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**Natural
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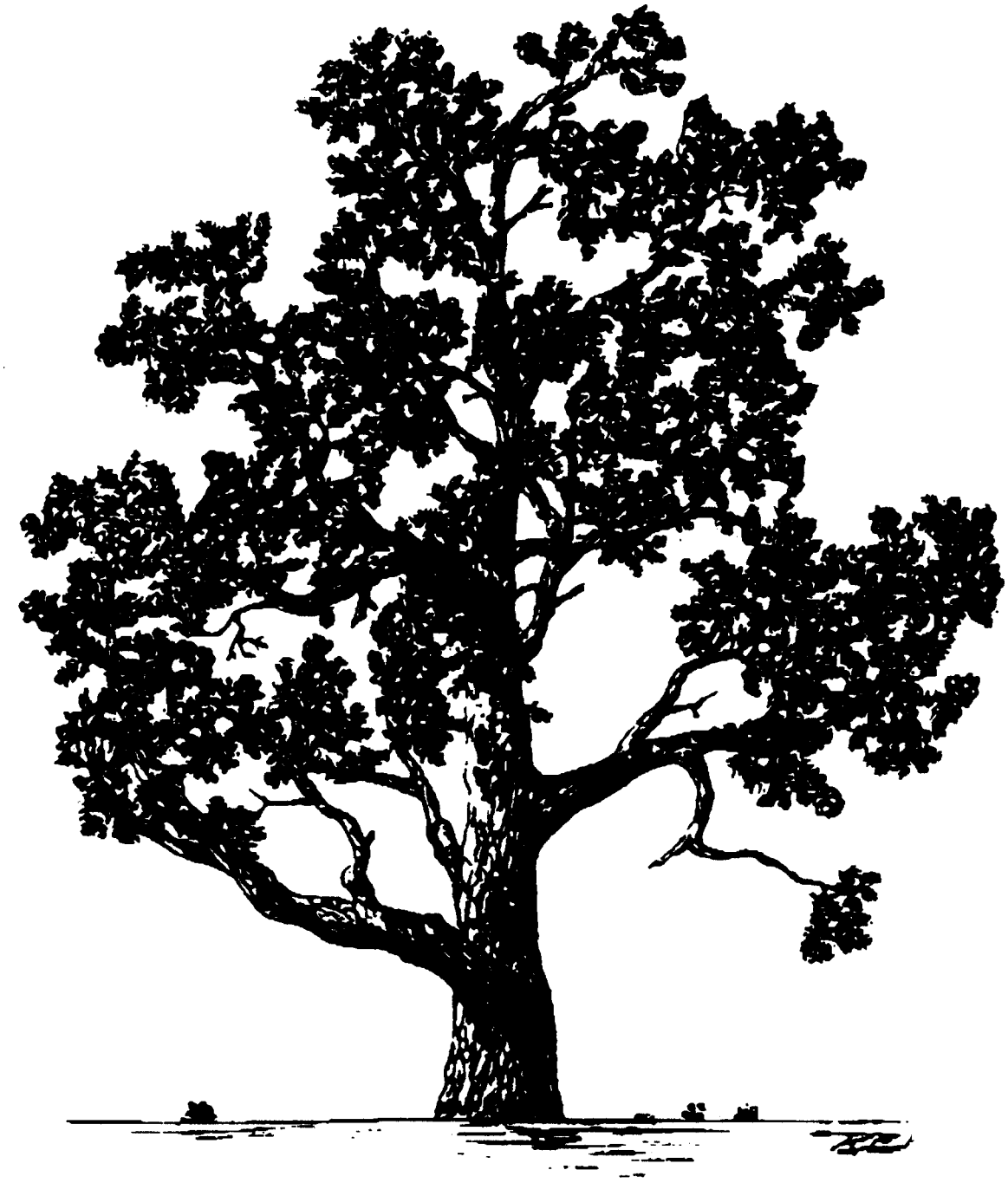
Conservation
Service**

**Grazing Lands
Technology
Institute**

Fort Worth, Texas

Inventorying, Classifying, and Correlating Juniper and Pinyon Communities

To Soils in Western United States



Contents

Appendixes

September 1997

Inventorying, Classifying, and Correlating Juniper and Pinyon Communities To Soils in Western United States

This publication provides general guidance for the inventorying, classifying, and correlation of juniper and pinyon (or piñon) into ecological sites. These guidelines are based on the ecological site descriptions for rangelands and forest lands. These guidelines are to be used during soil survey operations and any time ecological site development and revision is taking place.

Soil surveys on western rangelands and forest lands are normally completed with each major soil component correlated to a rangeland or forest land ecological site. As part of the National Cooperative Soil Survey, soil surveys include the characterization and classification of plant communities growing on each soil.

The National Cooperative Soil Survey is a joint effort of the U.S. Department of Agriculture and other Federal agencies, state agencies including the Agricultural Experiment Stations and local agencies. USDA's Natural Resources Conservation Service (NRCS) coordinates the Federal part.

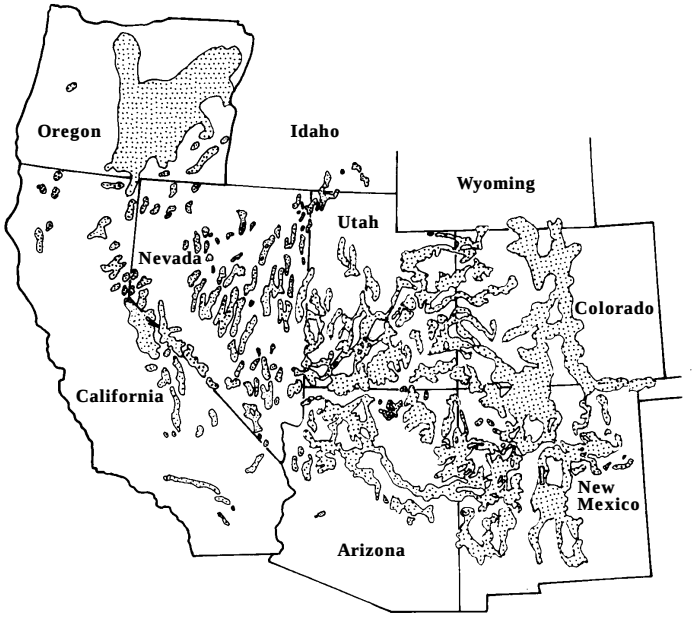
In the juniper or pinyon plant transitions between climax forest land and rangeland often exhibit vegetation that is of recent derivation and may not have been typical of the site when natural ecological processes were functioning on the site. The changes in the past 150 to 300 years often mask the potential plant communities of the sites and can create inconsistencies in inventory processes.

Knowing where pinyon or juniper communities, or both, have increased on rangeland, or invaded into adjacent rangeland is essential for understanding their ecology. The land also must be managed within its capabilities and limitations.

Juniper and pinyon communities

Estimates of the acreage of juniper and pinyon communities vary from 47 million to over 134 million acres in the western states of Arizona, California, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, and Wyoming (fig. 1). These

Figure 1. ***Coverage of juniper and pinyon communities in western United States*** (R.A. Evans, 1988. Management of Pinyon-Juniper Woodlands, USDA, Forest Service, Report INT-249)



estimates vary greatly because of the differing methods of survey, purposes and ages of surveys. The table below gives acreage figures based on the 1992 Natural Resources Inventory for non-Federal lands. The total acreage column is from various published and unpublished reports, and personal conversations with USDA, Natural Resources Conservation Service and Forest Service; Bureau of Land Management; universities; and state agency employees from the various states. The published reports are listed in the references section of this publication.

State	Non-Federal acres	Total acres
Arizona	3,982,700	12,604,800
California	328,800	2,932,000
Colorado	1,107,800	5,994,880
Idaho	170,200	1,550,200
Nevada	425,900	13,132,800
New Mexico	9,856,900	22,974,604
Oregon	2,311,400	6,000,000
Utah	1,205,900	15,516,645
Wyoming	294,200	1,217,198
Total	19,683,800	81,923,127

The distribution of these species is widespread and covers almost the entire western part of the United States. They occur as single species and in mixed stands. Elevations typically range from 4,000 to 8,000 feet and precipitation ranges from 10 to 20 inches. These communities tolerate a wide range of climatic conditions and extremes. They can be found where average monthly temperatures vary from 14 ºF in January to 95 ºF in July.

The **juniper** portion of these communities in the western United States is made up primarily of the following species:

- alligator juniper (*Juniperus deppeana* Steud.)
- one-seed juniper *(Juniperus monosperma* (Engelm.) Sarg.)
- western juniper *(Juniperus occidentalis* Hook.)
- Utah juniper (*Juniperus osteosperma* (Torr.) Little)
- Rocky Mountain juniper *(Juniperus scopulorum* Sarg.)

The **pinyon** component of these communities consists primarily of :

- Mexican pinyon (*Pinus cembroides* Zucc.)
- pinyon *(Pinus edulis* Engelm.)
- singleleaf pinyon *(Pinus monophylla* Torr. and Frem.)

Utah juniper and Rocky Mountain juniper along with pinyon and singleleaf pinyon are the common species in the basins and mountains of the intermountain west. Associated vegetation includes big sagebrush, antelope bitterbrush, bluebunch wheatgrass, and Thurber needlegrass. Western juniper is the common species in eastern Oregon, southwestern Idaho, and northern California. It is usually not associated with any pinyon species. Other associated species include bluebunch wheatgrass, Idaho fescue, and big sagebrush. In Arizona and New Mexico, one-seed juniper is common as a single species stand or in association with pinyon. Other associated species include manzanita, oak, sideoats grama, and blue grama.

The juniper and pinyon communities of the west have played an integral role in the culture and livelihood of many groups of Native Americans. These species have provided food, shelter, fuel, medicine, hunting cover, and spiritual well-being for many people. When Europeans arrived in America, beginning in the 1500's, and continuing through the 1800's, these plant communities provided them with many of the same products and resources.

The introduction of large numbers of domestic livestock and the aggressive suppression of fire has had a major impact in the character and range of these juniper and pinyon communities. This impact began in the southwest in the early 1600's following Spanish colonization, whereas it did not affect the Great Basin until the mid-1800's. Herbaceous cover was reduced until it could no longer compete with the woody species. The removal of fine fuel also reduced the sites ability to carry fires. These factors gave juniper and pinyon species a distinct competitive advantage in the plant communities and allowed them to greatly extend their range.

Juniper species

- alligator juniper (*Juniperus deppeana*)
  Mainly at higher elevations in Arizona and New Mexico, also found in western Texas. Native perennial tree that may reach 60 feet tall. Leaves are blue-green, toothed, and heavily glandular. Bark has deeply furrowed, square plates.

- one-seed juniper (*Juniperus monosperma*)
  Common species in Arizona and New Mexico. Also occurs in western Texas and Oklahoma, in southern Colorado, and in south central Wyoming. Native perennial tree. Leaves are gray-green and glandular. Seeds are one per cone.

- western juniper (*Juniperus occidentalis*)
  Common in eastern Oregon and the Sierra Nevada Mountains of California. Rarely in northwestern Nevada and southeastern Idaho. A native, perennial tree that is normally short and bushy but may reach heights of 60 feet in some locations. Leaves in whorls of three with distinct resin dot on each bundle.

- Utah juniper (*Juniperus osteosperma*)
  Widespread in Nevada, Utah, northern Arizona, western Colorado, and southern Idaho. Rarely found in California, New Mexico, and Wyoming. Native perennial tree that is round and low to the ground. Leaves are in whorls of three but without resin dot.

- Rocky Mountain juniper (*Juniperus scopulorum*)
  Widespread throughout the higher elevations of several western states including, Montana, Idaho, Washington, Wyoming, Utah, Colorado, Arizona, and New Mexico. Also occurs in the western part of North and South Dakota, western Nebraska, western Oklahoma, northeastern Oregon, and western Nevada. Native perennial tree that may reach 55 feet in height. Leaves in whorls of two, foliage appears fine and lacy.

Pinyon species

- pinyon (*Pinus edulis*)
  Widespread throughout Utah, Colorado, Arizona, and New Mexico. Rarely in California, Oklahoma, and Texas. Native perennial tree, can reach 40 feet in height, leaves typically in bundles of two, persistent, and entire.

- Mexican pinyon (*Pinus cembroides*)
  Range restricted to southeastern Arizona and southwestern New Mexico. Rarely in Texas. Native perennial tree, can reach a height of 40 feet. Leaves typically in bundles of three, persistent, and entire.

- Singleleaf pinyon (*Pinus monophylla*)
  Mainly in Nevada, western Utah, and the southern half of California. Rarely in Arizona and Idaho. Native perennial tree, can reach a height of 40 feet. Leaves are typically single, persistent, and entire.

Inventory and classification

A systematic approach for inventorying and classifying juniper and pinyon communities, and identifying where they have invaded adjacent rangeland or increased on rangeland, is essential for understanding their ecology. It is also essential to ensure that the land is managed within its capabilities and limitations.

NRCS has established guidelines that provide for consistent inventories in the juniper–pinyon vegetation areas. These guidelines are based on the establishment of ecological site descriptions for rangelands and forest lands. This describes the historic climax plant community for each ecological site. Rangeland and forest land ecological site descriptions are in section III of the Field Office Technical Guide. These site descriptions also include a description of the other steady state plant communities that may be on the site, and give a discussion of the pathways followed to each state. These site descriptions will also provide interpretations for the use and management of the site, including the present vegetation and the other steady states on the site.

On **Rangeland Ecological Sites** where juniper, pinyon, or both, are part of the historic climax plant community, they are recognized as such, both in the plant community description and the interpretations. Ecological dynamics discussions in the site descriptions will outline the processes that occurred to allow the juniper or pinyon, or both, to increase on this site and become dominate. **Rangeland Ecological Sites** where juniper or pinyon, or both, were not part of the historic climax plant community, but now exist on the site, will be explained in the ecological dynamics and interpretations sections of the site descriptions. Interpretations for the use and management of juniper, pinyon, or both, will be included in all **Rangeland Ecological Sites** descriptions where these species are part of the historic climax plant community and on sites where these species have invaded into other rangelands. **Forest Land Ecological Sites** where juniper, pinyon, or both, are the climax species for the site, will be explained and interpretations will include the use and management of these species.

This historical reference approach provides the necessary consistency to allow for uniform classification and soil and ecological site mapping. It also supplies the necessary interpretation for use and management of these areas.

Vegetation analysis and mapping

The following guidelines are designed to provide for the consistent analysis and mapping of **Rangeland** and **Forest Land Ecological Sites** in those areas where juniper, pinyon, or both, are in transition between forest land and rangeland.

- Rangeland is defined as: A kind of land on which the historic climax vegetation was predominantly grasses, grass-like plants, forbs, or shrubs.

- Forest land is defined as: A kind of land on which the historic climax vegetation was dominated by trees.

Soil taxonomic units identified in soil surveys completed by the NRCS are correlated to **Rangeland** or **Forest Land Ecological Sites** as appropriate. These sites are ecological subdivisions of rangeland and forest land that are separated in terms of the historic climax plant community they are capable of producing and supporting. **Forest Land Ecological Sites** are assigned to soil taxonomic units where the historic climax plant community was dominated by tree overstory. **Rangeland Ecological Sites** are assigned to soil taxonomic unit where the historic climax planet community was predominantly grasses, grass-likes, forbs, and shrubs.

Natural disturbances such as drought, fire, grazing or lack of grazing, and insects were inherent in the development and maintenance of the historic climax plant community. Where these natural environmental factors have been altered (overgrazing, suppression of fire) or the site is protected from these natural influences for extended periods (long-term exclosures, lack of fire), the present plant communities rarely typify the historic climax plant community and can be quite different. In the past 150 to 300 years, expansion of juniper and pinyon from its original distribution and densities has

presented problems in classifying present vegetation in relation to the historic climax plant community, and in correlating this plant community to specific environmental factors. Figure 2 indicates the influence of increase and encroachment of juniper trees from 1915 to 1978 at two different locations.

Expansion of juniper and pinyon has occurred in several ways.

- Density of these species has increased in the natural **Forest Land Ecological Sites** where juniper, pinyon, or both, are the climax dominate species for the site.

- Species have increased in density on **Rangeland Ecological Sites** where they were a part of the historic climax plant community.

- Juniper, pinyon, or both, have also invaded on to **Rangeland Ecological Sites** where they were not present in the historic climax plant community.

All of these methods of expansion and increase may have occurred within a few miles of each other. This can make the determination of **Forest Land/Rangeland Ecological Sites**, and the determination of the historic climax plant community a complex task.

These successional changes have been attributed to various factors including overgrazing by livestock, climatic changes, and the suppression of fire. There is considerable debate as to which of these factors, or combination of factors, is most significant in explaining the obvious increase in juniper and pinyon through the western United States. While this debate continues, there is general agreement that the juniper and pinyon have certainly increased in density and range throughout the western United States.

For many areas of juniper-pinyon occurrence, the distinction between forest land and rangeland potential plant communities is quite subtle. Soil-vegetation correlations made in these transition areas have often been more an assessment of the management implications presented by these trees occupying a given landscape than an evaluation of the natural environmental factors. Classification of an ecological site as either rangeland or forest land does not dictate use or management of the site. The historic climax plant community for a site related to the present plant community merely represents one kind of inventory information to be considered by land managers in developing management strategies for the site.

In April of 1989, an ad hoc group of NRCS (SCS) range conservationists and foresters met in Flagstaff, Arizona. This group included Keith Wadman, Larry Ellicott, Joel Brown, Jerry Reioux, Leonard Jurgens, Ed Olmsted, Bob Baum, Gary Brackley, Lendon Parker, Hall Brockman, Hugh Barrett, Russ Haltz, Mark Petersen, Greg Hendricks, Lyn Townsend, and Dee Gault. This group put many hours into the discussion and revisions of this method of inventorying, classifying, and correlating these vegetation types. The work of these individuals was routed for comment throughout the agency. As comments were received, another meeting was convened in Albuquerque, NM in October 1989. This group included: Gary Brackley, Lendon Parker, Pat Shaver, Dalton Merz, Kevin Hood, Barry Shupe, Berman Hudsen, Arnold Mendenhall, Rhett Johnson, Greg Hendricks, Keith Wadman, Terry Johnson, Lyn Townsend, and Harlan DeGarmo. This group further refined this procedure and it has been in use around the western states since that time. This current revision has been reviewed by the West Region Grazing Lands Consortium in September of 1996, and has received additional review by other NRCS, FS, and BLM employees and by several university and research professionals.

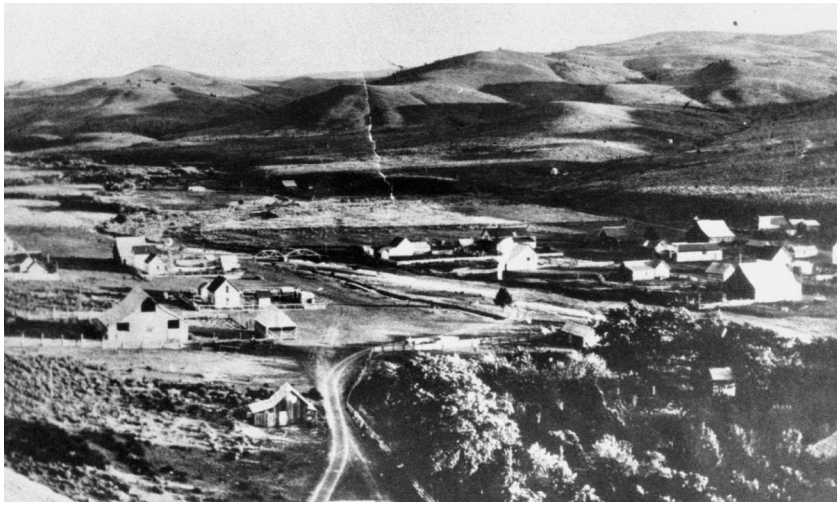
In the absence of definitive research that relates juniper and pinyon to specific environmental factors, the NRCS has developed criteria to be used in identifying where juniper and pinyon have invaded and increased onto rangelands. These criteria are based on information presented in research publications of the academic community and USDA and USDI technical papers.

- Forest occurs when trees in the mature or near mature plant community occupy 15 percent or greater canopy and are 12 to 16 feet or greater in height.

- Forest occurs when trees in the mature or near mature plant community occupy 25 percent or greater canopy.

- Woody plants less than 10 feet in height are generally considered to be shrubs.

Figure 2. Increases and encroachment of juniper trees from 1915 to 1978



Ashwood, Oregon in 1915

Ashwood, Oregon in 1968

Ashwood, Oregon in 1978

Figure 2. Increases and encroachment of juniper trees from 1915 to 1978—Continued

Plant community in western region in 1915

Plant community in western region in 1978

- Historic evidence indicates that the above conditions existed before the influence of settlement.

- Generally, forest does not occur on soils that are in the aridic or ustic aridic moisture regime, even when other soil factors of depth, texture, slope, etc., favor the correlation to **Forest Land Ecological Sites**.

- Allowing trees in the historic climax plant community on **Rangeland Ecological Sites** is procedurally, technically, and professionally correct.

These criteria are to be used as a general guide and should be considered and evaluated for specific locations. The criteria on age of the "mature potential" trees should be adjusted based on the length of time and impacts of settlement. The canopy cover of 15 percent may need to be adjusted somewhat based on species and site. For example: 15 percent canopy cover of mature potential trees for Utah juniper in Nevada may work well, although 20 percent canopy cover of mature potential trees of one-seed juniper in New Mexico is what is necessary. The pounds of fine fuel production may also be adjusted for different MLRA's or region of the juniper range. If adjustments are necessary in canopy cover, age, or fine fuel, they will be made with the most current scientific information available and in consultation with the necessary discipline specialists and researchers.

In the appendix are keys to separate **Rangeland** and **Forest Land Ecological Sites** that incorporate the main ideas in the criteria. They represent guidance to be used by NRCS personnel in completing soil/site correlations in the area of juniper-pinyon forest land/rangeland transition.

Also in the appendix are some suggested inventory techniques and data sheets for the use in soil/site correlation. Production tables are included that show the **annual** production per tree for Utah juniper. Unpublished clipping studies in New Mexico indicate that these tables will work well for one-seed juniper as well. The New Mexico studies also indicates that a pinyon tree, comparable in canopy diameter and foliage density produces more annual production than the one-seed juniper. The studies indicate that the pinyon produced about 6 pounds per tree and the juniper produced just over 4 pounds per tree.

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Appendixes

Appendix 1: Key for Separating Ecological Sites

Key to separating rangeland potential sites from juniper or pinyon forest land potential sites in areas of rangeland–forest land transition

1. Stand of juniper and/or trees present on the site.
   2. Presence of "mature potential" (more than 150 years old) juniper or pinyon, or both, within the stand.
      3. Present canopy cover of more than 150 year old trees within the stand is >25%...**Forest Land Ecological Site**
      3. Present canopy cover of more than 150 year old trees within the stand is <25%
         4. Physical evidence of "mature potential" (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an overstory canopy >25%...**Forest Land Ecological Site**
         4. Physical evidence of "mature potential" (more than 150 years old) tree removal by harvest, fire, or other factors does not exist that reasonably suggests the site once supported a stand of mature potential trees with an overstory canopy >25%
            5. Physical evidence of "mature potential" (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an average stand height less than 12 feet...**Rangeland Ecological Site**
            5. Physical evidence of "mature potential" (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an average stand height of 12 feet or greater.
               6. Physical evidence of "mature potential" (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an overstory canopy >15%...**Forest Land Ecological Site**
               6. Physical evidence of "mature potential" (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an overstory canopy <15%...**Rangeland Ecological Site**
   2. Individual trees within the stand are all less than 150 years old.
      7. Topographic and/or soil features of the site limit the frequency and intensity of natural fire. Soils are very shallow, rocky, droughty, and typically associated with areas of exposed bedrock. Soils are shallow, residual or colluvial over soft bedrock or soils with eroded surface layers. Potential for production of continuous fine fuels (including litter) is less than 600 pounds per acre.
         8. Present stand of trees (in absence of disturbance) is expected to progress to a stand of more than 150 year old trees with an overstory canopy >25%...**Forest Land Ecological Site**

8. Present stand of trees (in the absence of disturbance) is expected to progress to a sparse stand of more than 150 year old trees with an overstory canopy <25%.

9. Present stand of trees (in absence of disturbance) is not expected to achieve an average stand height of 12 feet...**Rangeland Ecological Site**

9. Present stand of trees (in absence of disturbance) is expected to achieve an average stand height of 12 feet or greater.

10. Present stand of trees (in absence of disturbance) is expected to progress to a stand of more than 150 year old trees with an overstory canopy >15%...**Forest Land Ecological Site**

10. Present stand of trees (in absence of disturbance) is expected to progress to a stand of more than 150 year old trees with an overstory canopy <15%...**Rangeland Ecological Site**

7. Topographic and/or soil features of site do not restrict natural fire. Surface relatively free of large rock fragments or high amounts of gravel. Residual or colluvial soils typically more than 14 inches deep. Includes most non-eroded alluvial soils. Potential for the production of continuous fine fuel (including litter) on the site greater than 600 pounds per acre. ...**Rangeland Ecological Site**

1. Juniper or pinyon trees, or both, not present on the site.

11. Physical evidence of mature potential tree (more than 150 years old) removal by harvest, fire or other factors that reasonably suggest the site once supported a stand of mature potential trees with an overstory canopy greater than 25%. Topographic and/or soil features appear to limit the frequency and intensity of natural fire on the site...**Forest Land Ecological Site**

11. Physical evidence of mature potential tree (more than 150 years old) removal by harvest, fire or other factors that reasonably suggest the site did not supported a stand of mature potential trees with an overstory canopy greater than 25%. Topographic or soil features, or both, do not limit the frequency and intensity of natural fire on the site.

12. Physical evidence of “mature potential” (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an average stand height less than 12 feet...**Rangeland Ecological Site**

12. Physical evidence of “mature potential” (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an average stand height of 12 feet or greater.

13. Physical evidence of “mature potential” (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an overstory canopy >15%...**Forest Land Ecological Site**

13. Physical evidence of “mature potential” (more than 150 years old) tree removal by harvest, fire, or other factors that reasonably suggests the site once supported a stand of mature potential trees with an overstory canopy <15%...**Rangeland Ecological Site**

Appendix 2: Instructions for pinyon–juniper site inventory worksheet

The Pinyon-Juniper Site Inventory Worksheet is used for the inventory of singleleaf pinyon (*Pinus monophylla*) and Utah juniper (*Juniperus osteosperma*) stands in Nevada. This worksheet is also used for recording pinyon (*Pinus edulis*) and Rocky Mountain juniper (*Juniperus scopulorum*) inventory data. This worksheet is not used for western juniper (*Juniperus occidentalis*) data collection.

Stand selection

Plots are generally selected on the basis of how well the soil supporting a stand of trees represents the particular soil series (and phase) being investigated. Landscape features, aspect and microtopography of the plot must be as defined for the soil series (and phase) being considered. Locate plots in stands free of insect or disease damage. Pinyon or mixed pinyon-juniper stands may have a light infection of dwarf mistletoe. The *mature* successional stage is the preferred condition for soil-woodland site correlation plots in pinyon-juniper. Plots may be located in the *young, immature,* or *climax* stages, however, the variability in site indexes is usually much greater within these successional stages.

Successional stages for pinyon–juniper woodland communities

Four successional stages for pinyon–juniper are used in soil-woodland site correlation (fig. 3).

Young: This stage follows major disturbance to the woodland community or as pinyon, and especially juniper, trees move out of original woodland sites and begin to colonize adjacent, non-woodland, plant communities. The visual and vegetal structure of the site are dominated by pinyon and juniper saplings (to 4.5 feet in height) in association with herbaceous vegetation and woody shrubs. Stem diameter at the 1-foot stump height of pinyon and juniper trees averages 3 inches or less. Plant species diversity is usually at a maximum for a woodland site. Pinyon and juniper seedlings are common in the community.

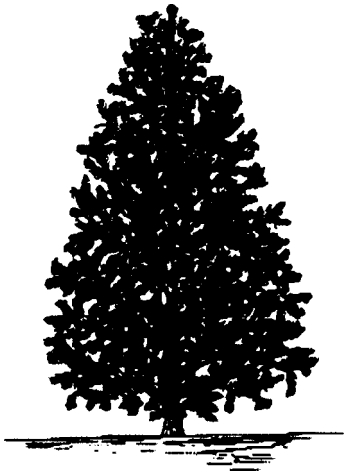
Immature: The visual and vegetal structure of the site are dominated by juniper or pinyon trees, or both, greater than 4.5 feet in height. Average stem diameter of pinyon and juniper trees is less than 5 inches at the 1-foot stump height. Individual trees typically have full, dense crowns. The upper crowns of dominant and codominant trees are cone, or pyramidal-shaped. Understory vegetation consists of grasses, forbs, and shrubs, in association with seedlings and saplings of overstory trees.

Mature: The visual and vegetal structure are dominated by juniper or pinyon trees, or both, that have reached or are near maximal heights for the site. Dominant trees typically average greater than 5 inches in diameter at the 1-foot stump height. Dominant and codominant trees have full crowns. The upper crowns are normally irregularly or smoothly flat-topped or rounded. Understory vegetation is strongly influenced by overstory tree shading, or duff accumulation.

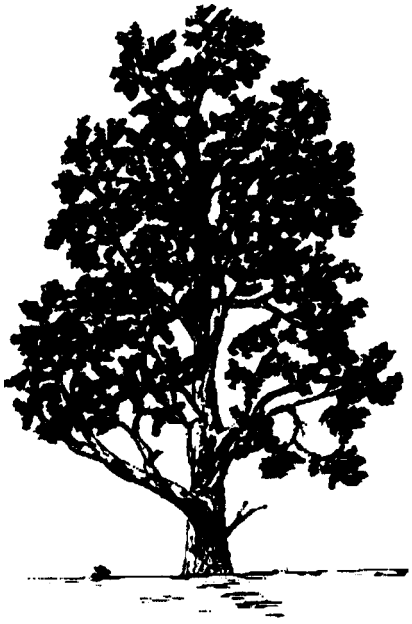
Climax: This stage is dominated by juniper or pinyon trees, or both, that have reached maximal heights for the site. Dominant and codominant trees average greater than 5 inches at the 1-foot stump height. Dominant pinyon and juniper trees typically have open, fragmented crowns. The upper crowns of dominant and codominant trees are normally flat-topped or rounded. Understory vegetation is sparse because of overstory tree competition.

Figure 3. Singleleaf pinyon age classes successional stages

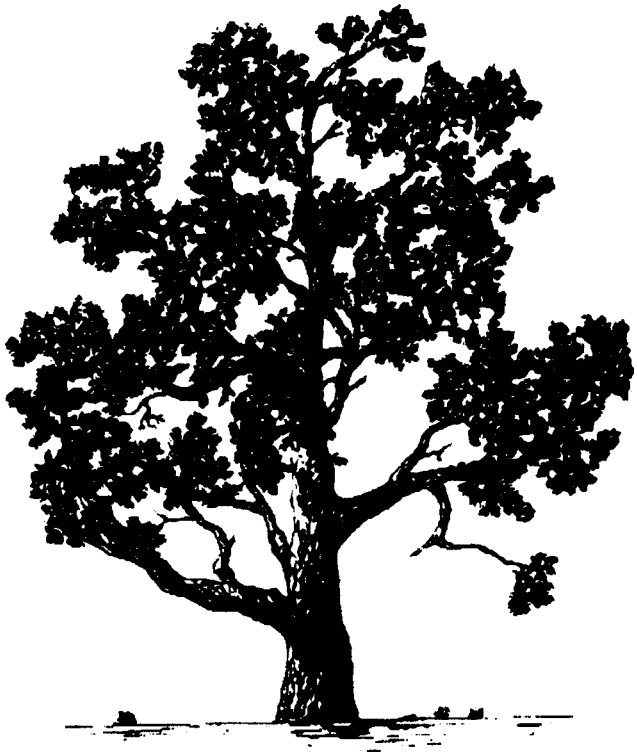
Young



Immature



Mature



Climax

Pinyon–Juniper Site Inventory Worksheet

Date: _____ Data by: _____ Location: Long. _____ Lat.. _____ Sec._____ T._____ R._____

Plot number: _____

Site number: _____ Field Office/ photo number: _____

Landowner name and soil survey area: _____

Soil classification: _____

Soil Series and Phase: _____ NRCS (SCS) SOI-5 No. _____

NRCS (SCS) SOI-232 No. _____ NRCS (SCS) RANGE-417 No. _____

Elevation: _____ ft Precipitation zone: _____ Slope: _____ % Azimuth: _____ degrees

Landform: _____

Slope component: Crest ❑ Summit ❑ Shoulder ❑ Backslope ❑ Footslope ❑

Kind of slope: Straight ❑ Concave ❑ Convex ❑

Surface rock cover: Boulders _____ % Stones _____ % Cobbles _____ % Gravel _____ %

Grazing history: _____ *Kind of animal:* _____ *Season of use:* _____

Wildlife species: _____ *Burning history:* _____ *Harvest history:* _____

Plot Data

Sampling method: Zig-zag ❑ Fixed plot ❑

Plot size: ____ Plot configuration: Circle ❑ Rectangular ❑ Square ❑

Successional stage: Immature ❑ Mature ❑ Overmature ❑

Ocular estimate of overstory canopy cover: ___ % (Total): ___ % Pinyon: ___% Juniper: ___% Other

Estimated average DRC: _____ *Estimated average spacing:* _____

Estimated D+X: _____ *Estimated site index:* _____

Understory plants:

Plant symbol/ common name	Percent cover (basal or canopy)	Weight (lb/ac)	Plant symbol/ common name	Percent cover (basal or canopy)	Weight (lb/ac)
Grasses:					
Forbs:					
Shrubs:					

Pinyon–Juniper Site Inventory Worksheet — Continued

Plot number _____

Tree data lines	Notes	Seeding and sapling count

Tree No.	Species	Distance ft	DRC	Basal area	Crown diam ft	Height ft	Juniper posts	Ring count [1/]	Number rings pith to 2.32 in

Ocular estimate

Pinyon
Seedlings _____ No./ac
Saplings _____ No./ac

Juniper
Seedlings _____ No./ac
Saplings _____ No./ac

Zig-zag transect

Species Distance Height

Fixed plot count

Pinyon
Seedlings = _____
Saplings = _____

Juniper
Seedlings = _____
Saplings = _____

[1/] Add the following to correct 1 foot height age to total age:
Add 9 years for pinyon and singleleaf pinyon; 12 years for Utah juniper; and 8 years for Rocky Mountain uuniper
These values are also added to ring count of pith to 2.3 inches to obtain total age at 5 inches diameter.

Heading data lines

Data entry labels listed in italic print denote data elements not included in the Nevada NRCS Pinyon-Juniper Inventory data base program.

Date: Enter date of inventory.

Data by: Enter names of all specialists collecting plot data.

Location: Enter coordinates of Longitude and Latitude or Section, Township, and Range. (Locate plot in section map provided.) Space is provided for a brief description of how to get to plot with any identifying features, landmarks, roads, etc.

Plot number: Enter identification number for inventory plot.

Site number: Enter the NRCS woodland suitability group description number for the woodland site being sampled or the range site number for which a pinyon/juniper overstory is being inventoried.

Field office/photo no.: Enter NRCS Field Office responsible for conservation planning activities at inventory location or soil survey photograph number (field sheet) that covers inventory site.

Landowner name or soil survey area: Enter landowner and/or ranch name(s) or soil survey name and/or number.

Soil classification: Enter taxonomic classification of soil at inventory location.

Soil Series and Phase: Enter name and phase of Soil Series at the inventory location.

NRCS (SCS)-SOI-5 No.: Enter soil interpretation record number for soil series and phase at inventory location.

NRCS (SCS)-SOI-232 No.: Enter when a form NRCS(SCS)-SOI-232 is completed for soil at inventory location.

NRCS (SCS)-RANGE-417 No.: Enter when a form NRCS(SCS)-RANGE-417 is completed for understory vegetation.

Elevation: Enter elevation at plot location.

Precipitation zone: Enter estimate of average annual precipitation at inventory location.

Slope: Enter the percent of slope.

Azimuth: Enter in degrees.

Landform: Briefly describe major or component landform and check appropriate boxes for slope component and shape (F. Peterson, 1981. Landforms of the Basin and Range Province, Technical Bulletin No. 28 University of Nevada, Reno).

Surface rock cover: Estimate percentages of surface rock by size:
Boulders - >40 inches in diameter
Stones - >10 inches and <40 inches in diameter
Cobbles - >3 inches and <10 inches in diameter
Gravels - >10 mm and <3 inches in diameter

***Grazing history*:** Show past grazing history of the area:
1 - None
2 - Slight
3 - Moderate
4 - Heavy

***Kind of animal*:** Enter kind and class of livestock grazing in the area.

***Season of use*:** Show season(s) of use where area is grazed:
U - Unknown
SP - Spring
SU - Summer
F - Fall
W - Winter

***Wildlife species*:** Enter wildlife species found in the area.

***Burning history*:**
U - Unknown
1 - Rarely burned
2 - Occasionally burned
3 - Systematically burned
4 - Burned ___|___ years ago (Enter code and years)

***Harvest history*:**
U - Unknown
1 - Not harvested
2 - Harvested ___|___ years ago (Enter code and years)

Plot data

Data entry labels listed in italic print denote data elements not included in the Nevada NRCS Pinyon-Juniper data base program.

Sampling method: Check appropriate box for sampling method used. If fixed plot method is used, enter plot size, that is, 1/10 acre. (See discussion of fixed-plot configuration and selection.)

Plot configuration: Enter plot shape.

Successional stage: Check appropriate successional stage represented by the plot. The "mature" stage is the preferred condition for soil-forest site correlation plots. (See descriptions of **Successional stages for pinyon or juniper communities**, or both.)

Ocular estimate of overstory canopy cover: Estimate total overstory tree canopy cover using vertical projection method. List overstory canopy cover by tree species as a percent of the total canopy cover.

Estimated average DRC: Enter ocular estimate of Diameter Root Collar (DRC) in inches for stand.

Estimated average spacing: Enter ocular estimate of average tree spacing, in feet, for stand.

Estimated D+X spacing: Enter estimate of D+X spacing (Average DRC - Average Spacing = Estimated D+X spacing).

Estimated site index: Using D+X spacing and average DRC, find basal area from table 5A-1. Using this "derived" basal area value, determine site index.

Understory plants: List the common understory species and estimate the percent cover (basal or crown) of each species. Basal cover is estimated for perennial herbaceous vegetation only. Crown cover is estimated only for woody vegetation. Enter an estimate of the annual production in pounds per acre (air-dry weight) for each species listed.

Fixed-plot transect: tree data lines

Fixed-area sampling units are called plots or strips depending on their dimensions. The term plot is loosely applied to sampling units of small areas that are square, rectangular, circular, or triangular in shape. A strip is a rectangular plot whose length is many times its width. Any fixed-area plot configuration may be used within a selected tree stand. The guiding principle in the choice of plot size should be to have a plot large enough to include a representative number of trees, but small enough that the time required for measurement is not excessive. For more sparse tree stands, use a 1/10-acre plot; for more dense stands, use a 1/20-acre plot size. Once a plot size is chosen for a soil series (and phase), the selected plot size should be used consistently for additional woodland inventories conducted on the soil. If plot data collection is to include the completion of a form NRCS(SCS)-ECS-417, choose a plot configuration compatible with this sampling of the understory plant community.

Commonly used circular and square plot dimensions—

Area		Radius of circular plot	Side of square plot	Diagonal square plot
Acres	*Feet*^{2}	*Feet*	*Feet*	*Feet*
1.00	43,560	117.75	208.71	295.16
0.50	21,780	83.26	147.58	208.71
0.25	10,890	58.88	104.36	147.58
0.20	8,712	52.66	93.34	132.00
0.10	4,356	37.24	66.00	93.34
0.05	2,178	26.33	46.67	66.00
0.01	435.6	11.78	20.87	29.52
0.001	43.56	3.72	6.60	9.33

General: The worksheet has lines for entering data from single-stemmed trees or single and multiple-stemmed trees. Flag each tree when measurements are completed so it is not inadvertently measured again. Use additional pages as needed, to complete stand inventory.

Tree data lines

Tree number: Starting in the upper left corner of the tree data lines section, enter "1" for the first tree measured, "2" for the second and so on. A multiple-stemmed tree is considered a single tree; number the first stem encountered and run an arrow down the "Tree No." column until all the stems of that tree are accounted for. Only those stems greater than 3 inches in diameter are recorded. For practical purposes (and for compliance with the "Howell" site index procedure), only trees greater than 4.5 feet in height will be assigned a number and entered in the tree data line section. Trees less than 4.5 feet in height are accounted for as "seedlings" or "saplings" and in measures of understory vegetation.

Species: Enter the appropriate scientific plant symbol for each tree measured:

singleleaf pinyon = PIMO
Utah juniper = JUOS
Rocky Mountain juniper = JUSC2
pinyon = PIED

Distance: Distance is not recorded in a fixed-plot transect.

DRC: Enter the "Diameter Root Collar" (DRC) of the tree to the nearest 1/10 inch. Measure DRC at just above the root collar or average ground line (mineral soil, after duff layer removed). DRC is measured at the ground line for single-stemmed trees with uniform stem taper. For multiple-stemmed trees that fork near (within 6 inches) or below the average ground line, a DRC of each stem is measured and an equivalent DRC (EDRC) in them computed and recorded in place of DRC.

$$\sqrt{\left(S1^2 + S2^2 + S3^2 + ...\right)}$$

S= Individual stem

For multiple-stemmed trees that fork above 6 inches from the average ground line, measure DRC at the tree base. This is done for all stems greater than 3 inches in diameter. Start with the the largest stem and be careful not to measure the same stem twice.

Basal area: Complete this column after returning to the office. Enter the appropriate basal area (in square feet to the nearest tenth) using the measure DRC or computed EDRC and table 5A-1, Basal area. An entry must be made for each single-stemmed tree (DRC) and for each multiple-stemmed tree (EDRC).

Crown diameter: Measure the live crown diameter of each tree within the plot along the long axis in two directions. Add the first crown diameter measurement to the second crown diameter measurement and divide by 2 to obtain an average crown diameter for each tree. Crown diameter, in feet, is rounded to the nearest whole number.

Height: Enter the height of each tree from the average ground line to the tip of the tallest live stem. Tree height, in feet, is rounded to the nearest whole number.

Juniper posts: Record the number of posts in each juniper tree. A post is a solid, reasonably straight, stem at least 7 feet long with a minimum small end diameter of 4 inches and a large end diameter of 7 to 9 inches. Record posts only for juniper species. Pinyon species are seldom used for fenceposts, as this wood has a short useful life span (4 to 6 years).

Notes

Use this column to record any pertinent information, or to identify trees selected for aging. When tree age is desired, select 3 to 5 dominant or codominant trees within the plot. Selected trees must be in the best health or condition relative to other trees within the plot. An increment core will be taken from each selected tree at 12 inches above the average ground line (1-foot stump height). Increment cores are marked for easy identification and stored so that tree rings can be counted after returning to office. Record total tree ring count and the ring count from pith to 2.3 inches from increment core is this column. Make the following adjusts to correct tree ring count to total tree age: add 9 years for pinyon and singleleaf pinyon; add 12 years for Utah juniper; add 8 years for Rocky Mountain juniper. Ring counts from the pith outward to 2.3 inches are also adjusted using these factors to obtain total tree age when at a 5-inch outside-bark (O.B.) diameter (4.6-inch inside-bark diameter). Ring counts made from pith to 2.3 inches will be used to validate site productivity.

Tree seedling and sapling count

Estimates of tree seedlings and saplings are not made for fixed plot sampling. If desirable, a zig-zag transect may also be completed adjacent to the fixed plot location to record seedlings or saplings, or both, at site. A tree seedling is less than 20 inches in height; a tree sapling is 20 inches to 4.5 feet in height. Enter the species, height, and distance between plants, for 20 seedlings or saplings, or both, in the space provided in right-hand margin of the worksheet. Distances can be summed after returning to office and the number of juniper or pinyon, or both, seedlings/saplings per acre calculated. (Refer to NRCS National Forestry Manual, Part 536, Section 536.10 through 536.27 for procedures to complete a zig-zag transect.)

Fixed plot count

Count tree seedlings and saplings found within fixed plot area and record, by species, in the space provided in lower-right corner of the worksheet. A seedling tree is less than 20 inches in height, a tree sampling is 20 inches to 4.5 inches in height.

Zig-Zag Transect: Tree Data Lines

Refer to NRCS National Forestry Manual, Part 536, Section 536.10 through 536.27 for procedures to complete a zig-zag transect.

General: Worksheet on page 19 contains lines for entering data of single-stemmed trees or a lesser number of single and multiple-stemmed trees. Use additional pages as needed to complete transect.

Tree Data Lines

Tree number: Starting in the upper left corner of the tree data lines section, enter "1" for the first tree measured, "2" for the send on and so on. A multiple-stemmed tree is considered a single tree; number the first stem encountered and run an arrow down the "Tree No." Column until all the stems of that tree are accounted for. Only those stems greater than 3 inches in diameter are recorded. For practical purposes (and for compliance with the "Howell" site index procedure), only trees greater than 4.5 feet in height will be assigned a number and entered in the tree data line section. Trees less than 4.5 feet in height are accounted for as "Seedlings" or "Saplings" and in measures of understory vegetation.

Species: Enter distance (measured in feet) between each tree included in transect.

DRC: Enter the "Diameter Root Collar" (DRC) of the tree to the nearest 1/10th inch. Measure DRC at just above the root collar or average ground line (mineral soil, after duff layer removed). DRC is measured at the ground line for single-stemmed trees with uniform stem taper. For multiple-stemmed trees that fork near (within 6 inches) or below the average ground line, a DRC of each stem is measured and an equivalent DRC (EDRC) is computed and recorded in place of DRC.

$$\sqrt{\left(S1^2 + S2^2 + S3^2 + ...\right)}$$

S = Individual stem

For multiple-stemmed trees that fork above 6 inches from the average ground line, measure DRC at the tree base. This is done for all stems greater than 3 inches in diameter. Start with the largest stem and be careful not to measure the same stem twice.

Basal area: Complete this column after returning to the office. Enter the appropriate basal area (in square feet to the nearest tenth) using the measured DRC or the computed EDRC and table 5A-1, Basal area. An entry must be made for each single-stemmed tree (DRC) and for each multiple-stemmed tree (EDRC).

Crown diameter: Measure the live crown diameter of each tree within plot along the long axis in two directions. Add the first crown diameter measurement to the second crown diameter measurement and divide by 2 to obtain an average crown diameter for each tree. Crown diameter, in feet, is rounded to the nearest whole number.

Height: Enter the height of each tree from the average ground line to the type of the tallest live stem. Tree height, in feet, is rounded to the nearest whole number.

Juniper posts: Record the number of posts in each juniper tree. A post is a solid, reasonable straight, stem, at least 7 feet long, with a minimum small end diameter of 4 inches and a large end diameter of 7 to 9 inches. Record posts only for juniper species. Pinyon species are seldom used for fenceposts as this wood has a short useful lifespan (4 to 6 years).

Notes

Use this column to record any pertinent information, or to identify trees selected for aging . When tree age is desired, select three to five dominant or codominant trees within the plot. Selected trees must be in the best health or condition relative to other trees within the plot. An increment core will be taken from each selected tree at 12 inches above the average ground line (1-foot stump height). Increment cores are marked for easy identification and stored so that tree rings can be counted after returning to office. Record total tree ring count and the ring count from pith to 2.3 inches from increment core in this column. Make the following adjustments to correct tree ring count to total tree age: add 9 years for pinyon and singleleaf pinyon; add 12 years for Utah juniper; add 8 years for Rocky Mountain juniper. Ring counts from the pith outward to 2.3 inches are also adjusted using these

factors in order to obtain total tree age when at a 5- inch outside-bark (O.B) diameter (4.6-inch inside-bark diameter). Ring counts made from pith to 2.3 inches will be used to validate site productivity.

Tree seedling or sapling count

Space is provided to enter estimates of pinyon and/or juniper seedlings and saplings for the stand being inventoried. A tree seedling is less than 20 inches in height, a tree sapling is 20 inches to 4.5 feet in height. If desirable, a zig-zag transect species, height, and distance between plants, for 20 seedlings or saplings, or both. Distances can be summed after returning to office and the number of juniper or pinyon, or both, seedlings/saplings per acre calculated.

Appendix 3: Instructions for fixed-plot summary worksheet

A. **CF** refers to the conversion factor for the plot. Enter 10 for a 1/10-acre plot, 20 for a 1/20-acre plot. (see "Sampling method").

Lines B through J are summations of tree data line entries recorded on Pinyon-Juniper Site Inventory Worksheet.

B. **Total number of trees in plot** equals the total number of trees, greater than 4.5 feet in height, recorded within plot.

C. **Total number of trees in plot - by species** equals the total number of each tree species recorded within the plot.

D., E. **Total number of seedlings** or **saplings in plot - by species** equals the total number encountered within the plot and entered in **Fixed plot count**.

F. **Summation of DRC** refers to the total sum of DRC's and EDRC's of all trees in the plot. The DRC of a single-stemmed tree (and a multiple-stemmed tree that forks at or above 6 inches) equals the measured DRC. The equivalent DRC, or EDRC, of a multiple-stemmed tree that forks below 6 inches equals the square root of the summation of the squares of each individual stem

$$\sqrt{\left(S1^2 + S2^2 + S3^2 + ...\right)}$$

S = Individual stem

For example, tree number 1 is multiple-stemmed and has 3 stems measuring 5, 6 and 7 inches. Each stem is squared (5x5, 6x6, 7x7), the products added (25 + 36 + 49 = 110), and the square root taken (10.5). continuing, the EDRC of tree number 1 is added to the DRC or EDRC of tree number 2, and so on for all trees in the plot. The resulting sum (to the nearest 1/10 inch) is entered on line F.

G. **Summation of basal area** equals the total of all entries in the **Basal area** column.

H. **Summation of individual tree crown diameters** equals the total of all entries in the **Crown diameter** column. Also enter sum of tree crown diameters for each tree species in plot.

I. **Summation of tree heights** equals the total of all entries in the **Height** column.

J. **Summation of juniper posts** equals the total of entries in the **Juniper posts** column.

Complete Lines 1 through 10 as instructed using the **Summations** entered in Lines A through J.

Complete line 11 as instructed using the **Summations** entered in Lines K through N.

Line 12. **Overstory canopy cover - line intercept method:** Where line intercept transacts are used to supplement canopy cover measurements from within the fixed plot, enter results in space provided.

Line 13. **Tree age summary** - Enter number of trees, by species, for which age measurements have been made. Enter average DRC or EDRC for these trees, the average total age, and the average tree height.

Line 14. **Tree age to 2.3-inch radial growth** - enter tree age at 2.3-inch radial growth (pith to 2.3 inches) by tree species. Enter 1-foot height age correction factor for juniper species.

Complete entry of Site Index as directed on Fixed-Plot Summary Worksheet.

Fixed-Plot Summary Worksheet

Plot Number: _____ Date: _____

Lines A - J are Summations from Pinyon-Juniper Site Inventory Worksheet

A. Conversion Factor:		_____ (CF)	
B. Total number of trees in plot:		_____ number	
C. Total number of tres in plot - by species	Pinyon	_____ number	Juniper _____ number
D. Total number of seedlings in plot - by species:	Pinyon	_____ number	Juniper _____ number
E. Total number of saplings in plot - by species	Pinyon	_____ number	Juniper _____ number
F. Summation of DRC:		_____ inches	
G. Summation of basal area:		_____ ft^2	
H. Summation of individual tree crown diameters:	Total	_____ ft	
Summation of tree crown diameters - by species:	Pinyon	_____ ft	Juniper: _____ ft
I. Summation of tree heights:		_____ ft	
J. Summation of juniper posts:		_____ number	

1. Tree species and composition: Pinyon _____ %
   (Species count/number trees in plot) x100 Juniper _____ %

2. Number of trees/acre = _____ Trees
   (Number trees in plot x CF)

3. Number of trees/acre - by species:
   (Percentage of pinyon trees in plot x number of trees in plot) Pinyon _____ number per acre
   (Percentage of juniper trees in plot x number of trees in plot) Juniper _____ number per acre

4. Number of seedlings/acre: Pinyon _____ number per acre
   (Species count in plot x CF) Juniper _____ number per acre

5. Number of saplings/acre: Pinyon _____ number per acre
   Juniper _____ number per acre

6. Average DRC= _____ inches
   (Summation of DRC/number trees in plot)

7. Total basal area/acre = _____ ft^2
   (Summation of basal area x CF)

8. Overstory canopy cover - Fixed Plot Method:
   Average crown diameter within plot = _____ ft Pinyon _____ ft Juniper
   (Sum of crown diameters - by species/number trees in transect - by plot)
   Average crown area = _____ ft^2 Pinyon _____ ft^2 Juniper
   (Average crown diameter - by species/2)^2 x 3.14
   Overstory canopy cover/acre = _____ % Pinyon _____ % Juniper
   [(Average crown area - by species x number trees/acre - by species)/43,560] x 100
   Total overstory canopy cover = _____ % Total canopy cover
   (Overstory canopy cover - pinyon + overstory canopy cover juniper)

9. Average tree height = _____ ft
   (Summation of tree heights/number trees in plot)

10. Number of juniper posts/acre = _____ posts/acre
    (Summation of juniper posts x CF)

Lines K-N are Summations from Pinyon-Juniper Site Inventory Worksheet/Seeding and Sapling Zig-Zag Transect

K. Summation of distances:		_____ ft		
L. Total number of stems in transect:		_____ number		
M. Total number of seedlings in transect - by species:	Pinyon	_____ number	Juniper _____	number
N. Total number of saplings in transect - by species:	Pinyon	_____ number	Juniper _____	number

11. Number of seedlings and saplings per acre

Average spacing of stems less than 4.5 feet in height = _____ ft average spacing
(Summation of distances/total number of stems in transect)

Total number of stems less than 4.5 feet in height per acre _____ number stems/acre
[43,560 / (Average spacing)^2]

Percentage of juniper seedlings and saplings in transect:

(Number juniper seedlings / total number of stems in transect) x 100 _____ % juniper seedlings
(Number juniper saplings / total number of stems in transect) x 100 _____ % juniper saplings

Percentage of pinyon seedlings and saplings in transect:

(Number pinyon seedlings/total number of stems in transect) x 100 _____ % pinyon seedlings
(Number pinyon saplings/total number of stems in transect) x 100 _____ % pinyon saplings

Number of seedlings and saplings per acre by species:

(Percent juniper seedlings) (number of stems per acre) Juniper _____ seedlings / acre
(Percent juniper saplings) (number of stems per acre) Juniper _____ saplings / acre
(Percent pinyon seedlings) (number of stems per acre) Pinyon _____ seedlings / acre
(Percent juniper saplings) (number of stems per acre) Pinyon _____ saplings / acre

12. Overstory canopy cover—line intercept method:

Line intercept transect length: _____ ft _____% Pinyon _____% Juniper
Pinyon _____ ft Juniper _____ ft Other _____ ft _____% Total

13. Age summary of trees sampled on plot:

Pinyon: Number trees sampled ____ Average DRC/EDRC ____ Average age____ Average height _____
Juniper: Number trees sampled ____ Average DRC/EDRC ____ Average age____ Average height _____

14. Age summary of pith to 2.3-inch radial growth for trees sampled on plot:

Pinyon - _____ average of ring counts, pith to 2.3 inch + 9 = ___ average age at 4.6-inch inside-bark diameter (5 inch o.b. diameter).

Juniper - _____ average of ring counts, pith to 2.3 inch +__= ___ average age at 4.6-inch inside-bark diameter (5 inch o.b. diameter).

Site Index

Howell, 1940 (W882) Pinyon - Juniper Site Index _____
SI= (5 inches/average DRC) (Total basal area / acre) Or determine Site Index using figure 4, p 33.

Chojnacky, 1986 (INT - 372) Pinyon Site Index _____ Juniper Site Index _____
SI = [0.9474HT] [exp (3.6778Dp + 2.5244Dj - 0.3137SP)] Or determine Site Index using figure 5, p 34.

Where: SI = site index (ft) referenced to 10-inch DRC pinyon DRC = tree diameter at 6-inch stump height (inches)
HT = total tree height (ft) Dj = 1/DRC for juniper, 0 for pinyon Dp = 1/DRC for pinyon, 0 for juniper exp = exponential function SP = 1 for pinyon, 0 for puniper

Appendix 4: Instructions for zig-zag summary worksheet

Lines A through G are summations of tree data lines recorded on Pinyon-Juniper Site Inventory Worksheet.

A. **Total number of trees in transect - by species** equals the total number of each tree species, greater than 4.5 feet in height, recorded in the transect.

B. **Summation of DRC** , Diameter Root C ollar, refers to the total sum of DRC's and EDRC's of all trees within the transect. The DRC of a single-stemmed tree (and a multiple-stemmed tree that forks at or above 6 inches) equals the measured DRC. The equivalent DRC, or EDRC, or a multiple-stemmed tree that forks below 6 inches equals the square root of the summation of the squares of each individual stem.

$$\sqrt{\left(S1^2 + S2^2 + S3^2 + ...\right)}$$

S + Individual stem

For example, tree number 1 is multiple-stemmed and has 3 stems measuring 5, 6, and 7 inches. Each stem is squared (5x5, 6x6, 7x7), the products added (25 + 36 + 49 = 110), and the square root taken (10.5). Continuing, the equilvalent DRC (EDRC) of tree number 1 is added to the DRC or EDRC of tree number 2, and so on for all trees in the plot. The resulting sum (to the nearest 1/10 inch is entered on line B.

C. **Summation of basal area** equals the total of all entries in the **Basal area** column.

D. **Summation of distances** equals the total of all entries in the **Distance** column.

E. **Summation of individual tree crown diameters** equals the total of all entries in the **Crown diameter** column. Also enter sum of tree crown diameters for each tree species in transect.

F. **Summation of juniper posts** equals the total of all entries in the **Juniper posts** column.

Complete Lines 1 through 9 as instructed at each line number using the **Summations** entered in Lines A through G.

Line 10 - Enter ocular estimates of seedlings and saplings per acre if recorded on Pinyon-Juniper Site Inventory Worksheet.

Complete Line 11 as instructed using the *summations* entered in Lines H through K.

Line 12 - **Overstory canopy cover—line intercept method**: Where line intercept transects are used to supplement canopy cover measurements from within the fixed plot, enter results in space provided.

Line 13 - **Tree age summary**: Enter number of trees, by species, for which are measurements have been made. Enter average DRC or EDRC for these trees, the average total age, and the average tree height.

Line 14 - **Tree age to 2.3-inch radial growth**: enter tree age at 2.3-inch radial growth (pith to 2.3 inches) by tree species. Enter 1-foot height age correction factor for juniper species.

Complete entry of Site Index as directed on Zig-Zag summary Worksheet.

Zig-Zag Transect Summary Worksheet

Plot number: _____ Date: _____

Lines A - G are Summations from Pinyon-Juniper Site Inventory Worksheet

A. Total number of trees in transect - by species:	Pinyon:	_____ number	Juniper: _____	number
B. Summation of DRC:		_____ inches		
C. Summation of basal area:		_____ ft^2		
D. Summation of distances:		_____ ft		
E. Summation of individual tree crown diameters:	Total:	_____ ft		
Summation of tree crown diameter - by species:	Pinyon:	_____ ft	Juniper: _____	ft
F. Summation of tree heights:		_____ ft		
G. Summation of juniper posts:		_____ number		

1. Tree species and composition: Pinyon _____ %
   (Species count / 20) x100 Juniper _____ %

2. Average DRC = _____ inches.
   (Summation of DRC / 20)

3. Average spacing = _____ ft
   (Summation of distances / 20)
   D + X Spacing = _____ D + X
   (Average spacing - average DRC)

4. Total number of trees/acre = _____ Trees
   [43,560 / (Average spacing)^2]

5. Number of trees/acre - by species:
   (Percentage of pinyon trees in transect x number of trees/acre) _____ number pinyon/acres
   (Percentage of juniper trees in transect x number of trees/acre) _____ number juniper/acre.

6. Total basal area/acre "measured" = _____ ft^2
   (Summation of basal area / 20) x number trees/acre

7. Overstory canopy cover - zig-zag method:
   Average crown diameter = _____ ft pinyon _____ ft juniper
   (Summation crown diameters - by species/number trees in transect - by species)
   Average crown area = _____ ft^2 pinyon _____ ft^2 juniper
   (Average crown diameter - by species /2)^2 x 3.14
   Overstory canopy cover/acre = _____ % Pinyon _____ % Juniper
   [(Average crown area - by species x number trees/ac - by species) / 43,560] x 100
   Total overstory canopy cover = _____ % Total canopy cover
   (Overstory canopy cover - pinyon + overstory canopy cover juniper)

8. Average tree height = _____ ft
   (Summation of heights/20)

9. Number of juniper posts/acre = _____ posts/acre
   [(Summation of juniper posts/number of juniper trees in transect) x number juniper trees/ac.]

10. Estimated number of seedlings/saplings per acre: Pinyon _____ Seedlings/acre _____ Saplingsacre
Juniper _____ Seedlings/acre _____ Saplings/acre

Lines H -K are Summations from **Pinyon-Juniper Site Inventory Worksheet**/Seeding and Sapling Zig-Zag Transect

H. Summation of distances: _____ ft
I. Total number of stems in transect: _____ number
J. Total number of seedlings in transect - by species: Pinyon _____ number Juniper _____ number
K. Total number of saplings in transect - by species: Pinyon _____ number Juniper _____ number

11. Number of seedlings and saplings per acre
Average spacing of stems less than 4.5 feet in height = _____ ft average spacing
(Summation of distances/total number of stems in transect)
Total number of stems less than 4.5 feet in height per acre _____ number stems/acre
[43,560 / (Average spacing)^2]
Percentage of juniper seedlings and saplings in transect:
(number juniper seedlings / total number of stems in transect) x 100 _____ % juniper seedlings
(number juniper saplings / total number of stems in transect) x 100 _____ % juniper saplings
Percentage of pinyon seedlings and saplings in transect:
(Number pinyon seedlings/total number of stems in transect) x 100 _____ % pinyon seedlings
(Number pinyon saplings/total number of stems in transect) x 100 _____ % pinyon saplings
Number of seedlings and saplings per acre by species:
(Percent juniper seedlings) (number of stems per acre) Juniper _____ seedlings / acre
(Percent juniper seedlings) (number of stems per acre) Juniper _____ saplings / acre
(Percent pinyon seedlings) (number of stems per acre) Pinyon _____ seedlings / acre
(Percent pinyon seedlings) (number of stems per acre) Pinyon _____ saplings / acre

12. Overstory canopy cover - line intercept method:
Line intercept transect length: _____ ft _____ % total _____% pinyon _____% juniper
Pinyon _____ ft Juniper _____ ft Other _____ ft

13. Age summary of trees sampled on plot:
Pinyon:Number trees sampled _____ average DRC/EDRC ___ average age _____ average height _____
Juniper:Number trees sampled _____ average DRC/EDRC ___ average age _____ average height _____

14. Age summary of pith to 2.3-inch radial growth for trees sampled on plot:
Pinyon - _____ Average of ring counts, pith to 2.3 inches + 9 = ____ Average age at 4.6 inches inside-bark diameter (5 inches O.B. diameter).
Juniper - _____ Average of ring counts, pith to 2.3 inches +__= ____ Average age at 4.6 inches inside-bark diameter (5 inches O.B. diameter).

Site Index

Howell, 1940 (W882) Juniper-Pinyon Site Index _____
SI= (5 inches/average DRC) (Total basal area /acre) Or determine Site Index using figure 4, p. 33.

Chojnacky, 1986 (INT - 372) Juniper Site Index _____ Pinyon Site Index _____
SI = [0.9474HT] [exp (3.6778Dp + 2.5244Dj - 0.3137SP)] Or determine Site Index using figure 5, p. 34.

Where: SI = site index (ft) referenced to 10-inch DRC pinyon DRC = tree diameter at 6-inch stump height (inches)
HT = total tree height (ft) Dj = 1/DRC for juniper, 0 for pinyon Dp = 1/DRC for pinyon, 0 for juniper
exp = exponential function SP = 1 for pinyon, 0 for juniper

Instructions for use of yield tables: foliage denseness classes

Two methods can be used:

1. On 1/10- or 1/100-acre plots selected by random, **tally crown diameter per tree and foliage denseness** (sparse, medium, and dense) on each tree.

   From the tables, **find yield per tree** for each tree by crown diameter and foliage denseness from the proper table (range site), and record this opposite each tree.

   Add this **column of weights**.

   Multiply by 10 on 1/10-acre plots and **by 100** on 1/100-acre plots.

   This **figure is pounds per acre annual yield**.

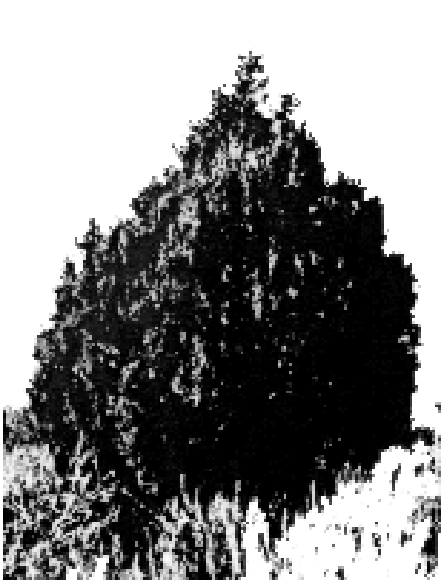
2. On 1/10- or 1/100-acre plots selected by random, **tally crown diameter and foliage denseness** for each tree.

   Average the crown diameter for the dense foliage trees; likewise, for the medium and sparse separately.

   Find the weight per tree in the proper tables opposite for average crown diameter and **multiply this figure by the number of trees** in the foliage class. Do this for each foliage class.

   Add the three figures.

   Multiply by 10 on 1/10-acre plots and **by 100** on the 1/100-acre plots **to get yield per acre**.



Dense

Medium

Sparse

Figure 4. Basal area curves for tentative site classifications

[Basis, basal area attained when the diameter at 1 foot average 5 inches outside bark for the stand above 4.5 feet in height. *Pinyon and Juniper: A Preliminary Study of Volume, Growth and Yield. Howell, J. Jr., SCS Reg. Bull. No 71, NM, 1940]*

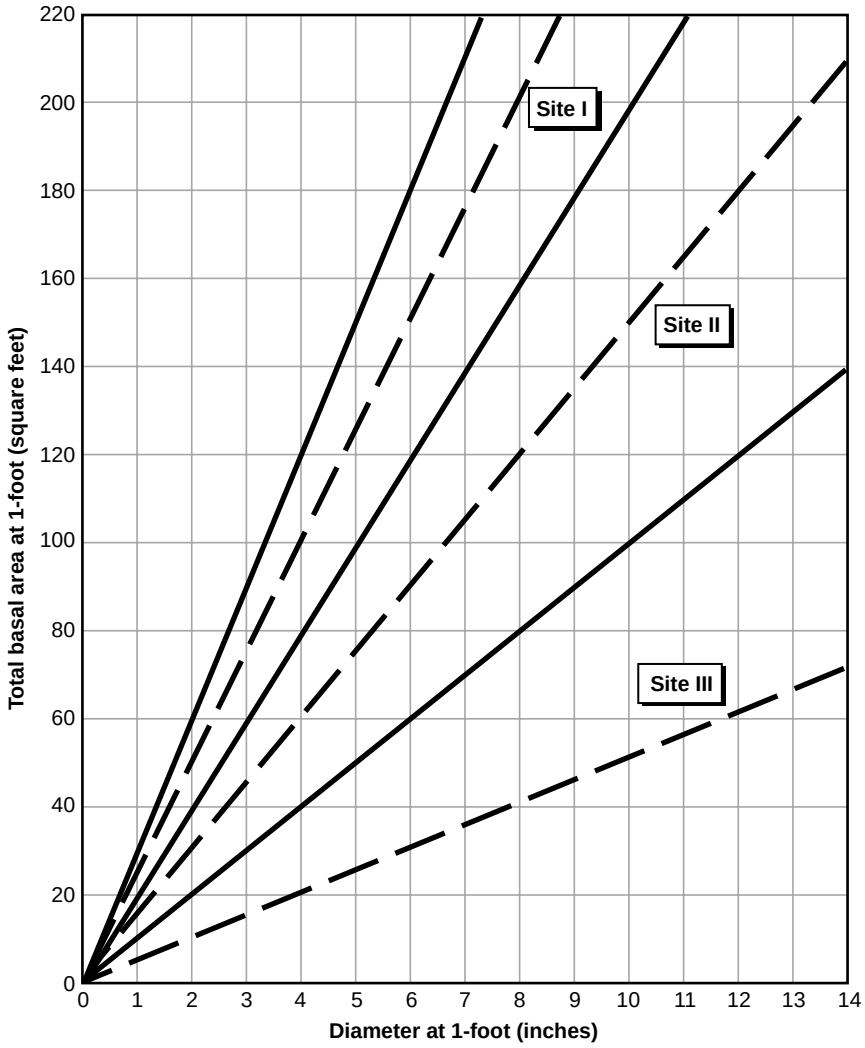


Figure 5. Height to diameter site index curves (reference tree is a 10-inch DRC pinyon)

[*Pinyon-Juniper Site Quality and Volume Growth Equations for Nevada. 1986. Chojnacky, D.C. USDA Forest Service. Research Paper INT-372. Intermountain Research Station, Ogden, Utah*]

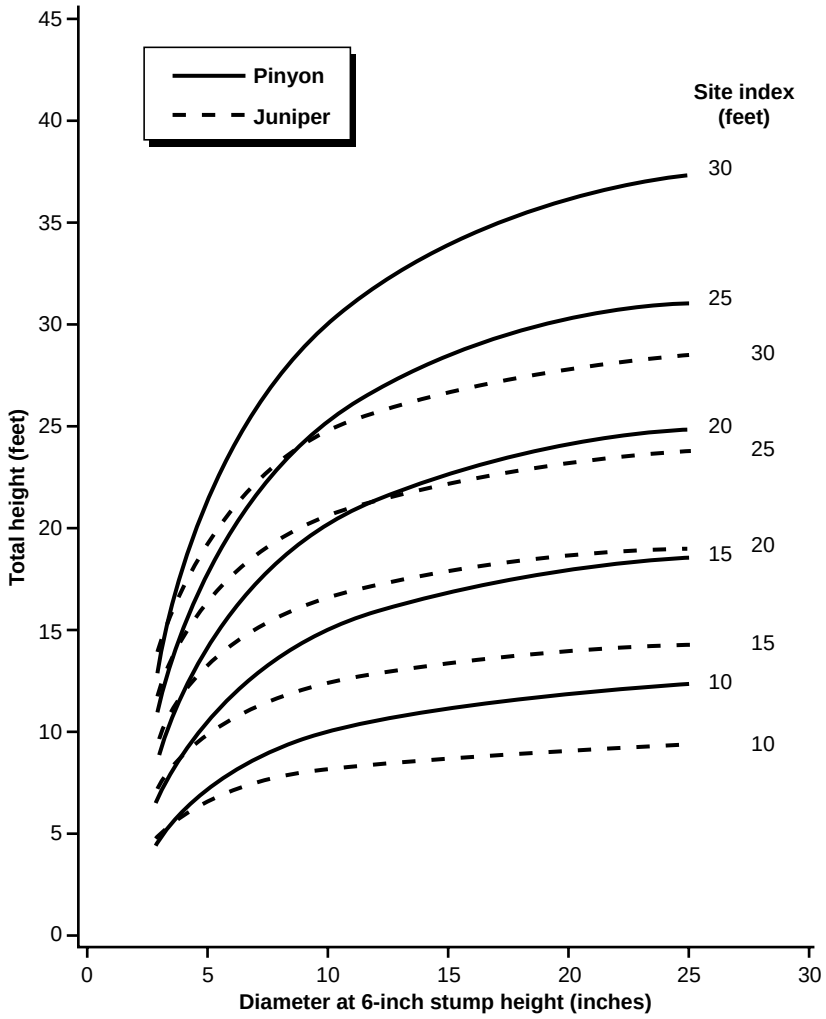


Table 5A–1. Basal area

[Basal area is square feet from given diameters of 0.1 to 60 inches.[1] From table 18, USDA Misc. Pub. 225]

Diameter inches	Area of circle ft^2	Diameter inches	Area of circle ft^2	Diameter inches	Area of circle ft^2	Diameter inches	Area of circle ft^2
0.1	.0001	7.9	.3404	15.7	1.3444	23.5	3.0121
0.2	.0002	8.0	.3491	15.8	1.3616	23.6	3.0577
0.3	.0006-	8.1	.3578	15.9	1.3790	23.7	3.0635+
0.4	.0009	8.2	.667	16.0	1.3963	23.8	3.0895-
0.5	.0014	8.3	.3757	16.1	4.4138	23.9	3.1155-
0.6	.0020	8.4	.3646	16.2	1.4314	24.0	3.1416
0.7	.0027	8.5	.3941	16.3	1.4491	24.1	3.1678
0.8	.0035-	8.6	.4034	16.4	1.4669	24.2	3.1942
0.9	.0044	8.7	.4126	16.5	1.4849	24.3	3.2206
1.0	.0055-	8.8	.4224	16.6	1.5029	24.4	3.2472
1.1	.0066	8.9	.4220	16.7	1.5211	24.5	3.2739
1.2	.0079	9.0	.4418	16.8	1.5394	24.6	3.6006
1.3	.0092	9.1	.4517	16.9	1.5578	24.7	3.3275+
1.4	.0107	9.2	.4616	17.0	1.3576	24.8	3.3545+
1.5	.0123	9.3	.4717	17.1	1.5948	24.9	3.3816
1.6	.0140	9.4	.4819	17.2	1.6126	25.0	3.4088
1.7	.0158	9.5	.4922	17.3	1.6334	25.1	3.4362
1.8	.0177	9.6	.5027	17.4	1.6513	25.2	3.4636
1.9	.0197	9.7	.5132	17.5	1.6703	25.3	3.4911
2.0	.0218	9.8	.5228/	17.6	1.3895-	25.4	3.5188
2.1	.0241	9.9	.5346	17.7	1.7087	25.5	3.5466
2.2	.0264	10.0	.5454	17.8	1.7281	25.6	3.5744
2.3	.0289	10.1	.5564	17.9	1.7476	25.7	3.6024
2.4	.0314	10.2	.5675-	18.0	1.7671	25.8	3.6205+
2.5	.0341	10.3	.5786	18.1	1.7868	25.9	3.6587
2.6	.0369	10.4	.5899	18.2	1.8066	26.0	3.6870
2.7	.0398	10.5	.6013	18.3	1.8565+	26.1	3.7254
2.8	.0428	10.6	.6128	18.4	1.8466	26.2	3.7439
2.9	.0459	10.7	.6244	18.5	1.8667	26.3	3.7726
3.0	.0491	10.8	.6362	18.6	1.8869	26.4	3.8013
3.1	.0524	10.9	.6480	18.7	1.9078	26.5	3.8302
3.2	.0559	11.0	.6600	18.8	1.9277	26.6	3.8591
3.3	.0594	11.1	.6720	18.9	1.9483	26.7	3.8882
3.4	.0631	11.2	.6842	19.0	1.9689	26.8	3.9174
3.5	.0668	11.3	.6964	19.1	1.9897	26.9	3.9467
3.6	.0707	11.4	.7088	19.2	2.0106	27.0	3.9761
3.7	.0747	11.5	.7213	19.3	2.0316	27.1	4.0056
3.8	.0788	11.6	.7339	19.4	2.0527	27.2	4.0352

Diameter inches	Area of circle ft^2	Diameter inches	Area of circle ft^2	Diameter inches	Area of circle ft^2	Diameter inches	Area of circle ft^2
3.9	.0830	11.7	.7466	19.5	2.0739	27.3	4.0649
4.0	.0873	11.8	.7594	19.6	2.0953	27.4	4.0948
4.1	.0917	11.9	.7724	19.7	2.1167	27.5	4.1247
4.2	.0962	12.0	.7854	19.8	2.1382	27.6	4.1548
4.3	.1008	12.1	.7985+	19.9	2.1599	27.7	4.1849
4.4	.1056	12.2	.8118	20.0	2.1817	27.8	4.2152
4.5	.1104	12.3	.8252	20.1	2.2035+	27.9	4.2456
4.6	.1154	12.4	.8386	20.2	2.2255+	28.0	4.2761
4.7	.1205-	12.5	.8522	20.3	2.2476	28.1	4.3067
4.8	.1257	12.6	.8659	20.4	2.2698	28.2	4.3374
4.9	.1310	12.7	.8797	20.5	2.2921	28.3	4.3682
5.0	.1364	12.8	.8936	20.6	2.3145+	28.4	4.3991
5.1	.1419	12.9	.9076	20.7	2.3371	28.5	4.4301
5.2	.1475	13.0	.9218	20.8	2.3597	28.6	4.4613
5.3	.1532	13.1	.9360	20.9	2.3824	28.7	4.4925+
5.4	.1590	13.2	.9503	21.0	2.4053	28.8	4.5239
5.5	.1650	13.3	.9648	21.1	2.4283	28.9	4.5554
5.6	.1710	13.4	.9793	21.2	2.4513	29.0	4.5869
5.7	.1772	13.5	.9940	21.3	2.4745-	29.1	4.6186
5.8	.1835-	13.6	1.0088	21.4	2.4978	29.2	4.6504
5.9	.1899	13.7	1.0237	21.5	2.5212	29.3	4.6823
6.0	.1963	13.8	1.0387	21.6	2.5447	29.4	4.7144
6.1	.2029	13.9	1.0538	21.7	2.5683	29.5	4.7465-
6.2	.2097	14.0	1.0690	21.8	2.5920	29.6	4.7787
6.3	.2165-	14.1	1.0843	21.9	2.6159	29.7	4.8111
6.4	.2234	14.2	1.0998	22.0	2.6398	29.8	4.8435+
6.5	.2304	14.3	1.1153	22.1	2.6639	29.9	4.8761
6.6	.2376	14.4	1.1310	22.2	2.6880	30.0	4.9067
6.7	.2448	14.5	1.1467	22.3	2.7123	30.1	4.9415+
6.8	.2522	14.6	1.1626	22.4	2.7367	30.2	4.9744
6.9	.2597	14.7	1.1789	22.5	2.7612	30.3	5.0074
7.0	.2673	14.8	1.1947	22.6	2.7858	30.4	5.0405+
7.1	.2749	14.9	1.2109	22.7	2.8105-	30.5	5.0737
7.2	.2827	15.0	1.2272	22.8	2.8353	30.6	5.1071
7.3	.2907	15.1	1.2436	22.9	2.8602	30.7	5.1405-
7.4	.2987	15.2	1.2601	23.0	2.8852	30.8	5.1740
7.5	.3068	15.3	1.2768	23.1	2.9104	30.9	5.2077
7.6	.3150	15.4	1.2935+	23.2	2.9358	31.0	5.2414
7.7	.3234	15.5	1.3104	23.3	2.9610	31.1	5.2753
7.8	.3318	15.6	1.3273	23.4	2.9865	31.2	5.3093

[1] 3.1415926536; basal area in square feet. 0.00545415391; (0.005454154) times the square of the diameter in inches.

Table 5A-2. Guide for determining current yield of Utah Juniper In Utah

[Upland Stony Loam (Juniper) Site current yield air dry pounds]

Crown diameter feet	Weight per tree	10 Trees	50 Trees	100 Trees	200 Trees	300 Trees	400 Trees	500 Trees
				Sparse foliage				
1	0.1	1	5	10	20	30	40	50
2	0.3	3	15	30	60	90	120	150
3	0.6	6	30	60	120	180	240	300
4	1.0	10	50	100	200	300	400	500
5	1.3	13	65	130	260	390	520	650
6	1.6	16	80	160	320	480	640	800
7	1.9	19	95	190	380	570	760	950
8	2.3	23	115	230	460	690	920	1150
9	2.6	26	130	260	520	780	1040	1300
10	2.9	29	145	290	580	870	1160	1450
11	3.3	33	165	330	660	990	1320	1650
12	3.6	36	180	360	720	1080	1440	1800
13	4.0	40	200	400	800	1200	1600	2000
14	4.4	44	220	440	880	1320	1760	2200
15	4.7	47	235	470	940	1410	1880	2350
16	5.1	51	255	510	1020	1530	2040	2550
17	5.5	55	275	550	1100	1650	2200	
18	5.8	58	290	580	1160	1740	2320	
19	6.2	62	310	620	1240	1860	2480	
20	6.6	66	330	660	1320	1980	2640	
				Medium foliage				
1	0.1	1	5	10	20	30	40	50
2	0.3	3	15	30	60	90	120	150
3	0.6	6	30	60	120	180	240	300
4	1.0	10	50	100	200	300	400	500
5	1.4	14	70	140	280	420	560	700
6	1.9	19	95	190	380	570	760	950
7	2.5	25	125	250	500	750	1000	1250
8	3.1	31	155	310	620	930	1240	1550
9	3.8	38	190	380	760	1140	1520	1900
10	4.6	46	230	460	920	1380	1840	2300
11	5.4	54	270	540	1080	1620	2160	2700
12	6.2	62	310	620	1240	1860	2480	
13	7.2	72	360	720	1440	2160		
14	8.1	81	405	810	1620	2430		
15	9.1	91	455	910	1820	2730		
16	10.2	102	510	1020	2040			
17	11.3	113	565	1130	2260			
18	12.4	124	620	1240	2480			
19	13.6	136	680	1360				
20	14.8	148	740	1480				

Table 5A-2. Guide for Guide for determining current yield of Utah Juniper In Utah—Continued

Crown diameter feet	Weight per tree	10 Trees	50 Trees	100 Trees	200 Trees	300 Trees	400 Trees	500 Trees
				Dense foliage				
1	0.1	1	5	10	20	30	40	50
2	0.3	3	15	30	60	90	120	150
3	0.7	7	35	70	140	210	280	350
4	1.2	12	60	120	240	360	480	600
5	1.9	19	95	190	380	570	760	950
6	2.7	27	135	270	540	810	1080	1350
7	3.6	36	180	360	720	1080	1440	1800
8	4.7	47	235	470	940	1410	1880	2350
9	5.9	59	295	590	1180	1770	2360	
10	7.2	72	360	720	1440	2160		
11	8.6	86	430	860	1720	2580		
12	10.2	102	510	1020	2040			
13	11.9	119	595	1190	2380			
14	13.7	137	685	1370	2740			
15	15.6	156	780	1560				
16	17.7	177	885	1770				
17	19.9	199	995	1990				
18	22.2	222	1110	2220				
19	24.6	246	1230	2460				
20	27.2	272	1360	2720				

***Table 5A-3. General soil features associated with sites named in* Guides for determining current yield of pimo and juos in Utah**

Site name	Precipitation zone *Inches*	Range in slope *Percent*	Soil depth *Inches*	Coarse fragments in profile *Percent*	Range in AWC *Inches*
Upland stony loam	12-16	5-30	Deep to very deep over bedrock.	50 (45-60 at soil surface)	2-4 (6)
Semidesert stony loam	8-12	5-30	50 over bedrock.	50 (45-60 at soil surface)	2-4
Upland gravely loam	12-16	4-15	35-40	35-65	2-3
Upland loam	12-16	3-20	40 to bedrock.	35-60 (in upper profile)	3-6
Upland shallow hardpan	12-16	5-20	6-20 over hardpan.	15-60) (often nonskeletal)	1.5-3
Upland shallow loam	12-16	8-60	14-20 (15) to bedrock.	75	0.5-1.5

Table 5A-4. Annual foliage and fruit production per juniper tree on different sites and for different foliage classes

Crown diameter	Site														
	Upland Loam Foliage and fruit Sparse/medium/dense			Upland Stony Loam Foliage and fruit Sparse/medium/dense			Upland Gravely Loam Foliage and fruit Sparse/medium/dense			Upland Shallow Loam Foliage and fruit Sparse/medium/dense			Upland Shallow Hardpan Foliage and fruit Sparse/medium/dense		
Feet	*Pounds*			*Pounds*			*Pounds*			*Pounds*			*Pounds*		
1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
2	0.2	0.3	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.2	0.2	0.5	0.3	0.4	0.5
3	0.4	0.6	0.9	0.7	0.6	0.7	0.6	0.7	0.9	0.4	0.5	1.0	0.7	0.9	1.4
4	0.6	1.1	1.5	1.0	1.0	1.2	1.0	1.1	1.5	0.7	0.8	1.6	1.2	1.6	2.4
5	0.9	1.6	2.1	1.3	1.4	1.9	1.3	1.6	2.1	1.0	1.3	2.2	1.8	2.6	3.8
6	1.3	2.1	3.1	1.6	1.9	2.7	1.7	2.1	2.7	1.4	1.8	2.9	2.7	3.7	5.4
7	1.6	2.8	4.0	1.9	2.5	3.6	2.1	2.6	3.5	1.7	2.4	3.8	3.6	5.0	7.4
8	2.0	3.5	5.1	2.3	3.1	4.7	2.6	3.2	4.3	2.2	3.1	4.6	4.7	6.5	9.6
9	2.5	4.3	6.3	2.6	3.8	5.9	3.1	3.9	5.1	2.6	3.8	5.6	6.0	8.2	12.2
10	3.0	5.2	7.6	2.9	4.6	7.2	3.6	4.6	6.0	3.1	4.6	6.6	7.4	10.1	15.1
11	3.5	6.2	9.0	3.3	5.4	8.6	4.1	5.3	7.0	3.6	5.5	7.6	9.0	12.1	18.2
12	4.0	7.2	10.5	3.6	6.2	10.2	4.7	6.1	8.0	4.2	6.5	8.8	10.7	14.4	21.7
13	4.6	8.3	12.1	4.0	7.2	11.9	5.2	6.9	9.1	4.7	7.6	9.9	12.6	16.9	25.5
14	5.2	9.4	13.9	4.4	8.1	13.7	5.8	7.8	10.2	5.3	8.7	11.2	14.6	19.5	29.6
15	5.9	10.6	15.6	4.7	9.1	15.6	6.5	8.7	11.3	6.0	9.9	12.4	16.7	22.4	33.9
16	6.5	11.9	17.5	5.1	10.2	17.7	7.1	9.6	12.5	6.6	11.1	13.8	19.0	25.5	38.6
17	7.2	13.2	19.4	5.5	11.3	19.9	7.8	10.5	13.7	7.3	12.4	15.1	21.5	28.7	43.6
18	8.0	14.6	21.5	5.8	12.4	22.2	8.4	11.5	15.0	8.0	13.8	16.6	24.1	32.1	48.9
19	8.7	16.1	23.7	6.2	13.6	24.6	9.1	12.5	16.3	8.7	15.3	18.0	26.9	35.5	54.5
20	9.5	17.6	26.0	6.6	14.8	27.2	9.8	13.6	17.6	9.5	16.8	19.6	29.8	39.5	60.4