for fuel. (5) Region east of Summit City around Castle Peak and Mount Lola. Scattered Shasta fir; Patton hemlock; white pine; a few yellow pines; western juniper less than 1 per cent; lodgepole pine of slender growth, all set on rocky slopes or on boulder-strewn flats; of little value and very difficult of access. (6) Region around Devil Peak, Cascade Lakes, and northern slopes of Mount Lincoln: Shasta fir, 50 to 75 per cent; balance lodgepole pine with small percentages of white pine and Patton hemlock; all set in very rocky ground, and below 7,000 feet in heavy undergrowth; of little value except for fuel.

Grade 3—2,000 to 5,000 feet B. M. per acre—(1) Region north of the river and east to Relief Hill: Scattered yellow pine, red fir and incense cedar, white fir in the canyons; all culls remaining after close logging and of little value for mill timber purposes. (2) Region south of the river to Galbraith. From 2 to 4 per cent yellow pine, scattered trees of sugar pine, 80 to 90 per cent red and white fir, incense cedar and oak; all long since culled of its best yellow and sugar pine, the red and white fir of medium quality, large quantities of oak, about 3 per cent fit for mill timber, balance with only a fuel value owing to rot at the core; timber comparatively easy of access. (3) From Relief Hill to Canyon Creek. In the extreme eastern portion 75 per cent Shasta fir of medium quality, balance white fir, incense cedar, and yellow pine, set on steep slopes and in heavy brush, generally difficult of access; average stand 4,500 feet B. M.; central and western portions, 40 to 65 per cent white fir, 8 to 15 per cent yellow pine, small quantities of sugar pine, 40 to 50 per cent red fir, incense cedar and oak; mostly set in heavy undergrowth and damaged by fire to the extent of 25 per cent. (4) From Galbraith to Eagle Bird: Small yellow pine, occasional sugar pines, these two species closely logged, white and red fir, 75 to 80 per cent; large quantities of oak and incense cedar, both species defective owing to rot. (5) From Canyon Creek north of the river and from Maybert south of the river to main range: On the eastern areas where not logged 75 to 85 per cent Shasta fir of medium quality, scattered yellow pine below 7,200 feet, stands of white pine and Patton hemlock thin and scattered, owing to fires and rocky ground, in the western portions 85 to 90 per cent Shasta fir; less than 1 per cent of yellow pine, a few sugar

pinces on the bluffs north of Eagle Bird, white fir and incense cedar; most of the timber poor and stocky, owing to rocky ground; south of the river along main canyon, Shasta fir of small dimensions, 10 to 12 inches diameter at the base, 40 to 60 feet in height, scattered yellow and white pine set in extensive stands of small lodgepole pine, the Shasta fir occasionally forming blocks of pure growth.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Head of Canyon and Poorman creeks: Shasta fir, 20 to 30 per cent; red fir, 3 to 5 per cent; white fir, 40 to 60 per cent; yellow pine, 3 to 10 per cent; some incense cedar; timber of fair quality, 5 to 10 per cent damaged by fire, mostly in heavy underbrush and on steep slopes moderately difficult of access. (2) Area south of Feeley lakes: Shasta fir of large growth in scattered blocks, a few yellow pines. (3) Area south of Cisco Butte: Shasta fir, 85 to 90 per cent, with balance white fir and a small percentage of yellow pine; timber small but thickset, growing along creek bottoms and on northern slopes. (4) Head of North and Rattlesnake creeks: Shasta fir 75 to 90 per cent, yellow pine below 6,800 feet to the extent of 5 per cent, Patton hemlock on the northern slopes and small quantities of white pine; at the lower levels the timber is of good quality, but occurs in irregular blocks separated by lanes of brush or areas of nearly bare rock; above 7,200 feet the timber is stocky and of poor quality, but often occurs in close stands. (5) Various bodies south of the river between Cisco Butte and summit of main range: Chiefly Shasta fir, with small quantities of white pine, of medium quality, but generally difficult of access.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Throughout the basin: Stands of Shasta fir, scattered yellow pine, small percentages of white pine, the Shasta fir generally forming from 75 to 90 per cent of the mill timber.

Grade 6—over 25,000 feet per acre.—(1) Northern slopes of Canyon Creek west of Feeley Lakes: Shasta fir of large size and thick stands varying from 35,000 to 45,000 feet B. M. per acre; small quantities of white fir, scattered yellow pines, the timber mostly growing on steep slopes and impossible of access from outside the district.

FIRES

Most of the forested as well as the woodland areas in the basin are marked by fire and a large acreage is badly burned. The estimates are as follows:

<i>Burned areas in South Fork of Yuba Basin</i>	
	Acres
Fire marked	250,200
Badly burned	62,600

As the forested, wooded, and chaparral covered tracts aggregate 254,510 acres, the fire-marked area embraces about 98 per cent of the region bearing or capable of bearing arborescent growth, while the badly burned districts situated

wholly in the forested region, which comprises 242,630 acres, amounts to nearly 26 per cent of this class of lands.

In the western portion of the basin the forest is merely fire marked. It has been logged so closely that if any considerable quantity of timber was destroyed in the fires of early days the amount can not now be ascertained. In some places fires swept the forest soon after it was logged, here and there consuming the young growth and creating small chaparral-covered areas. In the central area extensive surface fires have run through the timber north of the river, destroying about 25 per cent of it; south of the river only 4 or 5 per cent. Near Maybert large tracts of burned forest begin to make their appearance. They coincide closely with the western limits of the Shasta-fir forest in the basin and stand in direct connection with the big burns of Middle and North Fork of Yuba River districts. The timber in this section of the basin has been very badly damaged, at least 65 per cent having been consumed. The rocky areas west of Summit City show burns in nearly every one of the larger blocks of timber. As they usually stand isolated, fires must have been set in each separate block. From Summit City east to the main divide, including all the areas south of the river in the eastern portion of the basin, fires have run through nearly all of the forest. Small tracts in the wet canyons have escaped, but the total area of such places does not amount to more than 2,000 or 3,000 acres. The loss of timber by fires amounts at least to 20 per cent for the entire basin, while in the eastern portion alone 65 per cent has been destroyed.

The fires here have produced exactly the same results as in the other basins of the Yuba system. In the yellow-pine forest heavy undergrowths have come in. In the Shasta-fir forest below 7,000 feet one meets with the characteristic chaparral of manzanita and various species of ceanothus, scrub oak, wild cherry, and the like. At higher elevations there are, in some localities, broad patches of *Ceanothus cordulatus*, but in almost every instance, especially along the main range, the high-lying areas burned clear of forest are covered with a sparse and scattered growth of grass and coarse weeds, or with a low uniform growth of sagebrush.

Most of the burns date back more than twelve years. A few fires of limited extent have burned on the divide near Bear Valley within the last two or three years, chiefly consuming or killing a dense chaparral of manzanita.

REPRODUCTION

Restocking of the woodlands where the timber has been thinned or wholly removed by the woodchoppers is proceeding slowly. Most of the young growth is oak, less than 5 per cent is Digger pine, against 25 to 30 per cent of Digger pine in the old growth. The chief reason is that much of the young oak is

springing from the stumps of the older growth. Restocking in the logged areas of the yellow-pine type is abundant except where the ground has been turned up by placer mining. The young trees are set extraordinarily close, there being in many places 10,000 or 12,000 trees to the acre. Most of the timber is yet in the pole stage, the largest trees ranging from 25 to 45 years in age, measuring 12 inches at the base and 45 to 60 feet in height. Most of them, however, do not exceed 5 inches in basal diameter and 40 feet in height. Nearly all of the sapling growth is limby, notwithstanding the close stands. On the old worked-out placer grounds restocking has either not begun or exists as a thin and scattered growth. The gravel heaps which mark the placer mines are practically without mold or humus, and can not produce much forest for some hundreds of years to come. The composition of these reforestations differs somewhat from the old forest in the proportion of the species which compose them. Yellow pine predominates, ranging from 40 to 70 per cent, as against probably 25 to 40 per cent in the old growth. The increase in the percentage of this species is partly at the expense of the sugar pine, which does not form 1 per cent of the restockings, and is partly due to displacement of a certain percentage of red and white fir. The incense cedar has also gained in proportion, forming from 10 to 35 per cent of the growth, two to three times its former volume. These changes in reforestation are wholly due to the number of seed trees left by the loggers. Sugar pine, being closely cut, is far behind in the young growth, while incense cedar, having little value, was long rejected and had ample time to seed large tracts of the logged districts.

In the higher regions of the yellow-pine forest there is everywhere an increase of the percentages of white and red fir at the expense of yellow and sugar pine, owing, here as elsewhere, to closer cutting of these two species than of the others. Reproduction in the Shasta-fir type of forest is deficient. Where the timber has been destroyed from 90 to 95 per cent by fire, chaparral has followed and there is practically no reforestation. Where logging operations have thinned the timber, lodgepole pine is gaining the ascendancy, owing to the large number of seed trees of this species left. At elevations above the line of heavy brush growth, where the Shasta fir has been completely burned out or thinned 50 per cent or more, grass with coarse weeds have come in, and reproduction is scanty, owing to sheep grazing and destruction of the seedlings by trampling. That this is a correct conclusion is proven by the fact, patent to any observer, that on ground of this sort where, for some reason, sheep have not grazed or trampled for four or five years the young Shasta firs are covering the ground with a close and almost matted growth. The Patton hemlock and white pine, which form, on the whole, an inconsiderable portion of the Shasta-fir type, appear in the young growth in much the same proportions as in the older stands.

CHAPARRAL

The chaparral in the South Fork of Yuba Basin covers about 15,640 acres. However, in this region utter annihilation of the timber by burning does not always produce chaparral, at least not the dense, compact growth of manzanita, scrub oak, ceanothus, and chinquapin which constitute it elsewhere. The exceptions are areas situated above 7,200 feet and on, or adjacent to, the main divide. These tracts do not usually produce the brush growth after fires, owing to altitude and chiefly to soil and climatic aridity, but when present the brush is mostly in the form of low, spinescent ceanothus and sagebrush a foot or two in height. Where the typical chaparral exists manzanita, cherry scrub, and ceanothus compose it. In the yellow-pine forest, especially in the restocking where patches have been burned clean, a chaparral springs up 3 to 5 feet high, composed almost exclusively of manzanita. In the Shasta-fir forest the stands of brush are composed of the same species that constitute the characteristic chaparral on tracts where all the timber has been consumed, while in the yellow-pine forest the brush in such places is chiefly composed of species of ceanothus.

In the woodlands, thinning of the timber by fire brings increased quantities of *Ceanothus cuneatus*, the prevailing undergrowth. Close cutting has occasionally the same effects, producing heavy spreading stands of the above-named shrub 5 to 8 feet in height, young oak and Digger pine eventually coming in and crowding out the brush.

YUBA RIVER BASIN.

TOPOGRAPHY.

Yuba River is formed by the junction of North, Middle, and South forks, the three chief tributaries of the stream, which come together in the foothill region; thence it flows in a westerly direction to a junction with Feather River near Marysville in the Sacramento Valley.

The course of the Yuba River is through a tortuous canyon from 500 to 1,200 feet in depth. The slopes on the north side are moderately steep; those on the south side are generally abrupt and often precipitous; the channel is littered with boulders or, in some stretches, is smoothed out by the deposition of great quantities of débris which are continually sweeping down from the old hydraulic placer workings along the forks of the river. A few miles above Long Bar the canyon walls recede and merge into low rolling hills. About 3 miles below Long Bar the stream breaks through Browns Valley Ridge and enters the levels of Sacramento Valley, dividing into several branches which spread out over a space about 2 miles in width. The area drained by Yuba River within the limits of this examination comprises 284,130 acres, of which amount all but

58,000 acres is either foothill country or consists of level or gently rolling tracts in Sacramento Valley. The foothill areas are formed of irregular, broken ridges of low altitude with semidetached hills or buttes here and there rising to higher elevations. Between the ridges and on their summits lie more or less extensive flats, while the small streams meandering through the region flow sometimes through narrow canyons 150 to 400 feet in depth, their valleys occasionally widening into flats with no canyon formation whatever. The average elevation of the foothill part of the basin is about 1,500 feet.

The mountain districts of the basin are situated in the northeastern and extreme east-central portions of the basin. In the former they consist of two north-and-south-ridges—Hedge Hill and Oregon Hills—with their spurs and slopes. These ridges are of no great elevation, their summits hardly rising above 3,500 feet, and are neither very rocky nor steep. They give rise to Dry Creek, the largest affluent received by Yuba River below the forks. The east-central portion of the basin consists of ridges of moderate relief at the head of Deer Creek, the second largest tributary of Yuba River. These ridges are a part of the divide which separates Bear River Basin from the South Fork of Yuba drainage, and attain an elevation of nearly 5,000 feet. All of the areas of the Yuba River drainage are of moderate or low relief, and none exhibit evidence of glacial erosion.

SOIL.

The soil throughout the foothill and mountain areas of the basin consists chiefly of the characteristic loose, fine, red soil mentioned in connection with the basins of the Yuba River forks. On the levels of the Sacramento Valley the soil varies from the red soil of the foothills to a black, dark or light colored loam, clay or even adobe, depending on the amount of river silt, sand, or gravel which enters into its composition. The soil of the foothill region rests either directly on the bed rock, or more generally on thick deposits of sand and gravel mingled with quantities of bowlders of all sizes. As a rule, the soil of the foothills is not very productive.

MINING.

Almost the entire area of the basin is auriferous. Both quartz and placer mines are worked. The most important of the former are situated in the region around Nevada City in the Deer Creek drainage and adjacent to Browns Valley in the lower portion of the Dry Creek drainage. Placer diggings occur in numerous localities. The channel of the river is mined, as are many of the flats and small creek bottoms. The regions around Smartsville and north of the river near Sicard Flat were extensively mined by the hydraulic method some years ago, but are now practically abandoned.

AGRICULTURAL LAND.

The areas classed as agricultural comprise 68,350 acres. They are situated in small tracts throughout the basin, mostly where water for irrigation is available, and on the levels of the Sacramento Valley. Outside of the lands in that valley the region is not susceptible of extensive cultivation, owing partly to lack of irrigation facilities, partly to the gullying and washing of the red soil when stirred, even on moderately steep slopes. However, were water for irrigation at hand at least twice the amount of land now under cultivation would be available for orchard or general agricultural purposes.

Most of the cultivated land was originally covered with oak and Digger pine. The areas in the Sacramento Valley may be exceptions to some extent, though large oaks in the fields here and there indicate that some of the land was originally wooded. In the foothills most of the lands devoted to hay or grain raising are not wholly cleared of timber, scattered oak and Digger pine standing in the fields. Where water for irrigation is available, most of the land is utilized for orchard purposes, but there are also considerable tracts set in fruit, which seem to require no irrigation. Apples, pears, plums, cherries, peaches, and grapes thrive throughout the foothill country. Oranges, lemons, and olives grow up to the 1,200-foot level, at least along the areas fronting on the Sacramento Valley, while the upper limit of the fig appears to be close to the 1,800-foot level.

PASTURE.

Most of the region is under fence, and where not cultivated is utilized as pasture, especially during the winter, at elevations below 1,500 feet. The native grasses were long ago eaten out and the wild oat, a degenerate variety of the common cultivated oat, covers hills and valleys alike. It furnishes a moderate amount of second-rate feed during five or six months of the year. When mature, it dries up and constitutes the so-called "dry feed," and is then of very little value.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

The larger proportion of the basin bears an arborescent growth. Most of this is of the oak and Digger-pine type and is hence classed as woodland. The forested areas comprise a much smaller acreage. The areal extent of the two classes is as follows:

<i>Forest and wooded areas in main Yuba Basin.</i>	
	Acrea
Forested.....	28,700
Wooded.....	187,080
Total.....	215,780

As the total area of the basin is 284,130 acres, it follows that 76 per cent bears arborescent growth. The wooded areas include the central, most of the eastern, and all of the western portions of the basin not situated in the Sacramento Valley levels. Generally it comprises all the tracts between 500 and 2,500 feet. The forested portions in the northeastern area are situated mostly on the summits and slopes of Hedge and Oregon hills and along the creeks having their rise in these regions. In the east-central portions the middle and upper drainage of Deer Creek is forested. The tracts producing or capable of producing commercial timber are mostly situated above the 2,500-foot level.

CHARACTER OF FOREST

The forest in the basin is formed exclusively of stands belonging to the yellow-pine type. Owing to extensive logging operations, fully 70 per cent is young growth, while the balance is made up of oak, white fir, and red fir, with culls of yellow pine, rejected by the loggers.

The forest in the east-central areas of the basin consists of saplings. They occur in very close stands, with scarcely any underbrush, and vary in age from 20 to 45 years. The largest dimensions of the trees are 12 to 14 inches in diameter at the base, and 45 to 60 feet in height; 60 to 70 per cent is composed of yellow pine, the balance of red fir, with now and then a few sugar pines. In the extreme eastern area the forest consists chiefly of white and red fir, the yellow and sugar pine having been logged off. The stands are open, much mixed with underbrush, oak, and incense cedar, and have little value except for fuel. In the northeastern portion the timber, having been closely logged, is largely red and white fir, the remaining old growth of mill timber having the following composition:

Composition of old-growth forest in northeastern portion of main Yuba Basin

	Per cent
Yellow pine	2
Red fir	75
White fir	23

If the young stands restocking the logged tracts are included, the composition is as follows:

Composition of forest in northeastern portion of main Yuba Basin, including young growth

	Per cent
Yellow pine	30
Sugar pine	2
Red fir	40
White fir	8
Incense cedar	8
Oak	10
Digger pine	2

The timber of the woodlands is of much the same general character as elsewhere. Here and there along the 1,500-foot level scattered yellow pines are seen, and in the central portion occasionally a few red firs. The Digger pine decreases as the Sacramento Valley is approached and increases to the east, becoming most abundant in the central portions. An average composition of the woodland type is, oak, 65 per cent; Digger pine, 35 per cent, and yellow pine occasionally runs up to 15 per cent and replaces the oak to this extent. The woodland growth of timber is nearly always open and scattered. Along the ravines and on northern slopes young oak stands are occasionally met with where the trees are set quite close, at the rate of 4,000 to 5,000 trees per acre. Frequent openings occur—grassy hillsides with a few oaks or Digger pines and scattered clumps of brush. Undergrowth is abundant in places where fires have swept through or the timber has been much thinned by cutting; otherwise it is moderate in quantity.

LUMBERING.

The woodlands have been repeatedly culled over. The cutting has been mostly for fuel, partly as cord wood, partly as charcoal. The size of many of the stumps indicates that yellow and Digger pines large enough to furnish mill timber once grew here. Approximately 50 per cent of the growth of thirty or thirty-five years ago has been cut. In late years the cutting has been much less, and so far as charcoal production is concerned has wholly ceased.

The forested tracts have, without exception, been logged. In the upper area of the Dry Creek Basin most of the accessible and sound yellow pine and all of the sugar pine has been cut. Considerable quantities of red fir have also been logged, while the white fir, being defective from rot, remains uncut. In the eastern area, from Newtown to Willow Valley, the cut has been from 95 to 99 per cent of the old growth, only scattered yellow pine and red fir remaining. From Willow Valley to the head of Deer Creek the cut has averaged from 75 to 85 per cent of the mill timber and about 25 per cent of the oak, most of the yellow and sugar pine having been logged off. In the region around Nevada City, and throughout the eastern portion generally, wherever the restocking yellow pine and red fir have reached dimensions of 6 inches basal diameter, they are being cut for poles and utilized in the mines at Nevada City and Grass Valley.

The standard of merchantable timber in the basin in M feet B. M. is as follows:

Merchantable mill timber in main Yuba Basin

	Michigan standard	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine.....	35,000	23,000
Red fir	22,000	12,000
Total	57,000	35,000

DISTRIBUTION OF GRADES OF MILL TIMBER.

Grade 1—woodland.—(1) Browns Valley Ridge and adjoining tracts: Oak, 85 to 95 per cent; Digger pine, 5 to 15 per cent; much of the oak second growth from stumps of older growth which has been cut. (2) Central area: Oak, 65 to 70 per cent; Digger pine, 30 to 35 per cent, mostly scattered and about evenly mixed throughout, but occasionally, on slopes with seepage and in creek bottoms, forming thickset stands. (3) Eastern area: Chiefly oak and Digger pine, with yellow pine in small quantities, an occasional red fir, and a few sugar pines.

Grade 2—less than 2,000 feet B. M. per acre.—(1) Head of Dry Creek: Small yellow pine and red fir—culls remaining after logging, Digger pine as occasional trees, oak and incense cedar. (2) Region around Nevada City: Culls of yellow pine and red fir exclusively. The remaining mill timber in the two preceding districts averages about 600 feet B. M. per acre. (3) Region east of Willow Valley: Red fir and yellow pine, culls remaining after logging operations, or of better quality but always of slender growth, standing in places difficult of access and with an average stand of 1,200 feet B. M. per acre.

Grade 3—2,000 to 5,000 feet per acre.—(1) Head of Dry Creek drainage: Yellow pine and red fir of poor quality, 85 per cent logged. (2) Head of Deer Creek drainage: Yellow pine, 8 per cent; sugar pine, 2 per cent; white fir, 65 per cent; red fir, 25 per cent; the better qualities of yellow and sugar pine logged off; the red and white fir mostly of slender growth and poor quality; oak and incense cedar mixed throughout.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Oregon Hills: Chiefly red fir with scattered yellow pines, culled yellow and sugar pine timber remaining after close logging; average stand remaining, 5,500 feet B. M. per acre.

FIRES.

Light surface fires have marked 210,800 acres or nearly 98 per cent of the wooded and forested portions of the basin, while the badly burned tracts comprise only 1,500 acres. The destruction in the woodlands has been light,

probably less than 3 per cent, while in the forested areas it may have run up to 5 or 8 per cent. The badly burned tracts have been swept by fire within recent years. They occur as small scattered patches in different portions of the wooded and forested areas, mostly at the head of Dry Creek and in the eastern district of the basin.

REPRODUCTION

In the woodlands oak and Digger pine are the only species restocking. The small percentage of yellow pine, sugar pine, and red fir formerly existing in the more elevated portions is lacking in the young growth. The oak and Digger pine reappear in about the same proportions in which they existed in the old growth, but when a difference is observable it is in the line of a higher percentage of oak.

In the forested areas yellow pine is the prevailing species in reforestation. Sugar pine, which in the old stands probably exceeded 5 per cent, is now less than 1 per cent. Incense cedar is present in about twice the quantity and red fir in nearly the same amount as in the old growth.

CHAPARRAL

There is no chaparral in the basin except such as forms the undergrowth. In the wooded areas it is mostly composed of *Ceanothus cuneatus*, and where the timber has been considerably thinned by cutting or fires it develops into large, dense clumps. In the forested districts the brush is mostly species of *ceanothus* and *manzanita* (*Arctostaphylos glauca*).

BEAR RIVER BASIN.

TOPOGRAPHY.

The Bear River drainage occupies a geographical position intermediate between that of South Fork of Yuba and its continuation, Yuba River, and North Fork of American River. It heads along the western rim of the great granite area which forms so characteristic a feature in the central part of South Fork of Yuba Basin, within a mile of the point where the canyon of that stream begins to form its great gorge. The two streams here flow in a nearly parallel direction for a distance of 2 miles. At a point about opposite Langs the canyons approach within one-half mile of each other, with no ridge whatever intervening, the streams, however, flowing at different levels. From this point the canyons of the two rivers diverge, Bear River taking a southwesterly course and leaving a broad strip of country between its main canyon and the Yuba Basin. This block of country comprises most of the drainage basin of Bear River, the part of the basin situated south of the river consisting wholly of a narrow comb of rock and gravel which

forms the divide against North Fork of American River drainage and sheds but little water into the Bear River Valley.

The river in the upper and central parts of its course flows in a narrow canyon 1,200 to 1,500 feet in depth, which never really becomes a gorge, although frequently its sides slope at a high angle. In the western portion of the basin, where the river enters the foothill country, the canyon widens, and is only 300 to 400 feet in depth. At McCourtney Crossing the stream emerges from the foothills into the level or gently rolling Sacramento Valley region.

The area of the Bear River Basin included within this examination comprises 246,210 acres, of which about 168,210 acres consist of foothill country and 78,000 acres of mountain areas. Most of the drainage basin is situated at a comparatively low altitude. The elevation at the head of the river is 5,300 feet. A few areas north of Bear Valley reach altitudes of 5,800 feet, but by far the larger portion of the mountain drainage lies below 4,000 feet, 3,000 feet probably representing the mean elevation of the eastern or mountain district of the basin. The foothill region is of low altitude throughout. A few points near Grass Valley have an elevation of 3,000 feet. Most of it is situated below 1,800 feet, the mean elevation being probably about 1,000 feet excluding the level areas in the Sacramento Valley. Notwithstanding its comparatively low elevation the mountain portions of the basin stand out in rather strong relief. This is owing to two streams which enter Bear River from the north, viz, Greenhorn River and Sheep Hollow, both flowing in deep and, in the case of Sheep Hollow, gorge-like canyons, from which spread out on both sides networks of small ravines, most of them having the form of canyons or gorges. The foothill region consists of irregular hills and ridges inclosing small flats or creek bottoms. Although of low relief throughout, it occasionally presents sharp declivities, especially along the streams of the Wolf Creek drainage.

SOIL.

The soil is generally thin in all portions of the basin except in some of the small creek bottoms that have received and retained the washings of mold and humus brought down from adjacent hills. The slopes of the Bear River Canyon are rocky and bowlder strewn in the upper and central portions; in the lower the red soil forms a thin covering. The mountain portions of the drainage are covered with heavy deposits of sand and gravel mixed with bowlders. On this rests the common red soil, the thickness depending on the degree of slope. In the foothill region the same soil prevails. Except on the flats and in the creek bottoms it covers the bed rock very thinly. Here, as elsewhere, the red soil with plenty of moisture is exceptionally well adapted to the growth of heavy stands of forest, but is said to be unproductive in the raising of hay, grain, or vegetables unless heavily manured.

MINING.

All of the basin is auriferous and constitutes a part of the placer ground of California. The drainage basins of Greenhorn River and Sheep Hollow have been torn up in all directions by the hydraulic giants which have followed the hand mining of early days. The quartz mines around Grass Valley are situated within the Bear River drainage and are too well known to need any more than a passing mention. In the extreme western portion of the foothills near Spenceville copper is mined. Owing to lack of water there is little placer mining in the foothills, although most of the creeks and flats are gold bearing. At the present time hydraulic mining in the basin has nearly ceased.

AGRICULTURAL LAND.

The agricultural lands of the basin comprise 49,600 acres, chiefly consisting of tracts in Sacramento Valley west of the foothill region. The lands under cultivation throughout the foothills consist of small flats along creeks or on the more gentle slopes of the ridges. All are clearings, and in most of the fields scattered oak trees are still standing. The acreage of most of the clearings is small. A few are large enough to be termed farms, but the majority consists of 5 to 10 acres, cultivated in a careless and slovenly manner, producing a little hay and small quantities of fruit or vegetables. With irrigation facilities a much larger acreage of the foothills could be brought under tillage, but water is lacking, and the sloping character of the country will always preclude a very general application of irrigation, even if water were available. The agricultural lands in the mountain regions of the basin consist chiefly of small patches of clearings here and there, mostly on the summits and slopes of the ridges, the flats in the canyon bottoms and elsewhere having long since been dug up in the mining of their gold deposits or covered with tailings from the hydraulic workings. The land here under tillage comprises less than 6,500 acres, the largest and most important tracts being in the region around Grass Valley.

PASTURE.

All of the basin, wherever accessible, with the exception of orchard, vineyard, and vegetable or truck farms, is utilized during all or some portions of the year as pasture ground. The grain fields become sheep and cattle pastures in late fall and winter, while the woodlands are pastured throughout the year. The grazing is poor, owing to excessive sheepling in the early days and the consequent destruction of the better class of indigenous grasses, which have been supplanted by the ubiquitous wild oat. In the mountain districts there is practically no grass outside the inclosures, browse of one sort and another furnishing the pasturage. The naturally nonforested grazing grounds of the basin are confined to Bear Valley, a

swampy or glade-like flat near the head of Bear River, containing about 450 acres of open meadow land.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

The timber-bearing areas of the basin comprise 196,160 acres, and belong mostly to the woodland class, the acreage of the latter being nearly twice as large as the forested portions. The areal extent of the two classes is as follows

Forest and woodland in Bear River Basin

	Acres
Woodland	130,240
Forest	65,920

The wooded tracts begin at the western edge of the foothill region contiguous to the levels of Sacramento Valley. They include the entire foothill country, with the exception of some outlying tracts of forested ridges along the middle and upper portions of the Wolf Creek drainage. They are mostly situated between the 500 and 2,000 foot contour lines, the exceptions being a few elevated points in the Wolf Creek Mountains, which run up to altitudes of 2,700 feet. The forested areas include all of the basin east of Grass Valley. Their altitude varies from 800 to 5,800 feet, comparatively little lying at the lesser elevation outside the canyon bottom of Bear River.

CHARACTER OF FOREST

All of the forested areas are covered with stands of the yellow-pine type. Beginning with the region contiguous to the woodland tracts, the stands are composed of yellow pine to the extent of 30 to 70 per cent, scattered red fir, especially in the canyons and smaller ravines, Digger pine in small groups, or isolated trees hardly ever exceeding 5 per cent, usually less, and large quantities of oak. Farther eastward the Digger pine disappears, the percentages of yellow pine and red fir increase, and small quantities of sugar pine and white fir appear, mixed with varying proportions of incense cedar. The average composition of the type in the most eastern portion of the basin is as follows.

Composition of yellow-pine forest in eastern portion of Bear River Basin

	Per cent
Yellow pine	40
Sugar pine	5
White fir	20
Red fir	20
Incense cedar	8
Oak	7

Nearly one-half of the forested stands consists of young growth. In the region around Grass Valley and east to Dutch Flat these stands vary in age from 15 to 40

years. They are generally thickset except where fires have thinned them. Some of them are, evidently, second restockings, fires having destroyed the first ones. The older stands are in the pole stage, the largest individuals measuring from 8 to 12 inches at the base and 40 to 65 feet in height. The older stands consist either of old trees rejected by the loggers, but which now have advanced beyond the sapling stage and measure from 12 to 20 inches at the base and from 75 to 95 feet in height. As a rule, outside the restocking, the stands are open and thin owing to logging, placer-mining operations, or rocky ground. In the eastern portions of the forest there is considerable undergrowth; less in the western districts.

The timber in the wooded tracts consists of oak and Digger pine. On the areas contiguous to Sacramento Valley oak is the principal species, with scattered Digger pine. Farther eastward the proportion of Digger pine increases, and the composition of the growth is: Oak, 60 per cent; Digger pine, 40 per cent. On the tracts adjoining the forested regions yellow pine and occasional sugar pine make their appearance, the proportion of the different species being as follows:

Timber species found on wooded tracts in Bear River Basin.

	Per cent
Yellow pine	5
Digger pine	25
Oak	70
Sugar pine	Occasional trees

The woodland growth is thin, except along creek bottoms or on northern slopes, where oak at times forms very close, dense thickets. There is throughout a moderate quantity of undergrowth, which becomes chaparral on tracts denuded by fire or extensively thinned by cutting. It is chiefly composed of manzanita and *Ceanothus cuneatus*.

LUMBERING

All of the woodlands have been culled over. In the eastern portion yellow and sugar pine formerly grew as scattered trees or as small blocks set in the oak and Digger-pine growth. They have been long since cut for mill timber, as has been the case with the large Digger pine. Most of the cutting on these tracts has, however, been for cordwood and charcoal. Probably, as an average for the entire woodland region, 50 per cent of the stand of early days has been cut. More has been removed from the areas near the Sacramento Valley than farther eastward.

The forested regions have been logged throughout, except here and there on the slopes of Bear River Canyon, where the rough character of the country prevented it. The cutting has been somewhat selective in the eastern area, a good deal of red and white fir together with incense cedar remaining. But contiguous to the placer camps everything suitable for timber and fuel has been

cut, unless standing in places difficult of access or where the owners, for various reasons, protected the growth. The cut in these districts of the basin ranges from 75 to 99 per cent. In proximity to the mines of Grass Valley and eastward to Hunts Hill or beyond the young trees which have reached basal diameters of 5 inches and upward are being cut for poles. The tracts upon which the timber has been more or less closely culled comprise 196,000 acres, or within a trifle of the total acreage of forest and woodland.

The amount of mill timber in the basin in M feet B. M. is as follows:

Merchantable mill timber in Bear River Basin.

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	60,000	40,000
Sugar pine	20,000	12,000
Red fir	65,000	11,000
White fir	9,000
Total	154,000	63,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—(1) Area contiguous to Sacramento Valley: Oak and Digger pine, 85 to 90 per cent of the former, 10 to 15 per cent of the latter; the Digger pine generally of slender growth; considerable of the oak 2 to 3 feet in diameter, mostly hollow in the center owing to rot; all in thin, scattered stands. (2) Wolf Creek drainage: Oak, 50 to 70 per cent; Digger pine, 30 to 50 per cent; in the upper and central areas of the drainage scattered yellow pine and occasionally a sugar pine; all with only a fuel value.

Grade 2—less than 2,000 feet B. M. per acre.—(1) Region around Grass Valley: Yellow pine; scattered individuals remaining after close and exhaustive logging; a few red firs in the ravines, much young growth in scattered, thickset stands; average of mill timber in the district less than 100 feet B. M. per acre. (2) Region around Dutch Flat, Hunts Hill, Lowell Hill: Yellow pine and red fir of slender growth, occasionally trees of larger size growing in places difficult of access; all culls and of little value for mill-timber purposes; average capacity of stands about 650 feet B. M. per acre.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) Middle portion of Wolf Creek drainage: Yellow pine of fair size, rarely a sugar pine, all set in Digger pine and oak growth; a small block of forest which has remained uncut up to the present, now being logged; average stand about 3,000 feet B. M. per acre.

(2) Various tracts in the middle portions of the Greenhorn River and Sheep Hollow drainage: Yellow pine, 30 to 50 per cent; red fir, 50 to 70 per cent; scattered lines and small blocks of trees in the breaks to the canyons; all culls after logging and of little value. (3) Upper and middle portions of Bear River Canyon and Greenhorn River Yellow pine of medium dimensions, in places difficult of access; here and there close stands of this species 80 to 90 years old with trees 18 to 20 inches in basal diameter, 75 to 90 feet in height, no clear trunk; sugar pine of small size, except in Bear River Canyon, where a few large trees remain uncut: large quantities of red fir (50 per cent); white fir, and incense cedar. Most of the accessible timber consists of culls, the better class having been cut long ago.

FIRES

Most of the basin, wooded and forested, is fire marked, only about 9,000 acres showing no distinct marks of fire. In the wooded regions the fires have done little damage, burning a few trees here and there, marking and searing others; the total amounting to 3 per cent or less. In the forests fires have been more destructive. Considerable of the old growth has been burned, and it is evident that some of the young growth has been burned the second and even the third time in places around Grass Valley and eastward. The total damage is approximately 5 to 8 per cent. In late years there have been no fires of any consequence. The badly burned tracts comprise 3,500 acres and are situated on the ridges north and south of Bear Valley. The acreage of the burned and fire marked tracts is as follows:

Areas burned in Bear River Basin.

	Acres
Fire marked.....	187,000
Badly burned	3,500

REPRODUCTION

The reproduction of the woodland growth is generally slow and irregular, but does not differ essentially from that in the woodlands of the Yuba Basin. As a rule, the oaks are increasing in numbers at the expense of the Digger pine, solely owing to the regrowth of most of the oaks from the stump. In the eastern foothill region yellow and sugar pine were formerly more abundant, as is proved by the stumps. Reproduction of these species is wholly lacking on some of the tracts, owing to the entire destruction of the seed trees. In general, even where seed trees of the yellow and sugar pine are present in sufficient number, young growth of these species on tracts situated where forest and woodland blend is deficient and scattered.

In the forest regions restocking of the logged areas is abundant and vigorous except on the heaps of débris remaining after the hydraulic mining operations.

Around Dutch Flat, Red Dog, You Bet, and throughout the drainage basins of Greenhorn River and Sheep Hollow, ridges and bluffs have been razed, big gullies and ragged holes torn in the flats and in the sides of the ravines, and mounds of gravel, sand and bowlders have been left behind. On the older of these heaps of tailings a very sparse growth of yellow pine and red fir is beginning to appear, but on most of them no trees have yet effected a lodgment.

In the sapling stands in the western portion of the forest areas, yellow pine is the predominating tree. In the region near Grass Valley the species forms from 75 to 95 per cent of the stands. Next in importance and percentage comes the red fir. Here, as elsewhere in the region under examination, the sugar pine appears in the restockings in smaller quantities than it existed in the original growth, because of the close logging operations which have practically exterminated the seed trees of the species over large tracts. In the eastern portion of the basin, where such close cutting has not prevailed, a normal percentage of sugar pine is reforesting. There is a noticeable tendency toward a larger percentage of incense cedar in the young stands throughout the basin within the range of the species, especially around Bear Valley, where, in some places, 90 to 95 per cent of the reforestation is of this variety. The reason is the same as in the case of the sugar pine—exhaustive cutting of the seed trees of other species and rejection of the incense cedar.

CHAPARRAL

There are no large tracts of chaparral in the basin. Small brush-covered patches of ground occur here and there in the eastern portion, having followed as a sequel to fires in the yellow-pine forest. The brush consists chiefly of manzanita. Along the upper and central portions of Bear River Canyon there is considerable underbrush, composed of manzanita, *Ceanothus integerrimus*, and *Ceanothus cordulatus*. In the woodlands there is no chaparral but the common species of undergrowth (*Ceanothus cuneatus*).

BASIN OF NORTH FORK OF AMERICAN RIVER.

TOPOGRAPHY.

North Fork of American River heads in the main range of the Sierra Nevada, in the region between Mount Lincoln and the prominent elevations known as Granite Chief and Needle Peak. The basin at its head is about 8 miles across from north to south. The portion of the range at the head of the basin gives rise to a large number of small creeks which unite a mile or so above Heath Springs and form the river. The streams as they flow from the main range are sunk in canyons, none of them very deep except those which head on the northern slopes of Granite Chief, but none of them widen anywhere along their courses into

conspicuous flats or meadows. Two miles below Heath Springs the river enters the canyon, having cut at the point of entrance an immense gorge, known as American Royal Gorge. The north wall of the gorge rises almost vertically 3,750 feet from the river to the summit of Snow Mountain, forming a rocky, craggy precipice of great grandeur. The south wall is not quite so precipitous nor so high, rising only 2,700 feet from the river to the crest of the inclosing ridge. The canyon preserves its gorge-like character throughout its entire length within the area under consideration, ranging from 1,500 feet in depth in its lower portion to 3,300 feet below the entrance of Sailor Ravine. Throughout its course it is rocky and precipitous, and contains no bottom lands except where small bars have formed at the opening of side canyons. All the larger tributaries, from Heath Springs down, enter the main canyon through deep, precipitous gorges, the smaller affluents, which are very numerous, are mere furrows in the canyon walls. Heading near the brink of the canyon their descent is extremely rapid, often more than 2,000 feet per mile. Most of them are dry, except during the spring break-ups or after heavy rains. The erosive power of water flowing over such sharp declivities can well be imagined, and were any considerable volumes of water discharged continuously into the main gorge through these lateral creeks the entire basin would soon be scooped out to the level of the river.

The drainage basin of the river within the area considered comprises 177,440 acres. Its eastern district consists of portions of the Sierra Nevada main range and a mass of short spurs projecting from the divides against South Fork of Yuba River on the north and Middle Fork of American River on the south. The main ridge of the Sierra is narrow, the summit often scarcely more than a hogback, and the spurs radiating directly from the main range are short, steep, and rocky. The divide north of the river is plateau-like on its summit, with elevations rising here and there 700 to 1,100 feet above the average level, but where it breaks off to the canyon it is cut and indented by numerous ravines and gorges, between which lie short, steep spurs. The divide south of the river is a narrow, sinuous ridge, at intervals sending out toward the main canyon narrow spurs, separated by deep, precipitous canyons. The elevation of the eastern area, excluding the main canyon, varies from 6,000 to 9,000 feet, the mean elevation being probably about 7,000 feet.

South of the river the central district of the basin comprises hardly anything but the walls of the main canyon. The summit of the inclosing ridge is a narrow crest, on the north side sloping sharply and directly into the main canyon, on the south forming a series of long spurs and flats projecting into the drainage basin of Middle Fork of American River. North of the river the basin is formed of long ridges and spurs trending in southerly and westerly directions,

and giving rise to a system of large creeks, all of which lie in gorge-like canyons. The elevation of the central area varies from 3,000 to 7,000 feet, exclusive of the main canyon, the mean elevation being about 5,200 feet.

The western area of the basin is somewhat similar to the central, except that the relative position of the two halves of the basin north and south of the river is reversed—that is, the northern portion consists of a narrow, rocky ridge, forming the divide against Bear River, while the southern area consists of a plateau-like tract, intersected in various directions by small creeks. The elevation of these districts varies from 2,000 to 4,200 feet, exclusive of the main canyon, the mean altitude being approximately 3,500 feet.

SOIL.

The eastern portion of the basin, as well as the central area situated above the 6,000-foot level, has been subjected to glacial erosion. The soil is everywhere thin, sandy, or gravelly, and, in the upper portions of the basin, contains much coarse boulder drift. Along the main range of the Sierra many rock exposures occur on the slopes and summits of the ridges. In the western portions, and in most of the central, the soil consists of loose, friable, red, dust-like material characteristic of the areas in this region of California below the 4,000-foot level. The slopes of the canyons have a very thin soil, being too steep to permit the accumulation of deep deposits. The central tracts of the basin are in some places overlain with very thick deposits of sand and gravel, sometimes 100 to 200 feet in depth. On top rests the red soil, of varying thickness. It is evident that although the soil is comparatively thin and apparently lacking in the elements of fertility it is nevertheless well adapted to production of heavy stands of forest, provided sufficient moisture be present.

MINING.

There is little quartz mining in the basin, but all the gravel deposits in the central and western portions are auriferous, and have been extensively mined during many years. Hydraulic methods of mining were in operation for a long time, until closed down by the enactment of the Camminetti law. Throughout all of the placer grounds enormous holes have been washed in the gravel ridges and flats.

AGRICULTURAL LAND.

The lands utilized for agriculture comprise 3,170 acres, distributed through the central and western portions of the basin. The largest tracts occur in the vicinity of Colfax, and are devoted principally to orchards, vineyards, and truck farms. The agricultural lands in the central area are in small parcels, mostly near the towns, and consist of garden grounds, small hay meadows, or orchards.

The eastern portion contains no lands suitable for tillage. All of the agricultural lands are clearings. Those around Colfax are clearings in sparsely timbered woodlands; those in the central portion consist of tracts cleared of forest in logging operations or in cutting for fuel, and later converted into agricultural lands.

PASTURE.

While all the uninclosed and accessible areas of the basin are utilized for grazing purposes, the region contains no natural meadow lands. The western and central regions were long ago stripped of the little grass which originally grew there, and the pasturage is now chiefly confined to browse—coarse weeds, leaves, and young twigs of deciduous trees and shrubs.

The main pasture areas are situated in the eastern portion of the basin. Owing to past fires, grassy openings occur everywhere along the main range of the Sierra, and on the slopes and summits of most of the spurs at elevations of 7,000 feet and upward. There is also a thin sward of grass scattered through the lodgepole-pine openings along the margins of small creeks and wet glades. All such places are closely pastured by cattle, and, more especially, by large bands of sheep. The herbage is generally very scanty, as all of the tracts are poor in grass production and are excessively overpastured. It is merely a question of a few years when they will be completely sheeped off and produce nothing but a scanty growth of coarse herbs or small annual species of weeds.

FOREST AND WOODED AREAS

EXTENT AND ACREAGE

Most of the basin is forested, the woodland comprising only a small portion. The acreage of the two classes is as follows.

Forest and wooded areas in North Fork American River Basin.

	Acres
Forested	156,000
Wooded	5,800
Total	161,800

A trifle more than 90 per cent of the areal contents of the basin bears some sort of arborescent growth.

The woodland consists of a small tract of foothill country in the southwestern portion of the basin. It includes the main canyon and its direct slopes as far up as Robbers Ravine and the summits and slopes of the ridges west of the canyon from Colfax southward, but east of the river only takes in the lower and middle slopes of the canyon wall. Its elevation is between 1,000 and 2,000 feet. The forested region includes the remainder of the basin to its head, and is composed of the two

common types of forest, viz, yellow pine and Shasta fir, the acreage being as follows:

	Acres
Yellow pine	100,000
Shasta fir	46,000

The yellow-pine type of forest begins contiguous to the woodland tracts. It follows the main canyon and the smaller tributaries into which it splits up beyond Heath Springs almost to the base of Mount Lincoln and nearly to Soda Springs, reaching elevations of 6,600 feet. On the divides in the western and central portions of the basin, both north and south of the river, the type generally forms the forest on slopes and ridges up to 6,000 feet elevation, except on northern slopes, where it commonly ceases at altitudes of 5,800 feet.

The Shasta-fir type is the prevailing forest on the main range of the Sierra at the head of the basin and throughout the eastern portion, except in the main canyon and the canyons of the larger tributaries heading on the slopes of Mount Lincoln and Tinker Knob. In the central portion of the basin it covers the upper slopes and summit of Monumental Hill and the eastward spurs as well as the higher portions of Wilson and Sixmile valleys. South of the river it follows the crest of the divide against Middle Fork of American River as far west as Forks House, extending down the slopes of the main canyon to the 4,000-foot contour.

CHARACTER OF FOREST

The woodland type is composed of Digger pine and species of oak, mostly evergreen. It is open and scattered, much of it having been cut. On the slopes of the main canyon the stand is very sparse, owing to thin soil and numerous exposures of bare rock. There is comparatively little underbrush mixed with it.

The yellow-pine type begins with yellow pine and red fir, the latter species, along the lower elevations, following in thin lines the ravines entering the main canyon, but at altitudes of 3,000 feet its range widens and the tree becomes a component part of the type throughout. North of the river, from the point of junction with the woodlands as far east as the western slopes of Texas Hill and Monumental Hill, the larger portion of the yellow pine and practically all of the accessible sugar pine has been cut, and the type consists either of thickset young growth, with yellow pine as the dominant species, or of culls of slender red and white fir or of stands of young oak, which in some localities along Canyon Creek and Blue Canyon have come to occupy many of the logged tracts to the exclusion of nearly all coniferous growth; the whole is mixed with heavy underbrush and an abnormally large percentage of scrubby incense cedar. From Monumental Hill eastward the type consists of yellow and sugar pine, here and there small quantities of red fir, large percentages of white fir and lesser of incense cedar, the proportions

of the different species varying exceedingly with change of localities. Thus, from Texas Hill to Big Valley, along the 6,000-foot level, the yellow pine forms 30 to 40 per cent of the timber, with the sugar pine running up to 55 per cent, and in some cases 65 per cent, while a few hundred feet lower on the slopes the yellow pine has crowded out much of the sugar pine and constitutes 60 to 70 per cent of the growth. An average composition of the type in the unlogged central district north of the river is as follows:

Average composition of yellow-pine type in unlogged portion of North Fork American River Basin

	Per cent
Yellow pine	45
Sugar pine.....	15
Red fir	8
White fir	24
Incense cedar.....	5
Oak.....	3

With the exception of the direct slopes of the main canyon above the 5,000-foot contour the old forest is set in heavy underbrush, in part the result of fires, in part of excessive logging and deficient restocking.

In the main canyon the yellow-pine type is thin. There is not a great deal of change in its composition from the example given above, except that the sugar pine is present in smaller quantities, the red fir and oak in larger. The stand is thin throughout, the timber of poor quality as a rule, and impossible of access except for local use.

South of the river the forest is very thin and patchy as far east as Iowa Hill, most of the yellow pine, practically all of the sugar pine, and much of the red and white fir having been cut off long ago. Extensive hydraulic mining around Iowa Hill has also contributed to the thin and patchy character of the forest, as also have hot and widespread fires. The trees in the stands are small and slender or defective—generally from rot or fire marks—and are set in underbrush of moderate density. From Iowa Hill to Forks House the forest is likewise thin, but less patchy than west of Iowa Hill. It has been logged throughout; excepting where steep ravines have prevented close cutting stands of moderate density have been left. The large quantities of white and considerable red fir rejected by the loggers give parts of the forest an aspect of heavy growth. On the steep, rocky slopes of the larger canyons the timber is uniformly thin and stocky.

In the eastern portion of the basin the yellow-pine type occurs in lines in the bottoms of the large canyons and in scattered patches on southern slopes. It is composed to the extent of 40 to 50 per cent of yellow pine, scattered trees of the remainder being sugar pine, white fir, incense cedar, and small percentages of

Shasta fir. Owing to rocky ground the stands are thin and the timber stocky and limby.

The Shasta-fir type along the main range of the Sierra at the head of the basin is of open growth throughout. Owing to rocky ground and to fires much of it grows in small patches separated by lanes or tracts of nonforested ground or with scattered trees. Near the crest of the range 30 to 40 per cent consists of Patton hemlock and white pine mixed with small quantities of western juniper; the summit of the range is almost devoid of timber. The growth has little value except for fuel and the general utility in controlling rapid run-off possessed by forest cover. At lower elevations on the spurs passing westward from the range the forest is more solid and compact, attaining great density on the northern slopes of the main canyon above and to the west of Heath Springs. It is here composed of 75 to 85 per cent Shasta fir, the balance white pine, scattered yellow pine, and white fir. On the ridges and flats north of the river the stands of this type are thin, owing to logging; the larger percentage is composed of lodgepole pine with small quantities of Shasta fir and white pine mixed, all set in heavy underbrush. On the ridges radiating from Monumental Hill the type varies. In the saddles of the ridges between Cisco Hill and Monumental Hill occasional stands of thickset, pure-growth Shasta fir occur, the trees from 2 to 4 feet in diameter, 85 to 100 feet in height. Generally, however, the forest is scattered thinly over the ridges, with here and there a compact body of heavy growth 10 to 15 acres in extent, or narrow lines or small, close groups of trees set in thick brush. Along the heads of the streams rising in Monumental Hill and adjacent ridges much of the type exists as nearly pure, close stands of lodgepole pine, slender in growth and crooked and bent by the crushing weight of the winter's snows.

LUMBERING

All the western and central areas, where accessible, have been logged or are in process of logging. The woodlands have been cut over many times for fuel and about 99 per cent of the timber has been removed. The timber in the main canyon has been culled here and there for local use in connection with placer-mining operations along its channel, or on accessible slopes where the ground was auriferous. South of the river logging operations have been extended over all of the basin as far east as Red Point. The cut has been from 35 to 95 per cent, the average for the district being about 60 per cent. Most of the yellow and sugar pine has been cut, the remaining timber chiefly consisting of red and white fir, incense cedar, and oak. East of Red Point the forest has been culled to a small extent for local use in mining operations, but has not been systematically logged. Southeast of Heath Springs about 200 acres have been cut over, not very closely, however, and the felled timber has been allowed to

remain where cut. North of the river the basin has been closely logged, especially near the railroad. In all accessible places to the head of Sixmile and Wilson valleys the cut amounts to 95 per cent, and only culls of red and white fir with oak and incense cedar remain. South of Wilson Valley, in the region of Texas Hill, and in the canyons stretching west from Monumental Hill the cut ranges from 10 to 70 per cent, depending on the accessibility of the different tracts. The farthest point east, on this side of the river, to which logging operations have extended is situated about a mile east of Texas Hill on the ridges along the brink of the main canyon. The timber on this tract was being logged at the time this examination was made, and the cut amounted to 2 or 3 per cent.

The area situated south of the river in the eastern sections of the basin has been culled a little here and there for local use, but the region is too difficult of access for general logging, and the timber is of poor quality throughout the district.

The amount of standing mill timber in the basin in M feet B. M. is as follows:

Amount of mill timber in North Fork American River Basin

	Michigan practice.	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	380,000	305,000
Sugar pine	296,000	250,000
Shasta fir	261,000	170,000
Red fir	175,000	96,000
White fir	61,000	51,000
White pine	9,000	8,000
Total	1,182,000	880,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—Chiefly oak to the extent of 85 to 90 per cent, scattered Digger and yellow pines of small size, and rarely a few red firs in the side ravines leading down to the main canyon; low and scattered undergrowth; no mill timber.

Grade 2—less than 2,000 feet B. M. per acre.—(1) From Colfax to head of Sixmile Valley: Scattered yellow pine, 50 to 60 per cent red fir, 6 to 20 per cent white fir, here and there a sugar pine of small size, 5 to 15 per cent incense cedar, large quantities of low, brushy oak; a region closely logged of its yellow and sugar pine, large-size red and white fir, chiefly culls left, or small blocks of timber of medium quality and size, growing on tracts difficult of access; average capacity from 500 feet B. M. per acre in the western portion of the district to 1,200 feet B. M. in the eastern. (2) Region around Monumental

Hill. Red and white fir, yellow pine of small size, much oak, all in heavy underbrush; region logged and repeatedly burned over; 25 to 40 per cent of remaining timber defective from rot and fire marks. (3) Region south of Haysinck Lake: Along the higher levels Shasta fir and white pine, with here and there stands of lodgepole pine; at lower elevations scattered yellow pine, red and white fir; the forest throughout extremely difficult of access; timber all set in low chaparral and of poor quality, owing to fire marks and rocky, sterile soil. (4) Region south of Devil Peak. Shasta fir and white pine, a few scattered yellow pine, all set in heavy undergrowth, or mixed with stands of lodgepole pine; timber throughout of small dimensions and poor quality. (5) Slopes of main divide at head of basin. Shasta fir, white pine, Patton hemlock; at the lowest elevations a few yellow pines, rarely a sugar pine; thin stands, mostly occurring in isolated groups or in thin lines, generally separated by grassy or brushy tracts; timber of poor quality, stunted growth, and difficult of access. (6) South of the river from Iowa Hill east: Chiefly red and white fir, yellow pine 5 to 15 per cent, sugar pine less than 1 per cent, incense cedar, and oak; tracts all logged, from 800 feet B. M. to 1,500 feet B. M. per acre remaining. (7) Main canyon of river. Thin stands of the ordinary yellow-pine type; trees of slender growth owing to rocky soil, occasionally stocky and of large diameter; entire area difficult of access.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) Colfax to Emigrant Gap: Red fir, 40 to 60 per cent; white fir, 10 to 30 per cent; scattered yellow pine, incense cedar, and oak; entire district logged and remaining timber mostly composed of culls. (2) Region around Texas Hill: Yellow pine, 5 to 15 per cent; sugar pine, less than 1 per cent; large quantities of red fir, white fir, incense cedar, and oak; most of the district logged, but not very closely, owing to broken ground, deep canyons, and steep ridges; timber generally of small size but of fair quality. (3) Region southeast of Monumental Hill: At the higher levels, 6,000 feet and upward, Shasta fir is the prevailing species, of small and stunted growth; scattered yellow pine; all in heavy undergrowth and practically inaccessible; at lower altitudes, yellow pine, 30 to 50 per cent; sugar pine, 5 to 10 per cent; red and white fir, with incense cedar; timber of fair quality, but in very uneven stands, and mostly on steep slopes or on narrow ridges between deep canyons; extremely difficult of access; average capacity in mill timber of this and the preceding district, about 4,000 feet B. M. per acre. (4) Region around Devil Peak: Shasta fir of slender growth, white pine, stocky and limby; all of poor quality, set in thick underbrush and difficult of access. (5) Region at the head of the basin: Shasta fir, 60 to 80 per cent; yellow pine at the lower elevations, 3 to 10 per cent, at the higher altitudes lacking; white pine throughout, sometimes of good quality and size, 2 to 3 feet in diameter, clear trunks 20 to 30 feet in length; Patton hemlock at the highest elevations, but of small size and

unsuitable for mill timber; stands scattered in close, compact blocks or as thin lines bordering creeks and glades; average capacity by close cutting about 3,800 feet B. M. per acre; generally difficult of access. (6) South of American Royal Gorge: Shasta fir, 60 to 80 per cent; balance scattered yellow pine, white pine, and white fir; timber in uneven stands, separated by tracts of rocky ground; extremely difficult of access, owing to steepness of the ridges and great depth of the canyons. (7) Region along slopes of the main canyon east from Humbug Creek: Yellow pine, 10 to 40 per cent; sugar pine, 3 to 5 per cent; Shasta fir, 5 to 20 per cent; red and white fir, incense cedar, and small percentages of oak; stands of fair quality difficult of access, broken in all directions by lanes of brush growth. (8) From Humbug Creek to Iowa Hill: Yellow pine, 5 to 80 per cent; sugar pine, 3 to 60 per cent; red fir, 70 per cent; white fir, incense cedar, and oak; tracts easy of access; culled of their best yellow and sugar pine; large quantities of red fir remaining; timber of inferior quality; underbrush moderate; average stand about 3,900 feet B. M. per acre by close cutting. (9) Areas west of Iowa Hill: Culls of yellow pine, occasionally a sugar pine, mostly red fir, incense cedar, and oak; the red fir of slender growth and largely set on slopes too steep to be readily logged.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Region around Texas Hill: Yellow pine, 30 to 50 per cent; sugar pine, 5 to 10 per cent; red fir, 50 to 60 per cent; incense cedar, and oak; partly logged where accessible; much undergrowth; timber set on steep slopes. (2) Region between Monumental Hill and Devil Peak: Seventy-five to 80 per cent Shasta fir in close stands of fair quality, scattered yellow and white pine; all practically inaccessible. (3) Region at the head of the basin: Shasta fir, 65 to 85 per cent in open stands, but of large growth at the lower levels; white pine, Patton hemlock, here and there yellow pine in small quantities, short of body, rarely a few sugar pines; average stand of this and preceding districts of the grade 8,500 feet B. M. per acre. (4) South of the main canyon from Heath Springs to Humbug Creek: Shasta fir, 75 to 90 per cent of large growth, but 10 to 20 per cent defective from rot induced by fires; white pine; scattered yellow pine; all difficult of access; average capacity about 9,000 feet B. M. per acre. (5) Region between Iowa Hill and Humbug Canyon: Yellow pine, 10 to 25 per cent; sugar pine, 10 to 18 per cent; red fir, 25 to 45 per cent; white fir, 20 to 30 per cent; some incense cedar and oak; district culled throughout and here and there closely logged, but containing moderately heavy stands of timber in numerous localities; average stand about 9,500 feet B. M. per acre.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Region around Texas Hill: Yellow pine, 30 to 40 per cent; sugar pine, 35 to 40 per cent; red and white fir, 20 to 30 per cent; first-class timber; yellow and sugar pine 2 to 5 feet in diameter, 20 to 40 feet clear trunks; not easy of access, but reached by way of Texas Hill; average

stand 23,000 feet B. M. per acre. (2) East and southeast of Monumental Hill: At elevations above 6,000 feet, Shasta fir, 75 to 85 per cent; scattered yellow and white pine; at lower altitudes, yellow pine, 40 to 60 per cent; sugar pine, 20 to 30 per cent; red and white fir, incense cedar, and oak; heavy blocks of timber, but of small acreage, or in narrow thick lines following the canyons; good quality; difficult of access. (3) Southwest of Heath Springs: Shasta fir, 65 to 85 per cent; white pine, 5 to 10 per cent; yellow pine, 60 to 80 per cent; heavy stands, but uneven owing to past fires; set on steep slopes and moderately difficult of access; average stand about 19,000 feet B. M. per acre. (4) Between Iowa Hill and Humbug Creek. Yellow pine, 8 to 15 per cent; sugar pine, 18 to 20 per cent, red fir, 20 to 40 per cent; white fir, incense cedar, and oak; logged throughout, but not closely; remaining timber of good quality, with an average stand of 20,000 feet B. M. per acre.

Grade 6—over 25,000 feet B. M. per acre.—(1) South of Texas Hill: Yellow pine, 30 per cent; sugar pine, 60 per cent; balance red and white fir, incense cedar, and oak; an excellent block of timber, in good preservation; accessible by way of northern slopes of Texas Hill; average stand 50,000 feet B. M. per acre. (2) East of Monumental Hill: A block of timber composed of large, thickset Shasta fir situated in a broad saddle on summit of the divide between Cisco and Monumental Hill; stand 55,000 feet B. M. per acre. (3) Southeast from Heath Springs: Sugar pine and yellow pine from 10 to 20 per cent of each; Shasta fir, 35 to 50 per cent, in close stands occurring at and above the 6,500-foot contour; a small tract of heavy timber on a flat or gently sloping piece of land; difficult of access from outside; average stand 30,000 feet B. M. per acre.

FIRES

Fires have been quite as widespread in the North Fork of American River drainage as in the Yuba or Feather River basins, but the damage has not been so great. The percentage of badly burned tracts, however, is rather larger, proportionally, while those upon which the destruction of the timber has been total are less. The acreage of the different classes of burns is as follows:

<i>Burned areas in North Fork of American River Basin</i>	
	Acres
Fire-marked.....	157, 210
Badly burned.....	68, 290

As the forested, wooded, and chaparral areas comprise in the aggregate 164,810 acres, it follows that nearly 98 per cent of the area bearing or having in the past borne arborescent growth has been overrun by fire of sufficient intensity at least to leave its mark on most of the growth, while on a little more than 24 per cent of the area the destruction has varied from 50 per cent to total. As elsewhere, the destruction has been far more severe in the areas covered with Shasta fir than

in the stands of yellow-pine forest; hence, the larger proportion of severe burns occurs in the eastern part of the basin. There is a definite and intimate connection between the burns that have ravaged the Shasta-fir stands in the Yuba and Feather river basins and those which have laid low that type of timber in North Fork of American River drainage. One set of burns blends into the other, but why the forest has not been destroyed to the same extent in this as in the other basins mentioned is not clear.

Beginning with the western area of the basin north of the river, we find the woodland fire marked throughout. Not much damage has apparently resulted, but as the fires burned long ago, ample time has elapsed for the obliteration of most of the traces of those early fires. From the western limits of the forested regions to Emigrant Gap the traces of fire are more obvious. Partly or wholly dead timber seared by fires and the brush growths following in their wake exist in every canyon and on every ridge. The region has been logged and the damage done can only be approximated; probably 20 per cent is under rather than over. The region showing the most extensive devastations by fire begins on the western slopes leading up to Monumental Hill and continues to the head of the basin. Every slope and canyon radiating from the group of ridges of which that point forms the culmination has been visited by fire. At the lower elevations, where the yellow-pine type is the prevailing forest, the damage has been largely confined to the red and white firs, amounting to 15 or 20 per cent. At the higher altitudes, where the Shasta fir constituted the chief tree in the stands, the damage is fully 80 per cent, except in a few small tracts east of the summit of Monumental Hill, which, from some cause, the fires did not reach. East of Monumental Hill the forest is burned to the extent of 75 per cent on all the ridges at the head of Granite Canyon, Big Valley, and in general everywhere in the watershed as far east as Onion Creek. The fires have raged alike in the Shasta-fir and yellow-pine forest, here burning long lanes clear of timber, there destroying large blocks of forest, leaving behind isolated trees or small groups fire scarred or half consumed, and covering, as a sequel, ridge and slope with matted brush growths. At the head of the canyon the fires burned out the timber in spots here and there, and doubtless are responsible for the grassy tracts and thin, scattered stands of forest which characterize the slopes of the main range.

South of the river at the head of the basin the fires have burned out patches of timber in the midst of heavy stands, thinning the forest in other localities, the damage amounting to 35 per cent. Thence westward there is a line of heavy burns following the main canyon. The fires ate their way through what originally has been a heavily forested tract along the upper slopes of the canyon,

completely burning up wide blocks of timber and greatly thinning what they did not wholly destroy; the damage has been about 30 per cent. From Red Point westward to the woodlands the forest is fire marked nearly throughout, small stands, especially of red and white fir, having been burned out here and there, the destruction in isolated localities amounting to 50 or 60 per cent, while the average is approximately 5 per cent, as near as can be judged at this time, as most of the fires burned long ago and their traces have been obliterated to some extent by subsequent logging operations.

REPRODUCTION

Restocking of the woodlands is slow and uncertain. It is not keeping pace with the quantity cut for fuel, and the total denudation of these tracts is only a matter of a few years. On the logged areas north of the river reproduction is only moderate. As far east as Shady Run young growth in dense stands occurs here and there pretty much as in the Yuba basins, but farther eastward there is a noticeable diminution of the restocking processes. All along the Blue Canyon and Canyon Creek drainage a large proportion of the reforestation consists of scrubby oak instead of the coniferous species of trees which formerly constituted the timber in these localities. The extensive and heavy stands of brush which have here come as a sequel to fires show no sign of being replaced with tree growth. Around Texas Hill, along the slopes of Monumental Hill, and eastward to the head of the basin few of the logged or burned areas exhibit much young growth. All the higher slopes of Monumental Hill are covered with dense chaparral, which will not be replaced by forest for a century or more. The slopes and ridges situated within the Granite Canyon and Big Valley drainage show but little young growth. They are covered with chaparral, sometimes dense, in many places thin, but even where the brush growths are light the soil seems to have acquired a semiarid condition inimical to a renewal of the forest growth. Around Devil Peak and eastward to Onion Creek, wherever the timber has been so thinned and destroyed that brush has gained the ascendancy, there is no reforestation worth mentioning. Where this has not happened lodgepole pine is restocking the thinned tracts in larger proportions than it existed in the original growth. At the head of the basin reproduction is scanty. In the places where hot fires have burned and brush has come in no young growth, or at least only a very scanty one, is visible. On the slopes of the main range and, in general, wherever fires have given rise grassy or weed-covered openings the excessive sheep grazing to which such tracts are subjected is an absolute bar to any restocking, however scanty.

South of the river there is a moderate amount of young growth springing up everywhere in the logged areas, but in no locality does one meet with the extremely

dense sapling stands so characteristic of the restocking processes in the yellow-pine forests of the Yuba basins. The young growth is coming up in moderately thickset stands or is thinly and evenly dispersed. Where brush growths have obtained a firm foothold no more sign of reforestation is visible here than elsewhere in the basin. In the Shasta-fir stands on this side of the river reproduction is much better than north of the stream, solely owing to the prevalence of northern exposures, which insure a higher degree of soil humidity during the summer than do the south-facing slopes north of the stream. But wherever chaparral or heavy undergrowths occur, no matter on what sort of slope, there is practically no restocking going on.

The composition of the young growth is chiefly dependent on the presence of seed trees of any particular species. Throughout the yellow-pine forest there is a noticeable deficiency of sugar pine and an abnormal increase of incense cedar. The sugar pine in the coming forest, if allowed to grow and not cut for poles, will not amount to 1 per cent, whereas it was probably from 6 to 10 per cent in the stands before logging, while the incense cedar will form 10 to 20 per cent against a former 5 or 8 per cent. The yellow pine is holding its own, or if any change is taking place the ratio of the species is increasing; white and red fir show no great change. In Canyon and Blue Creek drainage the oak is increasing in immense proportions, in some localities forming 50 to 60 per cent of the young growth. However, the oak will eventually thin into open stands, and coniferous species will again occupy the ground.

The Shasta-fir type of forest generally restocks with Shasta fir as the chief species. Sometimes, however, lodgepole pine comes in and constitutes a larger proportion than the Shasta fir. This happens on ground adjacent to lakelets, glades, marshy localities, or creek bottoms, where the Shasta fir has been burned out or cut away, and where brush, by reason of altitude or other causes, has not come in to cover the ground. Patton hemlock and white pine also appear in reforestation of this type, rarely, however, in any but small percentages.

CHAPARRAL

The tracts classed as chaparral comprise in round numbers 6,000 acres, and are situated partly on the slopes of Monumental Hill and adjacent ridges, partly on the northern slopes of the main canyon between Red Point and New York Canyon. Above the 7,000-foot level the brush thins out, and mostly disappears at altitudes of 7,500 feet. In the stands of Shasta fir the undergrowth is composed of manzanita (*Arctostaphylos patula*), *Ceanothus cordulatus*, and *C. velutinus*. Chinquapin is generally present at the lower altitudes and more or less scrub oak. At the upper limits of the yellow-pine stands the composition of the undergrowth is very similar to that in the Shasta-fir forest, while at the middle and lower

elevations *Ceanothus integerrimus* and manzanita (*Arctostaphylos glauca*) replace the species of manzanita characteristic of the Shasta-fir forest, the chinquapin, and the scrub oak. In the woodlands *Ceanothus cuneatus* is the prevailing species of undergrowth, but is not abundant in any locality

BASINS OF MIDDLE FORK OF AMERICAN RIVER AND RUBICON RIVER

There is included within the limits of the present examination a portion of Middle Fork of American River Basin, comprising about 198,000 acres, and a tract draining into Rubicon River containing, approximately, 45,120 acres. The two areas are here treated together.

TOPOGRAPHY.

Middle Fork of American River heads in a narrow basin in the main range of the Sierra Nevada, between Needle Peak and Mount Mildred. The main branch of the river and all its lesser tributaries lie here in gorge-like channels. About 5 miles west of its head in Mount Mildred the river emerges from its upper gorge into a comparatively flat valley from one-half to 1 mile in width. The lower end of the valley widens into a gravelly flat called French Meadows. At the foot of this flat the river takes a plunge into an extremely narrow, rocky gorge, a mere trough cut through the granite. In the space of 2 or 3 miles the gorge attains a depth of 1,000 to 1,500 feet below the inclosing ridges, which it maintains throughout its course within the limits of this examination. The river receives a considerable number of large tributaries, all entering the stream from the north and all sunk in gorge-like canyons of considerable depth.

The eastern portions of the drainage basin of the stream are extremely rocky and of rather high relief. The region has been extensively glaciated and to the scoring and erosive powers of ice is due the great number of gorges which here form the stream channels. The slopes of the main range at the head of the basin are rocky and steep. Most of its summits are mere hogbacks, and the spurs radiating westward resemble it in this feature. Great quantities of boulder drift and glaciated detritus are deposited in the canyons and along their slopes. The altitude of this portion of the basin, exclusive of the canyon of the river, varies from 5,000 feet in the valleys to 8,500 feet on the summits of the main range; the mean is about 6,700 feet.

Between the eastern areas of high relief and the western portions of the basin lies a region which may be considered as once having formed a plateau, now consisting of a series of flats or tracts of gentle relief separated by deep gorges which form the basin of North Fork of Middle Fork. Deep Canyon cuts the tract in two. The southern half varies in altitude from 4,000 to 6,000 feet and consists of a series of flat terraces sloping gently to the west, where it

suddenly breaks off to the canyon of Middle Fork of American River. It is gashed by a number of long ravines, none of great depth. This flat is overlain by gravel deposits and exhibits no clear signs of glaciation. The northern half is a rocky glaciated region into which large canyons have eaten long, deep gorges.

The western district of the basin consists of a region of low relief containing about 10,000 acres, terminating at its southwestern extremity in a narrow ridge about 1 mile in width, which forms the crest of the divide between the Middle Fork and North Fork of American River. The ridge slopes sharply to the main canyon of Middle Fork and is cut into by several gorge-like canyons. None of these areas show evidence of glaciation. The altitude of the district varies from 3,000 to 4,500 feet, the mean being about 3,600 feet, exclusive of the main canyon of the river.

The Rubicon River heads in a high glaciated area of bare rock lying south of the region examined. Within the region examined the stream is sunk in a tremendous gorge from 3,000 to 3,500 feet in depth, remarkable for the almost perpendicular rock walls which inclose it. The gorge is a monument to the erosive power of the glaciers that anciently mantled the mountains at the head of this river. The bottom of the gorge is a succession of cliffs, rocky terraces, and hollows, some of them holding ponds or lakelets. The river drains a considerable portion of the slopes of the Sierra main range within our limits, extending from Squaw Peak southward. All the streams heading in the main range north of Millers Creek lie in deep, rocky canyons, with slopes extremely steep, and masses of bare rock, torn and gashed by glaciers which long ago disappeared, covering large tracts of their bottoms. Where the canyons break off to the Rubicon gorge the descent is extremely precipitous. The heads of most of these tributary canyons lie in amphitheatres of glacial origin, a series of lakelets or ponds usually forming their ultimate heads. South of the Rubicon the small tract of country included within our limits consists of a bare sheet of granite worn into ridges and hollows by ancient glaciers and dotted by numerous lakes. The altitude of the basin varies from 5,800 to 9,000 feet, the latter elevation at the head of Five Lakes Creek in the main range of the Sierra.

SOIL.

Owing to the extensive glaciation to which the eastern areas of both basins have been subjected the soil is thin and gravelly everywhere on the ridges and slopes and in most of the canyon bottoms as well. The canyon slopes of Rubicon River are often mere stretches of bare rock, or, where the angle of slope is less than 60°, great masses of drift boulders have accumulated, with small quantities of soil in the interstices. The bottom of this canyon is a succession of bare rocky crags, drift boulders, and here and there small gravel bars and flats with thin soil. The slopes of the main range of the Sierra at the head of Middle Fork

of American River are rocky, gravelly, and bowlder strewn almost everywhere. In some places on the northern slopes where the declivities are more gentle a moderate depth of soil has accumulated. This is likewise the case in the hollows and flats at the heads of creeks where washings of soil from surrounding slopes have formed deposits. Much of the rock formation of the region consists of brecciated lavas, which, when worn down, broken up, and pulverized appears to make good soil for forest growth, although of a rather unpromising appearance. Most of the heavy timber stands of this portion of the basin grow in soil of this character. The larger valleys, such as Grayhorse Valley, French Meadows, etc., are underlain by deposits of glacial gravel which are capped with thin layers of soil. The summits and flat tops of the ridges west and south of Duncan Peak are covered with soil of moderate depth, largely derived from adjacent volcanic rocks by glacial excavation. West and south of Red Point the soil is mostly of the characteristic red variety and covers the region more or less deeply, depending on local features of erosion.

In general, it may be said that outside the extremely rocky and bowlder-strewn slopes of the Rubicon River Canyon and the glacial basins and amphitheatres in the main range of the Sierra at the head of branches of Middle Fork of American River the region is covered with a soil deep enough to sustain a forest above medium density.

MINING.

The eastern portion of the basin is not mined; it is probably auriferous, but possibly not to paying capacity. West of Duncan Peak the gravel deposits carry placer gold and have been worked from early days. Here, as usual, are found the gravel beds, torn up in all directions by the hydraulic giants wherever the required head of water could be obtained. There is little quartz mining.

AGRICULTURAL LAND.

The lands under tillage are situated in the western portion of the Middle Fork Basin and consist of small clearings around the mining villages. None of them are of any importance, and the total area amounts to only 600 acres. A much larger acreage is susceptible of tillage on the flat tops of the ridges north and east from Forest City, if water for irrigation could be obtained. The eastern portions of both basins contain no agricultural land whatever.

PASTURE.

All the accessible portions of both basins are pastured, the western by cattle, the eastern by cattle and sheep. The western sections never produced much grass, and what little once grew there is now pretty closely eaten out. The eastern areas are the chief pasture grounds of both basins. The slopes of the Sierra

main range and of all the higher spurs are grassed over with a low growth of grass and sedge in the spaces between the scattered blocks of forest. There is also a grassy margin to all the little ponds at the head of the northern tributaries of the Rubicon River, and the creek bottoms above the 6,500-foot level generally have small patches of grass land in open glades too wet for the growth of timber or in the park-like lodgepole-pine stands which are of frequent occurrence. Along the slopes of the Long Canyon drainage the yellow-pine forest is of open growth in many places, and the ground bears scattered tufts of grass. The entire district east of Duncan Peak is one of the most important sheep-pasture areas in the region examined, and everywhere is closely sheeped off. The natural meadow lands of the basin, unsuitable for the production of timber owing to their marshy character, comprise about 1,100 acres and are situated along the bottoms of the streams entering the upper portion of Rubicon River from the north.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

Most of the region is forested, the woodland being limited to a small tract near Gray Eagle Bar. The acreage of the two classes is as follows:

Forest and wooded areas in Middle Fork of American River and Rubicon River basins

	Acres
Forested.....	218,700
Wooded.....	700
Total.....	219,400

The forested area comprises all of the basin except as noted above and the tracts classed as chaparral, lakes, bare rocks, pasture, and agricultural land; in the aggregate 25,120 acres. None of the tracts are at elevations above the timber line. Both types of forest—the yellow-pine and Shasta-fir—are represented. The area of each is—yellow-pine type, 138,700 acres; and Shasta-fir, 80,000 acres.

The yellow-pine type is the prevailing forest in all of the western areas with the exception of the region adjacent to Duncan Peak and the crest of the divide against North Fork of American River from that peak to Red Point. In the eastern portion it follows up the canyon of Rubicon River and crosses the main range of the Sierra in a thin line into Truckee Basin along the southern slopes of Miller and McKinney creeks. Where it crosses, the type consists of but two species, namely, yellow pine and white fir, the sugar pine not reaching the altitude of the pass by 800 feet and the red fir falling short nearly 1,600 feet. Elsewhere in the eastern districts the type extends up the main canyon of the

Middle Fork of American River nearly to its head, reaching elevations of 6,800 feet on the southern slopes of the canyon and 6,500 feet on the northern declivities. In the canyons of the smaller tributaries it usually ceases at elevations of 6,500 feet, although the yellow pine as a species ascends to altitudes of 7,800 feet in favorable situations.

The Shasta-fir type is the prevailing forest in the eastern areas of both basins. It covers all the ridges and summits from the 6,800-foot level to the highest altitudes, while on the northern declivities it often descends to the 5,600-foot level. In the western portions this type forms the forest on all the ridges around Duncan Peak within a radius of 2 or 3 miles and extends in scattered stands along the crest of the divide westward to near Red Point.

CHARACTER OF FOREST

There is a great deal of variation in the composition and aspect of the yellow-pine type in the basins, due partly to logging operations, partly to natural environments. The Shasta-fir type is of more homogeneous make-up and varies only along strictly altitudinal lines, the changes principally affecting the relative proportions of Patton hemlock and white pine.

In the western area the yellow-pine forest begins with thin stands composed of red fir, yellow pine, and incense cedar; occasionally a sugar pine is seen, and here and there in the canyons above 3,000 feet are small quantities of white fir. Most of the yellow and sugar pine was cut out long ago; hence the red and white fir predominate. The composition of the forest on these tracts, mostly situated west of Mayflower, is as follows:

Composition of yellow-pine forest west of Mayflower

	Per cent
Yellow pine	20
Sugar pine	1
Red fir	59
White fir	2
Incense cedar	10
Oak	8

The timber is small and of slender growth, set in moderately heavy underbrush, with an average stand of about 2,800 feet B. M. per acre. In the tract between Mayflower and Michigan Bluff there is an increase in the proportion of yellow and sugar pine and a corresponding decrease in the proportion of red fir; white fir also appears in large quantities, while incense cedar and oak are nearly the same. The tract has been extensively logged. The remaining forest is thin, set in irregular blocks, the heaviest stands occurring where red and white fir originally formed a large percentage of the forest. East of Michigan Bluff to

Big Oak Flat the region is a succession of steep canyon slopes and narrow crests. The forest is mostly yellow pine, not having been logged; the stands are thin and scattered, everywhere broken by tracts of chaparral or rocky exposures with little soil and hardly any tree growth. In an area extending eastward from Big Oak Flat to the canyon of Duncan Creek and northward across Deep Canyon to the summit of the divide against North Fork of American River lies the most valuable block of forest in the basins, unlogged because extremely difficult of access. The tract carries a heavy stand of timber, which on the area south of Deep Canyon is much denser than north of this stream. The composition of the stand in the southern portion of the tract is as follows:

Composition of yellow-pine forest south of Deer Creek

	Per cent
Yellow pine	30
Sugar pine.....	15
Red fir	35
White fir	10
Incense cedar.....	5
Oak.....	5

While in the northern area red fir is present in smaller proportions, white fir in larger, yellow and sugar pine in nearly the same percentages, along the higher levels Shasta fir comes in to the extent of 80 per cent. The stands are of good dimensions. In the northern areas rocky canyons interrupt the continuity of the forest, but south of Deep Canyon, owing to the flatness of the region and comparative freedom from destructive fires, the stand is fairly uniform. The trees are not set closely, averaging from 30 to 55 trees of mill size per acre, but are remarkably uniform in height and diameter; most of them 2 to 3 feet in diameter, 35 to 40 feet clear trunk. There is little undergrowth on the southern tracts; a moderate amount on the northern. The stand of merchantable timber per acre varies from 18,000 feet B. M. for the lighter stands to 45,000 feet B. M. for the heaviest. In the Duncan Canyon drainage the forest has been so extensively burned that the stands are extremely uneven. They occur in blocks, mostly of small extent, separated by narrow lanes of brush or thinly scattered through dense masses of undergrowth. At the head of Duncan Canyon and around Duncan Peak the forest is extremely thin and uneven, most of the timber being of the Shasta-fir type, badly burned, with brush following in great quantities. The remainder of the forest is set in thick chaparral or in straggling lines along the water courses and hillsides. In canyons and on northern slopes the trees are tall, of medium diametrical dimensions, but of poor quality, owing to the fire marks. On the ridges, where the ground is rocky and soil thin, the trees are stocky and limby. In the lower and middle portions of the Long Canyon drainage

most of the hillsides facing east or south bear stands of 60 or 70 per cent yellow pine, the balance made up of incense cedar and red and white fir. In the bottoms the sugar pine forms 6 to 10 per cent of the forest, while red fir frequently constitutes 40 to 60 per cent. On northern and western slopes the larger percentage of the stands consists of incense cedar and red and white fir. All the timber in this drainage is set in heavy underbrush. It has been greatly damaged throughout by successive fires, and most of the incense cedar, as well as much of the sugar pine, is hollow or rotten at the core in consequence. In the upper portion of Long Canyon drainage the forest consists of 75 or 80 per cent Shasta fir set in thick brush; most of it in small, irregular blocks, some in thin lines or as solitary trees scattered over the slopes. The middle portion of the main canyon of Middle Fork of American River, so far as it lies within the region examined, resembles Duncan Canyon in the character of its forest. Close-set stands alternate with thin lines of trees or scattered individuals rising out of heavy undergrowth. Yellow pine prevails to the extent of 40 per cent, with sugar pine, incense cedar and red and white fir. From the lower end of French Meadows to the head of the canyon the forest varies with elevation and the extent to which it has been burned. On the slopes west of the canyon the stands are open and consist of yellow pine, 60 to 70 per cent, small quantities of white fir and of Shasta fir. The flats bordering the river are covered with stands of lodgepole pine, mixed here and there with yellow pine, white fir, and Shasta fir. On the slopes east of the river the forest consists chiefly of white and Shasta fir, the yellow pine amounting to 20 or 25 per cent and the sugar pine from 3 to 4 per cent. Along the crests of the spurs most of the timber is Shasta fir. Yellow pine occurs as scattered trees, with white fir and white pine in small percentages. With the exception of a tract about 2 miles in length and one-half mile wide, bordering French Meadows on the east, the forest is patchy, sometimes by reason of rocky slopes, more often owing to wide breaks of brush-covered ground.

The forest on the slopes and in the canyon of Rubicon River below the mouth of Grayhorse Canyon is extremely thin. In the canyon bottom most of it exists as scattered trees on masses of boulder drift or in crevices of rocks. Here and there on gravel bars, accumulated in sheltered spots, are small blocks of red and white fir. On the northern slopes all forest cover is lacking over large areas, or it exists as thin lines of trees following down the side canyons, or more frequently as solitary trees dispersed over rocky slopes. On the southern declivities the forest occurs as isolated blocks of thin growth standing in heavy underbrush on boulder-strewn slopes. Yellow pine forms 25 to 40 per cent; white fir most of the remainder. Above Grayhorse Creek the slopes leading into the Rubicon Canyon are excessively abrupt and carry little forest. South of the river from McKinstry Peak eastward

to its head there is nothing on the slopes that can be termed forest. The region is bare rock, with solitary trees or narrow lines here and there in crevices of the rocks or along the water courses. North of the river the canyon slopes are less rocky, most of the timber being Shasta fir, with a small proportion of yellow pine.

The upper areas of all the streams entering Rubicon River and Middle Fork of American River from the main range of the Sierra bear blocks of forest in which Shasta fir forms the chief species to the extent of 70 to 90 per cent. Around glades, on flat, wet bottoms of canyons and on slopes with much seepage, lodgepole-pine stands occur. They are always parklike and open and of nearly pure growth. At the highest elevations and occasionally on northern slopes there are stands of timber composed of white pine and Patton hemlock, with the Shasta fir forming only 15 or 20 per cent. The timber on all these tracts is of poor quality. It is short of body, and in trees of middle age usually defective from rot. The timber is set either thinly, the trees dispersed with a tolerable degree of uniformity, or in scattered bunches, separated at the highest altitudes by grass-covered tracts and by brush at the lower.

LUMBERING

The areas on which the timber has been cut or culled more or less systematically comprise in the aggregate 47,500 acres, or a trifle more than 21 per cent of forest and woodland combined. Most of the cutting has been done in the areas of the Middle Fork of American River Basin, the cutting in the Rubicon River Basin being limited to timber for local use—as fuel, and the like.

The area logged extends from Forest Hill, or rather from a point a few miles farther west, at the head of streams emptying into the North Fork of American River, to Westville. Eastward beyond this point there has been a small amount of cutting all along the crest of the divide against North Fork of American River to Duncan Peak, wholly for local use in mining.

The tracts systematically logged are situated between Forest Hill and Red Point. The cut varies all the way from 10 to 95 per cent, the average being about 60 per cent of the original growth as nearly as can be judged by the stumps. The logging has been selective, most of the best yellow and sugar pine having been cut and the larger percentage of red and white fir left, but owing to local demand more of these species has been cut than has been the customary practice in the basins north within the region examined. The heavy forests east of Big Oak Flat have not been touched, owing to difficult transportation.

The amount of standing merchantable timber in the basin in M feet B. M. is as follows:

Merchantable timber in North Fork of American River and Rubicon River basins

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M.</i>
Yellow pine.....	850,000	610,000
Sugar pine.....	485,000	440,000
Shasta fir.....	305,000	180,000
Red fir.....	680,000	420,000
White fir.....	90,000	57,000
White pine.....	7,000	5,000
Total.....	2,417,000	1,712,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 1—woodland.—(1) Bottom of main canyon near Eagle Bar: Digger pine, oak, scattered yellow pine; no mill timber.

Grade 2—less than 2,000 feet B. M per acre.—(1) Scattered areas from Forest Hill east to Last Chance: Yellow pine, 5 to 25 per cent; sugar pine, 1 to 10 per cent; red and white fir, incense cedar, and oak; the western and central portions of the district were logged many years ago and the best timber cut off; the eastern portion consists of deep canyons, steep slopes, and narrow ridges, with timber very much scattered, generally of small size and inaccessible from without. (2) Region around Duncan Peak: Shasta fir, 70 to 90 per cent; small quantities of white pine, occasional trees of yellow pine, white fir, and incense cedar; all on rocky ground, difficult of access, and poor in quality. (3) Region around French Meadows: Shasta fir, 75 to 90 per cent, mostly isolated trees or small groups in dense brush on rocky slopes and crests of the ridges; badly burned; 60 per cent destroyed by fire, and the remainder defective to the extent of 20 per cent. (4) Slopes to Rubicon Canyon: The lower areas, scattered yellow pine, red and white fir, a good deal of small oak, all of very poor quality; the higher portions, Shasta fir, 85 to 90 per cent; white pine here and there; small quantities of Patton hemlock; part of the tracts with thin stands of timber owing to severe fires, part thinly stocked by reason of rocky areas mostly bare of soil; all inaccessible. (5) Main range of Sierra Nevada at head of basin: Thin, scattered stands of Shasta fir, white pine, Patton hemlock, and lodgepole pine, the former constituting 85 to 95 per cent of the growth; partly set in dense brush, partly as small groups or isolated trees on grassy slopes or margining marshy swales.

Grade 3 -2,000 to 5,000 feet B. M. per acre.—(1) Main range of Sierra at heads of basin: Shasta fir, 75 to 90 per cent; white pine and Patton hemlock; scattered trees of yellow pine at the lower elevations; timber poor in quality, generally inaccessible, set on rocky ground, steep slopes, in bottoms of glacial amphitheaters, and sometimes in small close stands, often thinly dispersed; at the lower and middle elevations set in dense brush, at the highest altitudes separated by narrow tracts of grass, sedge, or weed-covered openings. (2) Areas draining into Rubicon Canyon: Elevations above 6,500 feet, Shasta fir, 75 to 85 per cent; white pine and Patton hemlock, 4 to 5 per cent; white fir and scattered yellow pine up to the 7,000-foot level, all in small isolated blocks, with heavy undergrowth growing on steep slopes and high summits; generally inaccessible; below 6,500 feet yellow pine, red fir, white fir, incense cedar, oak in considerable quantities on southern declivities, Shasta fir, 10 to 15 per cent; on northern slopes 25 to 35 per cent; the stands set in rocky ground and containing much underbrush; timber generally poor, owing to damage received in successive fires; average stand of timber, 3,500 feet B. M. per acre. (3) Long Canyon drainage: At the head, Shasta fir, 60 to 80 per cent; scattered yellow pine and white fir; heavy undergrowths in all the stands; timber damaged by fire, 25 to 35 per cent; central area, yellow pine, 25 to 30 per cent; red fir, 35 to 45 per cent; white fir 20 to 30 per cent; incense cedar, scattered sugar pine; on the northern slopes, Shasta fir, 25 to 30 per cent, replacing red fir and yellow pine to that extent; stands thin and uneven, set in rocky ground, with much underbrush, and damaged by fire 20 to 30 per cent; average stand of timber about 4,000 feet B. M. per acre. (4) Region around French Meadows: Yellow pine, 18 to 30 per cent; white fir, 25 to 30 per cent; scattered sugar pines, Shasta fir, 30 to 80 per cent; small blocks of mixed forest or nearly pure stands of Shasta fir; the mixed forest set in heavy stands of lodgepole pine in the bottom lands, in thick brush on the slopes; the Shasta fir stands generally bordering small glades or creek bottoms. (5) Main canyon of Middle Fork of American River below French Meadows: Yellow pine, 25 to 30 per cent; red fir, 15 to 25 per cent; sugar pine, 5 to 18 per cent; white fir, incense cedar, oak; thin stands chiefly owing to past fires, damaged to the extent of 5 per cent; the yellow and sugar pine fair quality of timber; stands all set in heavy brush, mostly inaccessible, owing to steep slopes; average stand of timber per acre about 4,200 feet B. M. (6) Duncan Canyon: Yellow pine, 10 to 20 per cent; scattered sugar pine; red and white fir, 60 to 75 per cent; incense cedar, oak, and occasional Shasta firs; small blocks of timber growing on rocky ground, separated by lanes of brush growth; very difficult of access; damaged by fire to the extent of 25 to 30 per cent; average stand about 3,800 feet B. M. per acre. (7) Drainage basin of North Fork of Middle Fork of American River

Yellow pine, 30 to 40 per cent; balance red fir, white fir, incense cedar, and oak; open scattered stands growing on steep, rocky ridges and in the narrow bottoms of deep canyons; damaged by fire, 35 to 40 per cent. (8) Area between Forest Hill and Forks House: Yellow pine, 15 to 20 per cent; red fir, 30 to 50 per cent; sugar pine, 1 to 3 per cent; white fir, 8 to 10 per cent; incense cedar and oak; stands thin, having been logged and culled of the best timber during many years; average stand per acre about 4,200 feet.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Region between Michigan Bluff and Forks House. Areas cut and culled of most of the yellow and sugar pine, the remainder consisting of red fir, 70 per cent; white fir, 8 per cent; yellow pine, 15 per cent; sugar pine, 2 per cent; incense cedar and oak; timber of slender growth and medium quality. (2) South of Duncan Peak, at the head of Duncan Canyon: Yellow pine, 45 per cent; sugar pine, 10 to 15 per cent; balance red and white fir, with small quantities of Shasta fir on northern slopes; timber of good quality and dimensions in stands of moderate density; fire marked throughout, about 5 per cent badly damaged; mostly difficult of access; average capacity about 9,000 feet B. M. per acre. (3) Long Canyon: Yellow pine, 40 to 60 per cent; balance red and white fir, small quantities of sugar pine; timber of good quality, but of small dimensions, mostly less than 28 inches basal diameter; difficult of access. (4) Upper portions of Middle Fork drainage: Shasta fir, 60 to 80 per cent; at elevations above 7,000 feet, along the lower levels, yellow pine, 20 to 30 per cent; small quantities of red fir, white fir, and sugar pine; 30 to 40 per cent of the timber of large size—30 to 40 inches basal diameter, 20 to 40 feet clear trunk; damaged by fire 35 to 50 per cent; set in heavy underbrush, and generally difficult of access. (5) Areas draining into Rubicon River: Tracts situated mostly at high elevations; Shasta fir to the extent of 75 to 85 per cent; balance white pine, Patton hemlock, scattered yellow pine; stand per acre, 8,000 to 9,000 feet B. M.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Areas draining into Rubicon River: Shasta fir of moderate size, set in close stands; yellow pine 2 to 3 per cent, growing on steep slopes and generally inaccessible. (2) Upper areas of Middle Fork of American River drainage: Heavy stands of good-bodied timber, consisting of yellow pine, 60 per cent; sugar pine, 15 per cent; white fir, 10 per cent; red fir, 10 per cent; incense cedar, along the upper areas Shasta fir, 35 per cent, replacing all of the sugar pine and red fir and considerable of the yellow pine; stands forming fairly compact and uniform blocks; damaged by fire, 5 to 10 per cent; undergrowth moderately dense; difficult of access, owing to the broken character of the region; average stand, about 18,000 feet B. M. per acre. (3) Long Canyon drainage: Yellow pine, 50 to 60 per cent; sugar pine, 5 to 6 per cent; balance red and white fir, incense cedar, and oak; the yellow pine of

fair quality, stands on steep slopes and in the canyon bottoms, generally difficult of access; average capacity in mill timber about 20,000 feet B. M. per acre. (4) Region between Duncan Peak and Forks House: Yellow pine, 25 per cent; sugar pine, 8 to 15 per cent; red fir, 22 per cent; white fir, 20 per cent; Shasta fir, 8 to 10 per cent; incense cedar and occasionally a few oaks; region rocky; stands moderately dense, broken by numerous rocky canyons and gorges; timber of fair quality; damaged by fire, 5 to 10 per cent; large amount of underbrush throughout the stands; average stand of timber, about 20,000 feet B. M. per acre.

Grade 6—over 25,000 feet B. M. per acre.—(1) Region northeast from Big Oak Flat: Heavy stands of excellent timber, long bodied and clean; damaged by fire, 5 per cent; interrupted in some places by brush covering small acreage, yellow pine, 45 to 50 per cent; sugar pine, 25 to 40 per cent; red fir, 5 to 8 per cent; white fir, 10 to 15 per cent; incense cedar and oak; tract not logged and somewhat difficult of access; average stand per acre in mill timber 40,000 feet B. M. (2) Long Canyon drainage: Moderately compact bodies of timber composed of red fir, 50 to 70 per cent; balance yellow and sugar pine, white fir, and incense cedar, growing in wet canyon bottoms and set in dense underbrush, damaged by fire, 20 to 30 per cent; timber of large dimensions; red fir from 3 to 6 feet in diameter at base; sugar pine nearly as large; a very heavy body of timber before the fires; average stand, about 40,000 feet B. M. per acre. (3) Region east and south of French Meadows: A heavy and fairly uniform body of timber consisting of yellow pine, 20 to 35 per cent; sugar pine, 12 to 45 per cent; red fir, 10 to 15 per cent; white fir, 8 to 15 per cent, timber of large size, 3 to 4 feet in diameter, 30 to 50 feet clear trunk; damaged by fire, 5 to 15 per cent; undergrowth heavy; difficult of access from outside; average stand about 42,000 feet B. M. per acre.

FIRES

Nearly the entire extent of forest and woodland area in the basin is fire marked and a large percentage is badly burned, as is shown in the following table:

Burned areas in North Fork American River and Rubicon River basins

	Acres
Forest, woodland, and chaparral	231,900
Fire marked	229,000
Badly burned (including chaparral)	89,400

It will thus be seen that of the tracts bearing arborescent growth only 2,000 acres show no clear marks of fire. The probability is that no portion of the basins has been wholly exempt from fire during the past fifty or sixty years.

The eastern areas have suffered more from fire than the western. Most of the badly burned tracts are situated within the limits of the Shasta-fir type of

forest, as in all the basins north. However, owing to heavy stands of timber and much litter, there are plenty of badly burned tracts throughout the yellow-pine type as well.

In the area west of the main range at the head of the northern tributaries of Rubicon River, the Shasta-fir forest shows broad streaks of burned timber on all sides. The ridges bounding Powderhorn Creek on the east, the spurs radiating from Mount Mildred, and the tracts between Grayhorse Valley and Big Meadow have been burned over several times within the past thirty or forty years. Fully 60 per cent of the forest has been destroyed and in its place ridge and canyon bottom have become covered with thick growths of underbrush. The fires have burned their way southward into Rubicon Canyon, stripping the southern slopes of broad blocks of forest, burning long lanes nearly clear of timber, and thinning the remaining stands. As elsewhere, brush has followed as a sequel to the destruction of the timber. At the highest elevations along the main range stretches of ground formerly forested have become covered with grass, but such tracts are insignificant compared with the large areas which are brush-covered.

In all portions of the Long Canyon drainage there are big stretches of badly burned forest. Between Big Meadow and French Meadows 60 to 70 per cent of the timber has been destroyed, and the underbrush has, in consequence, become so dense that no living thing larger than a mouse can make its way through it. In the valley of Long Canyon 20 to 30 per cent of the timber has been destroyed. The former heavy stands of large incense cedar and sugar pine around Big Meadow are now chiefly remarkable for the great number of hollow trees which they contain—the work of successive fires. Down the Long Valley Canyon from Big Meadow 20 to 40 per cent of the red fir has been destroyed, and fully as much of the white fir, while both sugar and yellow pine have suffered severely. Everywhere the undergrowth, where the timber has not been wholly destroyed, has more than quadrupled in density, while on some of the southern slopes, like the ridges between Long Canyon and Rubicon River, soil aridity has followed to such an extent that the chaparral is scarcely able to obtain a foothold. All the areas around French Meadows tell the same tale and show the same picture of scattered broken stands of timber set in dense undergrowth, or separated by lanes of chaparral. All the way down the main canyon of the Middle Fork of American River there is a succession of these fire glades, alternating with heavy stands which serve to indicate the former density of the forest. All the slopes of Duncan Canyon from its head down show the same marks of fire—dead timber, dense undergrowth, stretches of chaparral, thin lines of trees or small groups rising out of the brush, and heavy blocks of forest surrounded by chaparral. North of Duncan Peak and connecting with the burns on the northern

slopes of North Fork of American River Canyon the forest has been burned out in narrow lanes and patches. In some places brush has replaced the timber, in other localities the ground has been too rocky, soil aridity has set in, and low shrubs or coarse weeds thinly cover the ground. In the region east of Big Oak Flat and on the tracts situated north of Deep Canyon the fires have not done such widespread damage. Here most of the timber consists of the yellow-pine type and the forest has escaped with a loss of about 5 per cent. On the slopes and in the canyons of the extremely broken region which forms the drainage basin of the North Fork of Middle Fork of American River the fires have ravaged the yellow-pine forest, destroying 15 to 25 per cent of the timber, causing soil aridity and thin growth of brush. West of Michigan Bluffs and Red Point damage due to fire has not been so extensive. The region has been logged for many years and the amount of destruction can not now be ascertained. Probably it will not fall much short of 5 or 6 per cent, and may be considerably higher.

In the eastern area of the basin there has been consumed by fire not less than 65 per cent of the timber, assuming that the stands now remaining fairly represent the condition of the forest as it was before burning.

REPRODUCTION

Reproduction of the forest is deficient, taking the basin throughout. In the western part there is a fair restocking of the logged areas on small tracts, very dense. Incense cedar forms 15 to 30 per cent, or from twice to three times the ratio the species held in the original stands; yellow pine constitutes from 40 to 60 per cent; sugar pine, 1 per cent or less; red fir, 15 to 40 per cent; white fir, 5 to 10 per cent; the high increase in the proportion of incense cedar is wholly due to the large number of seed trees of the species remaining on the logged area.

In the eastern portion reproduction is everywhere scanty. Along the higher slopes and in general wherever sheep runs are situated there is no restocking, the sheep trampling out the seedling trees from one season to another. On the tracts where heavy undergrowth or chaparral have followed extensive thinning of the forest by fire restocking is mostly a work for coming ages. It is not now progressing to any great extent. Here and there in the edges of the brush there are scattered saplings of Shasta fir endeavoring to recover lost ground; in glades and openings in the creek bottoms, or on slopes with much seepage, lodgepole pine is coming up, and occasionally on rocky northern slopes, too steep for sheep runs, Patton hemlocks are restocking the burns. There are numerous slopes with southern exposures along the upper portions of Middle Fork of American River and the Rubicon Canyon where the destruction of the forest has caused temporary soil aridity. No restocking is going on in such places. The ground has become too dry to support even a moderate brush growth, and the slopes are constantly losing soil

by the washing of rain and water from melting snow. Throughout the upper portions of both basins Shasta fir constitutes the chief species in reforestation, the other species maintaining practically the ratio they had in the burned stands.

CHAPARRAL

The pure growths of chaparral in the basins comprise 12,500 acres, of which 2,500 acres are situated in the yellow-pine type of forest and 10,000 acres in that of the Shasta fir. This acreage includes only the larger tracts of this sort of growth. If the numerous small patches of 2 to 10 acres which are scattered throughout the forests everywhere in the eastern portions of the basins were taken into account the chaparral acreage would amount to three or four times the figures given above.

TRUCKEE RIVER BASIN.

Only a portion of this basin is included within the limits of the examination. The area comprises 377,000 acres and consists of all the northern portion of the basin and about 110,000 acres of the southern, of which 62,000 acres are covered with the waters of Lake Tahoe.

TOPOGRAPHY.

The Truckee Basin is situated east of the main range of the Sierra, but is not, within our limits, directly contiguous to the desert or nonforested areas of adjacent Nevada, owing to the interposition of a secondary range, which stretches southward from the point where the main range makes its westward sweep south of Sierra Valley. Through this range the Truckee River has cut a deep, narrow canyon and affords an outlet for the waters of the basin. The general configuration of the basin is that of two semicircular depressed areas, a northern and southern, backed on the west by the main range of the Sierra Nevada, fronted on the east by a succession of high ridges and divided in the center by an east-west range, the Mount Pluto ridge, which, however, is cut in twain by the upper portion of Truckee River. The southern half of the basin consists chiefly of Lake Tahoe; the short eastern slope of the main range of the Sierra, the short slope of the Carson Mountains forming a smaller portion. The northern half consists of a few broad flats in the central portions, several small lakes, of which Donner, Independence, and Webber lakes are the principal ones, a number of long high spurs projecting eastward from the main range of the Sierra and various semidetached or isolated ridges which stretch in various directions through the middle of the district. The mountain portions of the basin are regions of high relief. The eastern slope of the main range of the Sierra is short and abrupt and has been subjected to a great deal of glacial wear, resulting in the formation of deep canyons and gorges, steep, rocky slopes, and narrow ridges on which

little or no soil has as yet accumulated. The Mount Pluto ridge as well as those inclosing the basin on the east likewise show evidences of glacial action, but in much less degree. The shores of Lake Tahoe from State Line Point to the lake outlet consist mostly of a series of terraces, generally narrow, rocky, and abrupt, but in some cases, as back of Tahoe, one-half mile to 1½ miles in width. Where streams enter the lake there are marshy flats. The beach is generally narrow and boulder strewn: along Agate Bay it is formed by a line of sand dunes 10 to 20 feet in height. Near State Line Point rocky spurs projecting southward dip into the lake with no intervening line of beach. South of the lake outlet there is a continuous narrow strip of beach or terrace between the lake and the points of spurs coming down from the main range of the Sierra. The terrace is elevated from 5 to 50 feet above the lake and is composed of sand, gravel, and boulders.

The levels of the northern portions of the basin are sandy or gravelly flats, here and there boulder strewn; around Prosser and northward more or less terraced, south of Truckee River almost level or gently rolling. Small creeks coming down from the mountains and cutting channels through these gravel flats have formed the terraces. Stampede Valley, Twin Valley, Euers Valley, and other smaller flats throughout this portion of the basin are bottoms of ancient glacial lakes.

The chief drainage channel of the basin is Truckee River, which forms the outlet of Lake Tahoe. Leaving the lake it flows northward and breaks through the Mount Pluto ridge in a narrow canyon 1,000 to 1,200 feet in depth. While the canyon is narrow and its slopes, especially on the east, are rocky and steep, it is not exactly gorgelike except for the space of a mile or so a short distance below Tahoe. Emerging from the upper canyon, the river bends eastward and takes its course across the northern end of the gravelly flat of Martis Valley, in a channel 200 to 250 feet below the level of the plain. At Boca it cuts through the eastern range with a canyon 1,000 to 3,500 feet in depth and emerges on the plains of the Nevada deserts between Verdi and Reno. The river receives a number of large tributaries; the principal ones are Little Truckee River and Prosser Creek, the former one heading in Webber Lake. The upper portion of Little Truckee River lies in a canyon of inconsiderable depth; the central and lower portions are excavated through gravelly flats and are bordered by low terraces and ridges. Prosser Creek heads in the main range of the Sierra, most of its sources lying in small lakes held in hollows and basins excavated by glaciers.

The altitude of the southern portion of the basin varies from 6,225 feet at the level of Lake Tahoe to 9,000 feet for the highest summits of the Sierra, the mean altitude being probably about 7,200 or 7,300 feet. The northern areas vary from 5,500 to 9,140 feet, the mean elevation being about 6,500 or 6,600 feet.

SOIL.

The soil of the basin is chiefly glacial detritus. On the slopes and summits of the ridges it is sandy, gravelly, and liberally strewn with masses of drift boulders. The flats, largely formed by silting while they still constituted beds of lakes, have a deep soil of fine sand and mold resting on coarse gravel and boulder drift. The soil of the flats in the northern area of the basin is invariably more or less alkaline. Ridges composed of brecciated lavas, which crumble easily under the influence of atmospheric agencies, are covered with soil 2 to 3 feet, or even more, in depth, where gentle slopes or broad saddles have favored deposition and prevented washing. The granite areas of the main range and elsewhere have a very thin soil. The flats at the entrance of small streams into Lake Tahoe are covered with deep soil, owing to deposition of vegetable matter brought from the slopes adjacent to their channels. As a whole, the soil of the Truckee Basin is of sufficient fertility to support a heavy forest growth; its depth depends wholly on local circumstances favoring washing and removal of the soil elements as fast as formed, or holding them in place and compelling accumulations.

MINING.

No mining operations are carried on in the basin.

AGRICULTURAL LAND.

Climatic conditions are inimical to agriculture; otherwise a large quantity of land could easily be brought under tillage. The flats of Martis Valley, the bench lands along Prosser Creek, Little Truckee, and in various other places afford good locations for farms. Although the climate is too cold to make general agriculture successful, it is nevertheless probable that much of the level tracts in the localities mentioned would produce crops of hay of the hardier kinds of grasses under irrigation.

PASTURE.

All of the basin, whether under fence or uninclosed, is utilized for pasture. The slopes and summit of the main range are closely pastured by sheep, the levels by cattle. All the uninclosed flats along Prosser Creek, Little Truckee River, and in Martis Valley have been overpastured and their grass eaten out long ago, only sagebrush remaining.

The pasture lands along the main range consist generally of grassy glades too wet for forest growth, but most frequently of tracts denuded of their forest cover by fire and grown up to grass, sedge, or coarse weeds. Along the shore of Lake Tahoe the pasture lands are, in part, sedgy meadows, bare of timber by reason of their marshy character, or covered with park-like lodgepole-pine stands

having the ground carpeted with a thin grassy sward. From the lake outlet south the pastures are chiefly fire glades or logged tracts. The pasture lands between Donner Lake and Truckee, along Prosser Creek and Little Truckee River, together with the grazing areas around Webber Lake, in Euers and Twin valleys, are wet meadows, in some localities fringed with open stands of lodgepole pine, in others with scattered trees of this species dispersed over most of their area. All such tracts are under fence and are utilized as dairy ranches during the summer season, the cows being driven to the valleys west of the mountains upon the approach of winter. The grazing on the open sheep runs and in general on all uninclosed land is extremely thin, but the sward of grass and sedge on the wet meadows and glades is strongly rooted and, notwithstanding many years of persistent grazing, yet yields a fair amount of pasturage. The grazing lands of the basin, including only such tracts as are naturally and permanently deforested, comprise 25,100 acres.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE.

All the timbered lands in the basin are classed as forested. There are none corresponding with the wooded areas of the foothills west of the range. The tracts sparsely timbered or which now carry no mill timber are such only temporarily, owing to logging or fire.

In this basin the forested area included in the examination amounts to 279,000 acres. Both of the forest types prevalent on the western slopes of the Sierra are represented, and in the following proportions:

<i>Forest types in Truckee Basin.</i>		Acres
Yellow pine		159,000
Shasta fir		120,000
Total		279,000

The yellow-pine type is the prevailing type of forest in all portions of the northern districts of the basin situated below the 7,000-foot level. It follows up the Truckee Canyon to the shores of Lake Tahoe, and borders the lake with a narrow fringe from 1 to 3 miles wide. It crosses the main range at Donner Pass and at the head of McKinney Creek, in both places as a narrow line, composed chiefly of the yellow-pine species. Eastward it extends to the borders of the nonforested Nevada ranges and plains.

The Shasta-fir type forms the forest on the main range, generally at elevations above 7,000 feet, but on northern slopes not infrequently descending below the 6,500-foot level. It is also the prevailing forest on the summit of Mount Pluto Ridge and on the high summits of the connecting ranges south of Truckee Canyon.

Northward it extends along the crest of the divide which parallels Truckee Canyon on the west, from Crystal Peak to the head of Stampede Valley, but in a broken and interrupted form, there joining the same type, following the summit of the main range around the south end of Sierra Valley.

CHARACTER OF FOREST.

The entire northern portion of the basin is semiarid. Hence the yellow-pine type of forest is composed principally of three species of coniferous trees, viz., yellow pine, white fir, and incense cedar. Mixed with them occur scattered stands of lodgepole pine and Western juniper. It is not unlikely that before logging operations began in the basin the yellow pine formed the largest percentage of the type, but at the present time the white fir is the superior, the ratio for the entire district being about 10 per cent of white fir to 1 per cent of yellow pine, if both sound and defective timber are taken into account. In some localities the proportion of white fir is as 18 to 1 of yellow pine. The forest, where not logged or much burned, is open and park like. In the southern portion of the basin the yellow-pine type of forest is composed of the same species of trees as west of the range, with the exception of the red fir, which is not found in the basin. The forest has been logged throughout, and now consists chiefly of white fir and incense cedar, the sugar pine having been practically exterminated, at least as regards large and medium sized trees. In the small areas of unlogged forest of this type on the southwestern slopes of Mount Pluto the yellow pine forms 10 to 15 per cent of the stands. The timber is invariably set in heavy undergrowth, which has come in as a sequel to extensive fires.

The Shasta-fir forest is patchy throughout except along the crest of Mount Pluto Ridge. All along the main range the continuity is broken by bare stretches of rock, grassy or brushy areas marking burns, grassy swards and glades along the valley bottoms, and logged areas. The composition of the type where unmixed with lodgepole pine is commonly Shasta fir, 75 to 95 per cent, the balance being white pine and Patton hemlock. Around swales and glades the Shasta fir is largely replaced by lodgepole pine, sometimes to the extent of 90 per cent, but the lodgepole-pine stands are never extensive in any one locality. The density of the Shasta-fir stands depends mostly on soil conditions. On northern slopes there are frequently blocks of very thickset timber averaging as high as 20,000 feet B. M. per acre. Where the soil is thin, the volume falls to 1,500 feet B. M. per acre. The thickset, unlogged stands of this type are generally free from brush, the forest is open, and the undergrowth consists mostly of sapling trees. Where the timber has been thinned by logging, heavy brush growths sometimes come in, but as a rule the Shasta-fir type in this basin is situated above the

upper limits of thick brush growth. There is no true timber line on any of the mountains in the basin, but the character of the forest on Castle Peak, in the northern district, indicates that the Shasta fir would not be the timber-line tree. On that peak snow lies in the hollows and basins below the summit on the northeastern slopes throughout the year, and the chief species of trees in these localities are the Patton hemlock and white pine, the latter largely predominating, while on the summit of the peak grow a few individuals of white-bark pine.

LUMBERING

The areas logged clean or culled comprise 170,000 acres, or nearly 59 per cent of the forest land. The areas not cut over or uncultured are, with a few large exceptions, situated in places difficult of access or carrying timber not fulfilling the requirements of the loggers.

Commencing with the southern districts of the basin, nearly all of the terraces bordering Lake Tahoe and the accessible mountain slopes and canyons have been logged, the cut varying from 10 to 99 per cent. All of the sound sugar and yellow pine and most of the Shasta fir reaching 12 inches in diameter has been cut. The white fir, being largely defective, was left by the loggers, but is now being cut for fuel. A few tracts between Ward Creek and Truckee River, a portion of the terraces northwest of Tahoe, and the northwestern slopes of Mount Pluto had not been logged at the time of this examination. The summits and slopes of Mount Pluto Ridge from Mount Pluto eastward have been logged, with the exception of a few hundred acres on the crest of ridges directly north of Agate Bay. The timber on those summits was exclusively Shasta fir, 70 per cent logged. On the lower northern slopes of Mount Pluto Ridge the cut has been from 70 per cent to nearly total, culls of white fir being the only species of tree left. From the lake outlet down the canyon of Truckee River, on all the areas between Truckee and Mount Pluto Ridge, on all the areas northeast from the town of Truckee to Stampede Valley, and on the high ridge of which Crystal Peak forms the culminating point, the cut of merchantable timber has been total. On the last-named ridge, near the crest and running down the western slope, a strip of uncut forest, containing about 30 per cent yellow pine, the balance white fir and incense cedar, still remains. The eastern declivities of the ridge and the adjoining slopes of Truckee Canyon have been entirely stripped of their mill timber. Between Truckee and Donner Pass 99 per cent of the mill timber has been cut. North of Truckee the cut has not been so uniform. On some tracts all the mill timber has been cut; others have been culled of their yellow pine and the white fir is left standing, while some blocks have remained uncut. The most northern area of the basin still has some good bodies of uncut timber, but they are not likely to remain long.

It is not possible to state with any degree of certainty the quantity of timber cut from the portion of the Truckee Basin examined. Much was cut so long ago that the stumps have rotted down, and it is evident that many of the tracts contiguous to Truckee were not nearly so heavily timbered as farther south. It may be said that the cut to date in the region in question has approximately amounted to 1,450,000,000 feet B. M. This, it is to be remembered, is only a portion of the cut in the basin, a considerable tract of the southern area lying outside this examination. The cut of mill timber at the present time is confined to tracts south of the lake outlet and to the northwestern portion of the basin. For other purposes white fir and lodgepole pine is being cut in many places, part being utilized for fuel, part as pulp wood to the paper and pulp mill at Floristan, in Truckee Canyon.

The standing mill timber in the basin is as follows:

Mill timber in Truckee Basin

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	490,000	320,000
Sugar pine	5,000	3,000
Shasta fir	550,000	210,000
White fir	640,000	405,000
White pine	25,000	11,000
Total	1,710,000	949,000

A great deal of this timber, about 35 per cent, is scattered along the slopes of the main range, on summits and declivities of steep spurs, or in canyons where it is not easy of access. The balance can doubtless be logged, although in some cases much expense will have to be entailed to get the logs to the mill. Most of the yellow pine is in the northern part of the basin; some is scattered over the slopes of Mount Pluto Ridge. The white pine of mill size chiefly grows on the high slopes of the main range, as is the case with much of the Shasta fir, while the white fir is scattered throughout the basin where any uncut timber remains.

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 2—less than 2,000 feet B M. per acre.—(1) Logged areas throughout the basin: Culls of white fir and yellow pine, scattered through brush stands, mixed with small percentages of lodgepole pine, and in the southern portion, incense cedar, all of little or no merchantable value; logged 99 per cent by local standard, about 85 per cent by Michigan standard; about 100 feet B. M. per acre

remaining in the northern part of the basin, 300 feet B. M. in the southern. (2) Area of the main range of the Sierra from Millers Creek to Donner Pass: Scattered stands of Shasta fir, white pine, Patton hemlock, with small percentages of yellow pine and white fir below 7,000 feet; timber generally of small size in very thin stands or set singly; mostly growing on steep and rocky slopes, inaccessible or nearly so; average stand about 1,500 feet per acre. (3) Slopes of main range of the Sierra from Donner Pass to Webber Lake: Shasta fir 60 to 70 per cent; yellow pine, 3 to 5 per cent; white fir, 20 to 30 per cent; white pine and Patton hemlock, the white pine on some small tracts near Castle Peak forming 80 to 90 per cent of the stands, timber generally stocky, limby, and weather beaten, of poor quality and mostly inaccessible; average stand about 1,800 feet per acre.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) Slopes of the main range of the Sierra from head of Millers Creek to Donner Pass: Shasta fir, 60 to 90 per cent; yellow pine, 4 to 8 per cent; balance white pine, Patton hemlock; incense cedar and white fir at elevations below 7,000 feet, the latter species constituting from 10 to 20 per cent in some of the stands; timber generally set on rocky slopes or on high ridges, in most cases inaccessible; average stand about 4,000 feet per acre. (2) Shore terraces of Lake Tahoe from Frosts to State Line Point: Yellow pine, 3 to 5 per cent; white fir, 60 to 80 per cent; now and again a sugar pine of small size; Shasta fir of small dimensions, incense cedar, and pure stands of lodgepole pine; all logged 50 to 60 per cent; average stand about 3,800 feet B. M. per acre. (3) Areas in the basin north of Mount Pluto Ridge. (4) Crystal Peak Ridge: Yellow pine, 25 to 35 per cent; balance white fir; elsewhere white fir, 60 to 90 per cent; yellow pine, 10 to 30 per cent; white fir of small size and mostly culls in the region south of Truckee River; north of this stream of larger dimensions, 18 to 30 inches in diameter, 15 to 30 feet clear trunks; yellow pine generally below 22 inches in diameter, the best long since having been cut off; average capacity in mill timber about 4,200 feet B. M. per acre.

Grade 4—5,000 to 10,000 feet B. M. per acre.—(1) Tracts south of Mount Pluto Ridge, including slopes of main range: Shasta fir, 60 to 80 per cent; yellow pine, 10 to 20 per cent; white fir, 10 to 30 per cent; incense cedar, and lodgepole pine; timber in medium close-set stands, fair quality; in most places difficult of access; average stand about 9,500 feet B. M. per acre. (2) Tracts north of Mount Pluto Ridge, including slopes of main range: Below elevations of 7,000 feet, white fir, 10 to 60 per cent, the high percentage on logged areas; yellow pine, 5 to 45 per cent in stands of medium density, generally in thick underbrush, not difficult of access, above elevations of 7,000 feet; Shasta fir, 60 to 80 per cent; white pine and Patton hemlock; timber of large size, but in broken stands and difficult of access; average stand 9,900 feet B. M. per acre.

Grade 5—10,000 to 25,000 feet B. M. per acre.—(1) Tracts in the southern portion of the basin: Shasta fir, 60 to 90 per cent; yellow pine, 10 to 15 per cent; white fir, 10 to 20 per cent; close stands of good timber moderately difficult of access; average stand about 23,000 feet B. M. per acre. (2) Tracts in the northern portion of the basin: Shasta fir, 60 to 80 per cent; yellow pine, 5 to 20 per cent; timber of fair quality; average stand 20,000 feet per acre.

FIRES

There is not a great deal of forest land in the portion of the basin examined which does not show clearly traces of fire. Most of the area is merely fire marked, less than 25 per cent having been badly burned, as is seen in the following table:

Burned areas in Truckee Basin

	Acres
Forest and chaparral	281,600
Fire marked	271,000
Badly burned	73,800

The areas not fire marked comprise but 10,600 acres, while the tracts exhibiting traces of fire or showing a considerable percentage of loss due to this cause embrace a trifle over 96 per cent of the forested districts.

All portions of the region have been visited by fires, but most of the destruction has been confined to the Shasta-fir stands, or to those tracts of yellow-pine forest in which white fir formed a considerable proportion. Commencing in the southern part of the basin, all the slopes leading to Rubicon Bay are badly burned; 40 to 60 per cent has been destroyed, and the slopes are covered with heavy brush growths. Going north from Rubicon Bay, all the shore terraces have been burned over; many of the fires appear to have followed the logging camps, others antedate them. From the lake shores fires have spread into the adjacent mountains in all directions, burning lanes through the forest or thinning the stands, brush growths replacing the forest in some localities, grassy or weedy swards in others. About 35 per cent of the timber has been destroyed. The next big burns are found in the canyon of Truckee River from the lake outlet down, on the southwestern slopes of Mount Pluto, on the terraces back of Carnelian Bay, and on the high ridges north of Agate Bay. Extensive fires have swept all these tracts, rarely, however, involving total destruction, but thinning the forest from 30 to 70 per cent and creating extensive brush growths.

In the northern portions of the basin there is a continuous line of burns extending from Donner Pass to Webber Lake. All the high ridges and slopes show numerous large fire glades, the burns in the lower areas overgrown with brush, the upper grassy or weedy or thinly covered with low, scattered shrubs. Much of the region around Donner, Independence, and Webber lakes was burned over a century ago, as shown by the lodgepole pine of approximately that age.

The stands of lodgepole pine have been in their turn extensively invaded by fires of more modern date. The areas in the eastern districts of this portion of the basin have suffered less damage than the western, owing to the high proportion of yellow pine in the forest. The damage has chiefly been confined to the crests of the ridges, where white fir is more abundant than yellow pine and has amounted to 10 or 15 per cent.

Owing to logging operations it is not possible to state, except approximately, the amount of timber consumed by fire. It is very clear that many of the fires were subsequent to the removal of most of the timber by the loggers, but the extensive brush growths which have come to occupy some of the sections indicate that large areas were burned previous to the cuttings. I should say that, taking the basin as a whole, 30 per cent of the present volume of timber is a moderate estimate to cover the fire losses during the last fifty years.

REPRODUCTION

Restocking of the logged and burned sections in the southern portion of the basin is only moderate. On all areas, like the slopes of Mount Pluto and the lake terraces north and northeast of the lake outlet, where a thick undergrowth has obtained a substantial foothold, reforestation is practically lacking. South of that point tracts on which seepage is abundant are developing young growths of lodgepole pine in much larger proportions than the species obtained in the old forest. Elsewhere Shasta fir is the leading species in the restockings at the higher elevations, white fir at lower altitudes, yellow pine appearing in smaller quantities than in the old forest; incense cedar is abundant, while sugar pine is practically obliterated. The grassy or weedy fire glades along the higher slopes of the main range are not reforesting, owing to the grazing and trampling of sheep.

In the northern areas of the basin restocking of the logged areas is moderate, while on many of the burned tracts the brush growths are giving way to dense masses of sapling white firs; in other localities of this character no reforestation is, as yet, taking place. The tracts along the upper areas of Prosser Creek are restocking with thickset stands of white fir and the coming forest in that region will be 70 to 80 per cent of this species. Along the main range of the Sierra the brush-covered slopes are not reforesting, nor are those on which grass or sedge have formed a sward. Here, as in the southern portion of the basin, excessive grazing and trampling of sheep kill out the seedling growth. On the tracts northeast from Truckee reforestation is extremely deficient. There are thin stands of yellow pine here and there, the growth limby and gnarly and very unpromising, and much lodgepole pine is scattered among them. Between Truckee and Donner Lake there is a thin restocking of the logged areas. Probably it is as dense as the original growth, that portion of the basin apparently never having had a very close forest

cover. On the slopes of Truckee Canyon reforestation is extremely scanty; the hillsides show evidence of great soil aridity, and much of the loose soil is washing into the canyon bottom during rains or at the time of melting snows.

CHAPARRAL

The pure growths of chaparral comprise 2,600 acres of the lands in the basin. Most of them are situated on the shore terraces of Lake Tahoe, a lesser area in the upper Truckee River Canyon. The growth is composed of scrub oak and manzanita (*Arctostaphylos patula*) at the lower elevations, but chiefly of *Ceanothus velutinus*, which forms 70 per cent of all the brush, chaparral, and undergrowth in the basin at all altitudes. Owing to lack of precipitation the brush is not as dense, high, and uniform in the Truckee drainage as in the basins west of the Sierra. Seldom is it more than 5 feet in height, usually only 3 to 4 feet, while open, tortuous lanes or small clear spaces are scattered all through it. These lanes and clear, open spots give a chance for the seeds of the different conifers to germinate and afford the saplings an opportunity to develop. Hence, the chaparral and undergrowth in the Truckee basin, except on steep slopes where soil aridity has set in, is not so prohibitive of the restocking processes as west of the range.

LONG VALLEY.

TOPOGRAPHY.

Long Valley is a depression situated east of the Sierra Nevada. Its slope is toward the north and the creek which runs through it empties into Honey Lake. The valley is of varying width, the bottom in the upper portion contracting to about one-half mile, in the lower expanding nearly to 3 miles. The western side is hemmed in by the Sierra, which here rises with a short, steep front; the eastern side is bounded by high ridges belonging to different Nevada ranges rising from the valley in a series of terraces to elevations of 6,500 or 7,000 feet. The elevation of the valley varies from 6,000 feet in the upper portions to 4,500 feet in the lower.

Long Valley Creek, which carries the drainage of the basin, is an intermittent stream. In the summer time it is nearly dry, except after heavy rains, in the spring its floods are at times torrential, to judge from the immense amount of gullying which the stream is doing in its valley. Most of its waters are drawn from the slopes of the Sierra, the ridges east of the valley furnishing but little.

The area of the basin within the limits of this examination is 111,980 acres.

SOIL.

The soil on the sides of the mountains bordering the valley is thin and gravelly. The summits and highest slopes are generally rocky, often with no soil

whatever. In the valley and in some of the side ravines there is an accumulation of soil, the washings from adjacent ridges, often 20 feet in depth, as shown in the gullies made by the stream. The soil is generally alkaline throughout all the level portions of the basin.

MINING.

There are no mining operations of any consequence within our limits.

AGRICULTURAL LANDS.

The lands under tillage comprise about 8,320 acres. The production is chiefly hay. The drawback to agriculture in the valley is lack of water for irrigation, the amount available being wholly insufficient to supply the tracts susceptible of cultivation.

PASTURE.

The pasture lands of the basin comprise 70,420 acres. They consist of the sage-covered slopes of the adjacent mountains, but they have been sheeped so long that the grass is practically all destroyed.

FOREST AND WOODED AREAS.

EXTENT AND ACREAGE

There are no wooded areas in the basin. The nearest approach to such exists on the slopes east of the basin, consisting of a thin and scattering growth of western juniper.

The forested areas comprise 33,240 acres and are situated on the eastern slope of the Sierra. In the lower portion of the basin the lower limit of the forest is 4,500 feet; in the upper areas of the valley it varies from 5,500 to 6,000 feet. The portion of the Sierra bordering the central section of the valley is wholly without timber and connects through Beckwith Pass with the nonforested Sierra Valley districts. The upper limits of the forest are determined by the altitude of the Sierra, which in this region is from 7,000 to 8,500 feet. There are no points at or above timber line.

CHARACTER OF FOREST.

The forest conditions are here extremely simple. Lying in juxtaposition to the desert areas of Nevada, the region is semiarid, and the species of conifers composing the forest are limited to western juniper, yellow pine, white fir, and at the summits of the ridges thin lines of white pine. The western juniper and white pine are inconsiderable factors in the composition of the forest. The principal trees are, therefore, the yellow pine and white fir. The composition of the forest in the lower portions of the valley is—yellow pine, from 60 to 85 per cent; white fir, from 15 to 40 per cent. At the head of the valley yellow pine increases in quantity and forms from 80 to 95 per cent of the timber, the balance consisting of white fir.

The forest throughout is open; there is little brush and only a small quantity of litter. On the summits, extensive copses of arborescent mountain mahogany and aspen break the continuity of the stands.

LUMBERING

The head of the valley has been logged to a small extent. Most of the cutting has been for fuel to supply the California, Nevada and Oregon Railway, which passes lengthwise through the valley. The tracts cut and more or less closely culled comprise 5,100 acres, or about one-third of what may be considered reasonably easy of access.

The amount of mill timber in the basin in M feet B. M. is as follows:

Mill timber in Long Valley

	Michigan practice	Local practice
	<i>M feet B M</i>	<i>M feet B M</i>
Yellow pine	85,400	63,000
White fir.....	9,000	7,000
Total.....	94,400	70,000

DISTRIBUTION OF GRADES OF MILL TIMBER

Grade 2—less than 2,000 feet B. M. per acre.—(1) Southern portion of the basin: Yellow pine, 60 to 80 per cent; balance white fir; thin stands of timber of little value. (2) Northern portion of the basin: Yellow pine and white fir in about the same proportions as in the preceding district; on very rocky slopes and spurs and broken by intervening patches of mountain mahogany and thickets of aspen.

Grade 3—2,000 to 5,000 feet B. M. per acre.—(1) Northern portion of the basin: Yellow pine, 70 per cent; balance white fir and white pine, the latter above 7,000 feet; stands open and poor in quality, set on steep, rocky ridges. (2) Southern portion of the basin: Yellow pine and white fir in the same proportions as in the preceding districts; open stands of fair timber below 6,500 feet; above that altitude poor in quality and badly broken by fire glades and brush; average capacity in mill timber of the two districts, 4,000 feet B. M. per acre.

Grade 4—5,000 to 10,000 feet B. M. per acre.—Consists of two small tracts at the head of the valley bearing stands of a fair quality of yellow pine, with an average capacity of about 8,000 feet B. M. per acre.

FIRES

The entire forested area is fire-marked; none of it is badly burned. The largest measure of destruction has come to the white fir, and chiefly in the stands along the crest of the Sierra. About 10 per cent of the forest has been destroyed

by fires of modern date, which appear to have followed the sheep runs along the high summits.

REPRODUCTION

Reforestation is everywhere deficient. Above 6,000 feet white fir forms the principal species in the young growth; at lower elevations yellow pine is the prevailing kind. In the brush growths which have followed the fires there is a moderate amount of sapling trees, as these brush stands are nearly always of open growth.

CHAPARRAL.

There are no tracts in the basin covered with stands of pure chaparral, unless blocks of arborescent mountain mahogany on the summit of the Sierra may be considered as such. Stands composed of this tree occur in many places, mostly as thin, irregular lines; but south of the pass, at the head of Balls Canyon, they form broad stretches of scrub.

SUMMARY.

Total stand, by species, in northern Sierra Nevada

	Michigan practice	Local practice
	<i>Feet B. M.</i>	<i>Feet B. M.</i>
Yellow pine	6,155,000,000	4,439,000,000
Sugar pine	2,622,000,000	2,214,000,000
Shasta fir	3,622,000,000	2,139,000,000
Red fir	2,825,000,000	1,767,000,000
White fir	2,508,400,000	1,596,000,000
White pine	141,500,000	67,900,000
Patton hemlock	23,100,000	1,300,000
Total	17,897,000,000	12,224,200,000

Classification of land in northern Sierra Nevada.

	Acres
Forested	2,337,930
Wooded	364,000
Chaparral	213,730
Pasture	208,760
Agricultural	264,630
Lakes	72,800
Bare rock	29,250
Total	3,491,100
Cut and culled	1,386,890
Fire-marked	2,754,770
Badly burned	715,440

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