# TECHNICAL NOTES

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**WOODLAND TECHNICAL NOTE NO.34**

## SAMPLING AND ANALYSIS OF MIXED WOODLANDS


**Summary.** This technical note outlines a sampling and analysis protocol for mixed woodlands composed of ponderosa pine and pinyon-juniper (any pinyon pine and southwestern juniper species). The field procedure was developed to facilitate data collection by a single-person crew although it can also be applied by multi-person crews.


**Background.** Tree species managed for timber production or dimension lumber typically have single, straight, clear boles (e.g., ponderosa pine). Tree species that typically have multiple, crooked, or limby stems (e.g., pinyon-juniper) are usually managed for nontimber uses such as production of fence posts or firewood. Tree species are sampled differently based on their growth form and management objective, thus complicating description of mixed woodlands. While mixed woodlands containing both ponderosa pine and pinyon-juniper are common, procedures for calculation and database entry of site index and wood production data for mixed woodlands, or individual tree species from mixed woodlands, are problematic or nonexistent. This technical note outlines methods of estimating site index and culmination of mean annual increment (CMAI) for individual tree species from mixed woodlands for entry in the National Soil Information System (NASIS) and for estimating total annual wood production by all tree species in a mixed woodland for inclusion in Ecological Site Descriptions (ESDs).

**Field procedure for pinyon-juniper**

Site index is calculated from basal area derived from tree diameter measurements. Use of canopy cover is another method of estimating site index although its accuracy is less reliable than the basal area method. Both methods use a 100-ft transect line oriented so that it represents the stand and, for the basal area approach, forms the center line of a rectangular plot. The beginning of the transect (0-ft mark on tape) is randomly located. These same transects are also used to measure the understory and ground cover. Transects are repeated until the stand is well represented by the data. The canopy cover method is a quick approximation of site index based on the correlation between canopy cover and basal area. To validate the canopy cover approach in determining site index, it will be beneficial to use both the canopy cover and basal area methods to study the strength of this correlation.

*Canopy cover method.* Overstory canopy cover (the downward vertical projection of the canopy that intercepts the edge of the 100-ft tape) for each tree* is recorded by species to the nearest 0.1 ft. Minor within-tree canopy gaps are ignored (canopy measurement for an individual tree is not interrupted by minor gaps in that tree's canopy). Site index is calculated from canopy cover.†

*Basal area method.* Diameters of all trees* in a 1/20-acre fixed plot are measured at stump height (1 ft above average ground level) and recorded. This fixed plot is bisected lengthwise by the 100-ft transect described above. It is not necessary to mark the perimeter or corners of the plot. A tree

is in the plot if the center of the bole (or center of a cluster of a multi-stemmed tree) at stump height is within 10.89 ft (perpendicular) of the 100-ft transect tape. Basal area, site index, and CMAI are calculated from these diameter measurements.†

**Field procedure for ponderosa pine**
Ponderosa pine site index and CMAI are calculated from its fixed-plot basal-area data and site tree data.‡

*Basal area.* The diameters of all ponderosa pine trees measured at breast height (4.5 ft above average ground level) in the same 1/20-acre fixed plot(s) described above are recorded. A tree is in the plot if the center of the bole at breast height is within 10.89 ft (perpendicular) of the 100-ft transect tape. Basal area of ponderosa pine is calculated from these diameter measurements.‡

*Site Index.* For each stand, measure the height and age (bore at breast height) of 4-5 ponderosa pine site trees. A site tree is a dominant or codominant tree that appears to be one of the healthiest and fastest-growing individuals in the stand (limited to the same soil component but not limited to the 1/20-acre plots).

**Stand history**
Use an increment borer to determine the ages of the oldest-appearing trees in the stand (at least one per species). Bore pinyon-juniper at stump height; bore ponderosa pine at breast height. Tree selection is not limited to the 1/20-acre plot, but it is limited to the stand occurring on the soil component of interest. Examine the stand for evidence of past fire, logging, grazing, etc.

**Understory**
Understory data and ground cover are read using a 1-$m^2$ plot frame placed systematically along transect line (5 plots per 100 ft of transect distance; double-sample 2 plots of every 10 plots). Use an expanded plot (1/100-acre) to measure woody understory (2 expanded plots per 100 ft of transect distance).

**Analysis**
NASIS lists the CMAI for each species correlated to a specific soil component. Note that some soil map units have two or more soil components. CMAI is an estimate of maximum average annual growth based on the site index of the particular species expressed in cubic feet per acre per year ($ft^3$/ac/yr). Typically, CMAI represents the growth of a species assuming it occurs as a pure stand on the soil component. Mixed stands of ponderosa pine and pinyon-juniper (combined for wood growth purposes) pose a special case. Because the site index and correlated CMAI of either species are influenced by the presence of the other species, total basal area of the inventory plot is an important metric. The approach to determine species-specific and composite values of basal area, site index, and CMAI includes: (1) a basal area adjustment to ponderosa pine CMAI based on the ratio of the total plot basal area (both ponderosa pine and pinyon-juniper) to the "normal" basal area for the assigned ponderosa pine site index, (2) computation of the pinyon-juniper site index and correlated CMAI based on the total basal area of the mixed stand (including ponderosa pine), and (3) a weighted average of both CMAIs.

**Example**
A mixed woodland has an average total basal area for all plots of 120 $ft^2$/ac (ponderosa pine = 100 $ft^2$/ac, pinyon-juniper = 20 $ft^2$/ac).

*Ponderosa pine*. The measured heights and ages of the ponderosa pine site trees indicate a site index (SI) of 40. For a normal pure stand of ponderosa pine with an SI of 40, CMAI = 30 $ft^3$/ac/yr and basal area (BA) = 141 $ft^2$/ac.‡ Because the measured BA is different from the

normal BA, the CMAI is adjusted accordingly by multiplying the normal CMAI by the ratio of measured BA to normal BA: 30 × (120/141) = 25.5 $ft^3$/ac/yr. These values (SI = 40, CMAI [rounded] = 26) can be used for ponderosa pine for the applicable soil component in the NASIS forest productivity data field. These values represent a pure stand of ponderosa pine with a BA equal to the total measured BA. The ponderosa pine portion of the cumulative CMAI for the site is calculated by multiplying the site CMAI by the ponderosa pine proportion of the total BA: 25.5 × (100/120) = 21.3 $ft^3$/ac/yr. (Note: SI is not adjusted to account for the pinyon-juniper portion of the mixed stand because it is assumed that the effect of pinyon-juniper BA on ponderosa pine SI is similar to the effect of an equal amount of ponderosa pine BA.)

*Pinyon-juniper*. For all plots in this same example, the average stump height diameter of all trees[*] is 2.2 inches. Pinyon-juniper SI calculation is based on a reference diameter of 5 inches.[†] SI for the pinyon-juniper portion of this stand is calculated by dividing the reference diameter by the average stump height diameter and multiplying by the pinyon-juniper BA. In this example, SI = 5.0 ÷ 2.2 × 20 = 45. The CMAI for an SI of 45 is 3.7 $ft^3$/ac/yr. To estimate what the CMAI and SI of this site would be if it were a pure stand of pinyon-juniper with BA equal to the total BA, the CMAI of pinyon-juniper is divided by its proportion of the total BA: 3.7 ÷ (20/120) = 22.2 $ft^3$/ac/yr. The SI for a stand of pinyon-juniper with a CMAI of 22.2 is 190.[†] These values (SI = 190, CMAI [rounded] = 22) can be used for pinyon pine and juniper species for the applicable soil component in the NASIS forest productivity data field. (Note: Calculations of SI and CMAI for pinyon-juniper were developed specifically for trees with typical pinyon-juniper form and do not apply to timber species; therefore, SI and CMAI are calculated only for the pinyon-juniper component first, then adjusted to produce the SI and CMAI for the site.)

*Cumulative CMAI*. The cumulative CMAI for the stand equals the sum of the CMAIs for the individual portions of ponderosa pine and pinyon-juniper of the mixed stand. In this example, the cumulative CMAI = 21.3 (ponderosa pine) + 3.7 (pinyon-juniper) = 25.0 $ft^3$/ac/yr. These individual and cumulative CMAI values can be included in the applicable ESD.

[*] Pinyon-juniper only; minimum height of 4.5 ft.

[†] Pinyon-Juniper_Forest-ESI-Cover-Site_Index-Basal_Area
http://www.nm.nrcs.usda.gov/technical/tech-notes/wood/wood34a1.xls

[‡] Ponderosa_Pine-SI-BA-CMAI
http://www.nm.nrcs.usda.gov/technical/tech-notes/wood/wood34a2.xls