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THE MISSING FRÉMONT CANNON—AN ECOLOGICAL SOLUTION?

JACK L. REVEAL AND JAMES L. REVEAL

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CHRYSOTHAMNUS BOLANDERI, AN INTERGENERIC HYBRID

LORAN C. ANDERSON AND JACK L. REVEAL

The genus *Chrysothamnus* (Astereae, Compositae) is closely related to *Haplopappus*, and, particularly, *C. bolanderi* (Gray) Greene has been noted for its similarity to *H. macronema* Gray (section *Macronema*). Gray (1873) and Greene (1895) both suggested *C. bolanderi* could easily be placed in the other genus, and later Greene (1904) did so as *Macronema bolanderi*. This close resemblance to a species of *Haplopappus* makes the identification of *C. bolanderi* essential to an understanding of the systematics and evolution of *Chrysothamnus*. This plant has been, unfortunately, rarely collected. In addition to the earlier collections: *Bolander 6137* in 1866 (GH—holotype, UC!, US!) and *Rattan s. n.* in 1867 (DS!, mixed, *H. macronema* in part), it is now represented by *Reveal 1057* (KSC) and *Anderson & Fish 2923* and *2926* (KSC).

Bolander's type collection is labeled: "At Mono Pass, California, elevation 9000–10000 ft." The only plants we found after extensive independent search (Reveal in 1964, Anderson in 1965) were located east of Mono Pass (elevation 10604 ft.) in Bloody Canyon where they were restricted to a small oasis surrounded by barren rock. A small population was found at 10000 ft. on a steep talus-filled crevasse which rises abruptly from the northwest edge of Lower Sardine Lake (ca. 8 air miles southwest of Lee Vining). A few more plants were found in talus along the trail just below the lake at 9800 ft. A total of 25–50 plants, then, represents the extent of *C. bolanderi*.

Hall (Hall and Clements, 1923) described this taxon as a relict subspecies derived from *C. parryi* (Gray) Greene ssp. *parryi*. However, recent studies (Sharp and Birman, 1963) show that five advances of upper Pleistocene glaciation can be recognized in Bloody Canyon; these are Tioga, Tenaya, and Tahoe (of the Wisconsin), Mono Basin (Illinoian?), and Sherwin (Kansan?). This history of recent repeated glaciation does not support the designation of *C. bolanderi* as a relict. An alternative, as indicated by the extremely limited range and the fact that the plants are growing in very close association with *C. nauseosus* (Pallas) Britt. ssp. *albicaulis* (Nutt.) Hall & Clem. and *H. macronema*, is that it is of recent hybrid origin.

To elucidate the relationship of *C. bolanderi*, comparative studies on gross morphology, cytology, and anatomy were undertaken. Since *C. nauseosus* and *H. macronema* both vary considerably throughout their ranges, only collections associated with *C. bolanderi* are dealt with here. Data collected for *C. parryi* ssp. *monocephalus* (Nels. & Kenn.) Hall & Clem. and *H. suffruticosus* (Nutt.) Gray, also found in Bloody Canyon, indicate they are not related to the problem.

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see corrections

Reprinted from Madroño, Volume 18, Number 8, October 1966

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Loran C. Anderson and Jack L. Reveal

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Tree Classifications for Pinus Monophylla and Juniperus Utahensis

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TREE CLASSIFICATIONS FOR PINUS MONOPHYLLA AND JUNIPERUS UTAHENSIS

By KENNETH E. BRADSHAW
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"Leader"

More and more attention is being directed toward the diminutive forest trees of the semi-arid western states, and general cognizance is being given to the fact that forest management practices are needed to insure their future productivity. Maturity classifications for singleleaf pinon and Utah juniper are herein presented and illustrated, in order to establish a uniform method for describing the trees and stands. The need for classifications, and their applicability to the functions of inventorying, management, and utilization, are pointed out. Site variations as described show the importance of recognizing growth variations in such trees.

Western Indians are still the principal harvesters of the annual crop of native pinon pine seeds, which are often locally termed "pine nuts." From this harvest they realize a considerable sales revenue, and a certain percentage of the nuts are retained for home consumption. It was this dependance of the Indians upon the land which first indirectly led the Soil Conservation Service to map and study the region in western Nevada known as the Pine Nut Hills, in a cooperative arrangement with the Bureau of Indian Affairs. Woodland survey data was gathered, and silvicultural and management studies were initiated with the intention of improving the physical and economic conditions of the stands. With the inception of such activities, a need was found for tree classifications which would properly describe the abundant stands of singleleaf pinon (Pinus monophylla Torr. and Frem.) and Utah juniper (Juniperus utahensis (Engel.) Lemmon) found in the Pine Nut Hills. A tentative grouping into four classes, namely, reproduction, immature, mature, and overmature, was used to expedite the description of tree and stand conditions from the start, but until early in 1940 no definitions of the

classes existed. At that time the authors prepared the maturity class[1] descriptions presented in this paper, and they were put to practical use in the gathering of woodland data by a range and soil survey party then operating in southeastern Nevada. Subsequent checking has established the descriptions as being reasonably constant and worthy of presentation for use by others.

THE NEED FOR CLASSIFICATIONS

The opportunities for application of these simple classifications are many. The primary value of their present presentation is the initial establishment of a basis for uniformity of description. Forest officers and other persons who are associated with the mapping or use of pinon and juniper forests should have a common basis for describing tree and stand conditions. The first important functional application of these classifications of course will be in mapping and inventory compilations, wherein proper descriptions of the wood resources necessarily precede management. To go one step farther, proper management itself requires a knowledge of maturity classes to supplement simple information regarding location and density

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[1] The term "maturity class" is used advisedly in preference to the more common expression "age class", because of the lack of significant correlations between age in years and physiological characters used for classification.

of tree stands. The integration of utilization with volume, tree size, and growth rate, all of which are factors related to maturity classes, should constitute a phase of all management programs. The designation of cutting areas, and tree marking, should likewise be facilitated by tree classifications. In the field of research and investigation, such operations as plot descriptions, construction of volume tables, growth predictions, etc., should reveal that maturity classifications can be of considerable descriptive and analytical value.

THE TREE CLASSES

The four maturity classes proposed for singleleaf pinon pine and Utah juniper are characterized as follows:

Singleleaf pinon

Class 1. —Reproduction:

From one-year seedlings, up to 4.5 feet in height or 0.5 inch d.b.h.

Generally dense crown, straight vigorous stem.

Crown rounded in shape due to wide-spreading branches.

Reproduction

Immature

Mature

Overmature

Fig. 1. --Maturity classes of singleleaf pinon.

Bark smooth or flaky.

Age one to twenty years.

Class 2. --Immature:

Four and one half to twenty feet in height; 0.6 to ten inches d.b.h.

Crown dense, and low to ground, practically concealing trunk and large branches; conical or rounded in shape.

Bark fissures shallow.

Age twenty to one hundred years.

Class 3. --Mature:

Ten to thirty feet in height; six to sixteen inches d.b.h.

Crown more sparse and open, rounded in general outline, but becoming irregular.

Trunk and large branches more exposed; lower branches tending to prune off. Terminal twigs relatively more compact.

Bark fissures deep -- more definite plate formation.

Age one hundred to one hundred seventy-five years.

Class 4. --Overmature:

Twelve feet or more in height; ten inches or more d.b.h.

Crown very sparse and open, rounded or flat-topped in general outline, but very irregular. Branches large and gnarled; little foliage near the ground or towards

center of tree.

Terminal twigs compact.

Bark thick, corky, with more definite plates.

Age one hundred seventy-five years or more.

Utah juniper

Class 1. --Reproduction:

From one-year seedlings, up to 4.5 feet in height or 0.5 inch d.b.h.

Generally not greater than four inches in diameter at ground level.

Crown typically slender and straggly, or conical, with prominent leader and main branch tips.

Age one to thirty years.

Class 2. --Immature:

Four and one-half to fourteen feet in height; 0.6 to six inches d.b.h.; four to eight inches at stump height (one foot above ground).

Crown pointed or rounded, symmetrical.

Branches mostly slender, erect or ascending at acute angles, terminating in vigorous tips which give a fringed appearance to profile view of tree.

Reproduction

Immature

Mature

Overmature

Fig. 2. --Maturity classes of Utah juniper.

May or may not contain one or more stems suitable for smallest class of posts (6 inches diameter stump height, and 7 feet long to a 2 inch top).

Age thirty to one hundred twenty-five years.

Class 3. --Mature:

Fourteen to twenty feet in height; three or eight to twelve inches d.b.h.; eight to sixteen inches at stump height.

Crown ranging from obtusely pointed to rounded or flattened, becoming somewhat irregular in outline.

Branches heavy, stouter, and somewhat gnarled, ascending at acute or obtuse angles in upper part of crown, the lower branches tending towards horizontal position.

Foliage on branches less dense toward center of tree, with dying out of smaller interior twigs, crown thus becoming more open than in the immature class. Tips of branches rounded and smooth in profile view.

Generally contains one or more posts per tree.

Age one hundred twenty-five to two hundred years.

Class 4. --Overmature:

Fourteen feet or more in height; six or ten inches or more d.b.h.; twelve inches or more at stump height.

Crown rounded or flattened, always irregular in outline.

Branches heavier, often gnarled and twisted, and diverging from trunk or base at more horizontal or odd angles.

Foliage sparse except at ends of branches, giving open crown. Tips of branches rounded and smooth in profile view. Many dead branches and twigs.

Contains one or more posts.

Age two hundred years or more.

CHARACTERS USED IN CLASSIFICATION

The above definitions of the maturity classes can be best understood by referring to the accompanying illustrations. Figures 1 and 2 portray only one growth form of each species, and express the characters of the maturity classes as tabulated. It must be understood that a wide field of variation in branching habit, crown form and other features can be found in any group of pinons or junipers of the same class, and the basic distinctions rather than comparison with the sample sketches alone must be used in field classification procedures.

It was discovered during the establishment of these characters that an unfortunate lack of direct correlation existed between tree sizes and maturity classes. It will be

noticed by reference to the definitions that the overlaps between class diameter and height ranges are considerable. These overlaps apparently are brought about by the natural tendency toward variable growth forms in both species, as well as by the differences induced by variations in environmental factors. The relationship between tree classes and wood utilization standards is not lost, however, since both species are primarily judged on a volume basis for cordwood, while Utah juniper has a supplementary value for posts. Enough of a relationship exists to point out that an immature juniper may or may not produce a post, and trees of the two older classes will certainly produce at least one post per tree providing deformities or abnormal growth structures do not exist. Due to the variability in number of stems or primary branches which may be found in a single juniper tree, a local inventory[2] is prerequisite to an accurate expression of post material available in any region; yet a broad survey showing stand compositions, densities, and maturity classes can conceivably be used to gain a working estimate of the resources available. A rough judgement of cordwood resources can also be gotten from the same data, which should be within the limits of accuracy

[2] A paper designed for future publication is now being written by Mr. Reveal which deals with the preparation and use of volume tables for pinon and juniper.

allowed by the variations in individual trees, and which would undoubtedly be more accurate than an estimation based on data which lacks maturity class segregations. Since pine nuts are produced in greatest quantities on mature trees which are large and full-foliaged, it can be seen that tree class data will provide information helpful in management for nut production.

Most singleleaf pinon and Utah juniper stands are quite open, and there is little basis for a dominance and suppression classification. Nevertheless, crown characters give a good basis for judging tree maturity in a relative, if not wholly absolute, manner.

SITE VARIATIONS

One factor which may tend to limit the applicability of these tree classifications is the quality of the growing site. Considerable latitude has been allowed in the descriptions to make them inclusive of most sites, but the lowest extremes have not been mentioned. The writers have encountered and analysed low-quality sites which apparently are common enough throughout the pinon-juniper zone to warrant some mention here. Characteristics of such sites are the following:

Position. --Generally on alluvial fans or rolling hills

toward the lower limits of tree zones, or on crests of mountains and ridges.

Tree Form. —Junipers typically from six to twelve feet in height, bushy, with numerous stems from base; branches and stems spiralled, gnarled, twisted, and fluted; much dead wood in older trees. Pinons typically eight to sixteen feet in height, with the sparse foliage concentrated at ends of branches; crown very irregular in outline; trunk and branches contorted.

Tree Quality. —Quality is poor. Junipers cannot produce usable posts. Only apparent value of site is the production of sparse, slow-growing firewood, which is difficult to cut.

Density. —Trees sparse, covering from a trace up to possibly ten percent of the ground space. Associated vegetation sparse, low growing, covering up to twenty percent of ground space.

Associated Vegetation. —Commonly black sage (Artemisia tridentata var. nova (Nels.) McMinn) rather than big sagebrush (A. tridentata Nutt.) in sage areas; in southern Nevada, scrubby black bush (Coleogyne ramosissima Torr.), green ephedra (Ephedra viridis Cov.), and cliffrose (Cowania mexicana var. Stansburiana (Torr.) Jepson) on limestone hills; and shadscale (Atriplex confertifolia (Torr. & Fremont) Wats.) on lower ends of alluvial fans.

Fig. 3. --A. Overmature juniper growing on good site.

In photo
Jack Reveal
near Caliente,
Lincoln Co, Nevada 1940?

Fig. 3. —B. Overmature juniper growing on poor site.

In photo: Ken Bradshaw.
near Caliente, Lincoln Co Nev.
Jan 1940 ?

Soil. —Alluvial soils shallow and inferior in quality; generally of heavy, gravelly texture; strong profile development; poor water penetration. May have desert pavement and vesicular layer. On residual hills, soil will be shallow, rocky, and sparsely vegetated; limestone hills are especially of low site nature.

Tree classes on low sites are predominantly mature and overmature since poor utilization qualities have protected the scrubby trees from cutting. While the tree classifications set up for good sites will not apply on inferior sites, a general reduction of size ranges and a decrease in the whole scale of characters representing physiological vigor will give a rough basis for maturity class segregations. Figure 5 shows the striking contrast between trees of the same maturity class growing on different sites.

CONCLUSION

While the tree classifications as described in this paper are based on observations in southeastern and central-western Nevada, it is presumed that they will have some application to the whole pinon and juniper type throughout the ranges of these species, with perhaps certain adjustments in the size ranges

and ages to suit local conditions. After being checked, and adjusted if necessary, the classifications should find an important place in the description and management operations connected with the pinon and juniper forests.

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Single-Leaf Pinon and Utah Juniper Woodlands of Western Nevada

Jack L. Reveal[1]

This article presents new information concerning the stand and tree characteristics of two species—single-leaf piñon and Utah juniper—which are little known to most foresters but are of major importance in the wood economy of the Great Basin.

THE discovery of the Comstock Lode at the western edge of the Great Basin in 1859 heralded the wholesale exploitation of western Nevada's timber and woodland resources. In the half century that followed, approximately four-fifths of the near-by coniferous timberland was cut over to produce lumber, mine props, fuelwood, charcoal, fence posts, and other wood products needed by ranching and mining enterprises.[2] From the pine-fir forests of the Sierra Nevada were cut an estimated 600 million board feet of mine timbers plus large quantities of lumber and cordwood, and in the Washoe and Pine Nut Hills to the east, where for many centuries the Indian had hunted game and gathered the rich nut of the piñon pine, laborers cut thousands of cords of single-leaf piñon (*Pinus monophylla* Torr. and Frem.) and Utah juniper (*Juniperus utahensis* [Engelm.] Lemmon) for charcoal, mine timbers, and fuelwood.

When the mining excitement began to wane, the valleys were settled by ranchers who turned to piñon-juniper woodlands for fence posts and fuel. The friction that developed between the rancher and the Indians caused the Bureau of Indian Affairs some years ago to set aside 65,000 acres of the best woodlands for use by the resident Indians.

In the summer of 1939 the Soil Conservation Service, at the request of the Bureau of Indian Affairs, made a woodland survey[3] of the Indian allotments in the Pine Nut Hills to gather data which were later used to guide the preparation of a management plan. From these data can be drawn a picture of the single-leaf piñon and Utah juniper—two trees little known to commercial foresters but all important to the wood economy of the Great Basin.

Stand Characteristics

Piñon-juniper woodlands may be roughly divided into three altitudinal belts. On low dry fans Utah juniper occurs in nearly pure stands. Single-leaf piñon occurs at higher elevations where the annual precipitation is greater, while in between is a middle belt where the two species mix in proportions usually favoring the piñon.

In general, the stands are composed of widely spaced, low, globular trees. Half of the woodland studied has a crown density of less than 10 per cent, and nine-tenths a crown density under 20 per cent. Between the trees grow equally sparse desert shrubs, forbs, and grasses, mainly *Artemisia tridentata, A. nova,* and species of *Festuca, Oryzopsis, Agropyron,* and *Elymus.*

The number of trees per acre ranges from 52 in young stands to 380 in dense overmature piñon, and either remains fairly constant or increases as the stand reaches maturity.

Cordwood volumes on average acres vary from 73 to 1,440 cubic feet.[4] Cordwood increment increases with age and stand density, from 28 cubic feet per acre per decade in immature stands of low density to 456 cubic feet per acre per decade in overmature stands of dense piñon.

Second-growth stands usually contain a greater volume of cordwood and have a greater potential yield of fence posts than do virgin stands of the same age and density because of the many-stemmed character of second-growth trees.

The number of juniper fence posts varied from 2.8 to 11.3 pieces per acre, with the average piñon-juniper stand containing 9 usable posts per acre.

Table 1 gives the number of stems, cubic foot volumes, and yields per acre, by density and maturity classes, for single-leaf piñon and Utah juniper in the Pine Nut Hills.

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[1]Assistant forester, Soil Conservation Service, Sebastopol, Calif. This article was written while employed as area forester with the Soil Conservation Service in northern Nevada.

[2]Anon. Queen of them all was Virginia City. Timberman 42(8): 11-14, 50-62. 1941.

[3]Aerial photographs were used to determine stand density which was expressed as the per cent of the total ground area covered by the spreading crowns of the trees. Tenth-acre random sample plots were employed to obtain data on stands and individual trees.

[4]For Utah juniper and single-leaf piñon, a standard cord averages 70 cubic feet of wood.

SINGLE-LEAF PIÑON[1] AND UTAH JUNIPER[2] WOODLANDS OF WESTERN NEVADA

Jack L. Reveal

Introduction

The discovery of the Constock Lodes at the western edge of the Great Basin in 1859, heralded the wholesale exploitation of western Nevada's timber and woodland resources. In the half century that followed, approximately four-fifths of the nearby coniferous timberland was cut-over to produce lumber, mine props, fuelwood, charcoal, fence posts and other wood products needed by ranching and mining enterprises. (1)[3] From the pine-fir forests of the Sierra Nevadas were cut an estimated 600 million board feet of mine timbers plus large quantities of lumber and cordwood. And in the Washoe and Pine Nut hills to the east, where for many centuries the Indian had hunted game and gathered the rich nut of the piñon pine, laborers cut thousands of cords of single-leaf piñon and Utah juniper for charcoal, mine timbers and fuelwood. (2)

When the mining excitement began to wane, the valleys were settled by ranchers who turned to the piñon-juniper woodlands for fence posts and fuel. But the friction that developed between the rancher and the Indians, who feared the total destruction of their nutting grounds, caused the Bureau of Indian Affairs some years ago to set aside 65,000 acres of the best woodlands for the resident Indians.

In the summer of 1939, the Soil Conservation Service, at the request of the Bureau of Indian Affairs, made a woodland survey of the Indian allotments in the Pine Nut hills to gather data which was later used to guide the preparation of a management plan for the woodland.[4] From these data can be drawn a picture of the single-leaf piñon and Utah juniper --two trees little known to the forester but all important to the wood economy of the Great Basin.

Stand Characteristics. Piñon-juniper woodlands may be roughly divided into three altitudinal belts. On low dry fans Utah juniper occurs in nearly pure stands. At higher elevations where the annual precipitation is greater, single-leaf piñon occurs, separated from the juniper on the low fans by a middle belt where the two species mix in proportions usually favoring the piñon.

In general, the stands are composed of widely spaced, low, globular trees. Half of the woodland studied has a crown density of less than 10 percent, and nine-tenths of the woodland has a crown density under 20 percent. Between the trees grow equally sparse desert shrubs, forbs

1 Pinus monophylla, Torr. and Frem.

2. Juniperus utahensis [Engel.] Lemmon.

3. Numbers in parenthesis refer to references at end of article.

4. In the woodland survey, aerial photographs were used to determine stand densities which was expressed as the percent of the total ground area covered by the spreading crowns of the trees. Tenth-acre random sample plots were employed to obtain data on stands and individual trees.

and grasses, mainly Artemisia tridentata and nova and species of Festuca, Oryzopsis, Agropyron, and Elymus.

Stems per acre range from 52 in young stands to 380 in dense overmature piñon. Unlike the true forest, the number of stems per acre remains fairly constant or even increases as the stand reaches maturity.

Cordwood volumes on average acres vary from 102 cu. ft. to nearly 1700 cu. ft.[5] Cordwood increment increases, with age and stand density, from 35.5 cu. ft. per acre per decade in immature stands of low density to 487 cu. ft. per acre per decade in overmature stands of dense piñon.

Second growth stands usually contain a greater volume of cordwood and have a greater potential yield of fence posts than do old growth stands of the same age and density because of the many-stemmed character of second growth trees.

The number of juniper fence posts was found to vary from 2.8 to 11.3 pieces per acre, with the average pinon-juniper stand containing 9 useable posts per acre.

Table I gives the number of stems, cubic foot volumes, and yields per acre, by density and maturity classes, for single-leaf piñon and Utah juniper of the Pine Nut hills.

Tree Characteristics. In pure stands at low elevations, Utah juniper is usually sparse, knarled and scrubby with the appearance of being overmature. (3) On better sites, however, especially where it mixes with single-leaf piñon, its form and value improves. Mature Utah juniper is commonly single stemmed and may attain 12 inches d.b.h. and a height of 20 feet with a crown spread somewhat exceeding the height. Maturity is reached at about 180 years.

Vigorous immature ~~trees~~ juniper, usually second growth in the woodlands studied, are from 60 to 80 years old and range from three to five inches

5. For Utah juniper and single-leaf piñon, a standard cord contains 70 cu. ft. of wood.

in d.b.h. The average tree is from 10 to 14 feet in height with a crown spread about equal to the total height. Usually several stems arise from the base . Either lack of shading while young or the upward growth of basal branches left on the stumps after cutting for fence posts contributes to the multi-stemmed condition characteristic of second growth trees.

Utah juniper seems to maintain a fairly uniform rate of growth well into maturity. Although reliable curves of diameter growth could not be prepared from the data on Utah juniper as secured from increment borings, the apparent diameter growth[6] at breast height was found to average 0.6 inches per decade.

A cubic foot volume table was prepared for Utah juniper by measuring in ~~the~~ standing sample trees the amount of four-foot wood having a middle diameter of 2 inches or more outside bark. The table was based on the d.b.h. of the tallest stem. These volumes, together with corresponding heights and crown widths, are given in Table LL. The table also gives the average number of fence posts per tree by d.b.h. classes.

The typical single-leaf piñon, occuring either in pure stands or mixed with Utah juniper, may have one or several stems, the dominant one 6 inches d.b.h. and 16 feet tall with a crown spread a foot or so less than the total height. Its age is about 70 years.

Apparent Diameter growth of piñon is maintained at approximately one inch per decade for the first one hundred years. As maturity advances, the diameter growth decreases to 0.25 inches at the end of the second century. The life span is seldom over 250 years.

Height growth of immature single-leaf piñon trees is rapid ~~and quite uniform~~, but the rate decreases slowly as age increases. Crown width, however, increases uniformly until the tree reaches 12 inches d.b.h. and then practically ceases.

6. The term "~~apparent age~~" apparent diameter growth" is used since it has been established that the formation of extra or false growth rings is so common in these species that true age or true rate of growth cannot be determined by ring counts.

Since height growth continues after crown diameter growth has stopped, the single-leaf piñon loses its globular shape in maturity, quite unlike the Utah juniper whose crown diameter keeps pace with height growth throughout life.

Table IV gives cubic foot volumes, diameter growths per decade, and other tree characteristics for single-leaf piñon. The tables were prepared in the same manner as those for Utah juniper.

TABLE I

YIELD, VOLUMES AND STEMS PER ACRE

Pure and Mixed Stands of Single-leaf Pinon and Utah Juniper
(exclusive of stands on low alluvial fans)

Maturity Class	Density Class	Stems per Acre	Volume per Acre	Yield per Acre per Decade
		Number	Cu. ft.	Cu. ft.
IMMATURE	1-10%	52	102	35.5
	11-20%	120	240	91.5
	21-40%	174	447	147.2
	41-60%	216	582	193.7
MATURE	1-10%	49	114	40.3
	11-20%	128	429	126.7
	21-40%	154	724	188.2
	41-60%	314	1039	337.0
OVER-MATURE	1-10%	53	203	46.3
	11-20%	92	807	147.8
	21-40%	182	1218	343.9
	41-60%	380	1699	487.2

TABLE II

TREE CHARACTERISTICS OF UTAH JUNIPER (Juniperus utahensis)
(From curves)

D.B.H.	Sample Trees	Total Ht. from 1 ft. Stump	Crown Width	Partial Volume	Fence posts per tree
Inches	No.	feet	feet	Cu. Ft.	No.
1	3	7.0	6.0	0.3	
2	6	9.0	8.0	0.7	
3	10	10.5	10.0	1.0	
4	5	12.0	11.5	1.8	
5	11	13.0	13.0	3.0	
6	5	14.0	14.5	4.6	0.9
7	4	15.0	16.0	6.2	1.0
8	1	16.0	17.0	8.2	1.1
9	1	16.8	18.4	10.6	1.4
10	1	17.6	19.5	13.1	1.6
12	3	19.0	21.5	18.1	2.0
14	2	20.2	23.0	23.1	2.4

TABLE III

TREE CHARACTERISTICS OF SINGLE-LEAF PINON (Pinus monophylla)
(from curves)

D.B.H.	Sample trees	Total Ht. from 1 ft. Stump	Crown Width	Apparent Age	Apparent Growth	Partial Volume
Inches	No.	feet	feet	Years	Inches	C. Ft.
1	11	7.0	5.0	25	1.07	0.1
2	6	9.0	7.0	34	1.05	0.3
3	10	11.0	9.0	43	1.02	0.8
4	13	12.7	11.0	52	.99	1.5
5	13	14.2	13.0	62	.95	2.3
6	19	15.8	14.5	73	.90	3.4
7	9	17.2	16.0	84	.85	4.7
8	14	18.4	16.5	96	.79	6.3
9	6	19.7	17.0	109	.74	8.3
10	6	21.0	17.8	123	.68	10.9
12	3	23.2	18.2	155	.54	16.5
14	1	25.2	18.5	-	-	22.3
16	0	27.0	18.8	-	-	29.0
18	0	28.4	19.2	-	-	36.0

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