# REVISED INTERIM OLD GROWTH DEFINITIONS FOR INTERIOR PONDEROSA PINE (SAF 237) IN NORTHEAST CALIFORNIA

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## 1. INTRODUCTION

Ecology classification and Forest Inventory data were examined and analyzed to formulate a set of descriptors for old growth stands in the Interior Ponderosa Pine existing vegetation cover type in northeastern California. This is an ecological definition, based on field observations of vegetational structure and composition, rather than on economic value, timber age, or stocking-classes (Marcot et al 1991).

Interim guidelines were distributed, tested, and reviewed during the summer of 1991. Appropriate changes suggested by the testing and review process are incorporated in this paper.

The development of the descriptors responds to direction from the Chief of the Forest Service (2410 letter, 1/17/90), and by the Regional Forester, Pacific Southwest Region (2410 letter, 2/27/90).

Interior Ponderosa Pine, SAF cover type 237, labels forest stands characterized by ponderosa pine in pure stands (greater than 80% basal area stocking), or mixed species stands where ponderosa pine is a plurality species (largest proportion basal area stocking). Distribution of the type in the Pacific Southwest Region is east of a line connecting Lake Tahoe to central Siskiyou County, generally east of the Sierra Nevada crest (Barrett et al 1980). The descriptors in this paper apply to the same area.

Synonyms for Interior Ponderosa Pine in the Pacific Southwest Region are: Eastside Pine (Mayer et al 1988); Eastside Ponderosa Pine Forest (CNDDB, 1986); Yellow Pine-Shrub Forest (Kuchler, 1977); Yellow Pine Forest (Munz and Keck, 1973); Ponderosa Pine (Parker and Matyas, 1981); Ponderosa/Jeffrey Pine (Payson et al, 1980); Yellow Pine Forest (Thorne, 1976).

## 2. METHODS

Data were derived from two sources: Ecosystem Classification plots and Forest Inventory plots.

### A. ECOSYSTEM CLASSIFICATION PLOTS

The data were collected as part of a classification project of Eastside Pine (ponderosa pine and Jeffrey Pine potential vegetation series) stands in northeastern California National Forests. Data collection followed the procedures outlined in the Region 5 Ecosystem Classification Handbook (USDA Forest Service 1987). Minimally disturbed sample stands were selected in a variety of environments in order to sample the diversity of vegetation and habitats in the target type. Sample stands were selected subjectively, without preconcieved bias (Mueller-Dombois and Ellenberg, 1974). Homogeneous, older stands are well represented in the data set. A total of 283 Ecology Program plots that met the basal area requirements for SAF 237 were used in the analysis.

Data collection at each plot included a sampling of timber attributes according to modified Forest Inventory Analysis protocols developed in Region 5 (USDA Forest Service 1988). Trees were sampled at three variable radius points per plot. Attributes collected for prism trees included basal area, diameter at breast height, and crown class. One dominant or codominant site tree was measured for age, height, and 10 and 20 year radial growth increment at each of the three points.

Snag and log data were collected on a smaller subset of the ecosystem classification plots.

A complete species list and percent cover of vegetative layers were recorded on a 1/10 acre circular plot placed at cluster plot center

Data were collected on the Klamath, Shasta-Trinity, Modoc, Lassen, Plumas, and Tahoe National Forests in 1985, 1986, 1987, and 1990.

## B. FOREST INVENTORY ANALYSIS (FIA) PLOTS

Forty-six plots from the Region 5 Forest Inventory were used in the analysis. Inventory data bases from the Klamath, Modoc, Lassen, Plumas, and Tahoe National Forests were examined for suitable plots. Most of this data was collected in the late 1970's and early 1980's. Inventory plots were included in the old growth definition data set if basal area stocking was at least 80% ponderosa and/or Jeffrey Pine, and if ponderosa pine was the majority species in the pine stocking. These data were collected using the procedures in the R-5 Timber Management Plan Inventory Handbook (USDA Forest Service 1988). The plots were located in different aged stands. Environmental setting and disturbance history of these plots could not be determined from the raw data. Plots that displayed structures suggesting unusual heterogeneity or recent logging disturbance were removed from the data set.

Age of the oldest measure tree (rather than average of the 3-5 measure tree ages) was used in the combined data set as the measure of stand age. This allowed for more consistent comparisons between the two somewhat different source data sets. Age of the oldest tree and average measure tree age are, however, highly correlated (r =.93) in the data set.

## C. DATA ANALYSIS PROCEDURES

The raw data were expanded and summarized using the Region 5 Forest Inventory and Analysis computer programs FIA*SUMMARY and FIA*MATRIX (USDA Forest Service 1988). Attributes extracted from these programs included total basal area/acre (BA/ACRE), basal area by tree diameter groups, quadratic mean diameter (QMD), trees per acre (TPA) by stand and by diameter groups, R-5 Site Class; and growth estimates.

The data were analyzed with the SYSTAT and SYGRAPH statistical software (Wilkinson, 1990a,b). Some 40 attributes and attribute combinations were examined. Robust locally weighted regression (Cleveland 1979, Chambers et al 1983) was used to smooth scatterplots of BA/ACRE, TPA, QMD, numbers of small, medium, and large trees, measures of diameter diversity, and a snag and log subset vs. age of the oldest measure tree.

The smoothed scatterplot curves were examined visually to determine the average age where stand structure changes from growth stage to a maintenance or plateau stage. This point was interpreted as the beginning of the old growth stage, and occurred at a point on the curves where QMD, BA/acre, and numbers of large trees culminated, accompanied by a decrease in total trees per acre. Preliminary curves for numbers of large snags and logs suggested that these variables culminate thirty to fifty years later than the live tree variables.

Statistics were developed by using the stand age breakpoints suggested by the smoothed scatterplot curves to partition the data set into old growth and non-old growth classes, and describing the old growth stands in terms of averages of stands attributes.

Comparing different groupings of attributes by site classes with analysis of variance and Tukey box plots (McGill et al 1978; Wilkinson 1990b) resulted in the combining of site classes into two categories: high-medium (R-5 Site Classes 1,2,3) and low (R-5 Site Classes 4,5).

Minimums were hypothesized in two ways:

1. Normally distributed variables

   The point in the distribution at the 90% probability level. This point is about 1.28 standard units below the mean. The probability cutoff of 90% was chosen subjectively.

2. Non-normal variables

   The lower interquartile was reported as the minimum. This minimum level was also selected subjectively.

Distributions were examined, and, where appropriate, averages and standard deviations were used to describe the data. When distributions were non-normal, medians and interquartiles were used to describe the data (Chatfield, 1990).

The "typical range" reported is the interquartile range in both normal and non-normal data.

D. TESTING

a. Data set testing

   The descriptors were tested in the data set by graphical and numerical exploratory data techniques (notched box plots, stem-and-leaf plots, analysis of variance) and by discriminant analysis of transformed, standardized variables.

The graphical exploration techniques and discriminant analysis indicated that applying the minimum large tree numbers to the data set was an effective means of partitioning the data set into old growth and non-old growth components.

b. Field testing

The old growth descriptors presented in this paper were field tested in 1991. Twenty-six stands on the Modoc, Deschutes, Plumas, Lassen, and Klamath National Forests were used to evaluate the descriptors. Some refinements to clarify the descriptors resulted.

## 3. OLD GROWTH ATTRIBUTES (see Table I)

The National Old Growth Task Group (2410 letter, 11/21/90, Enclosure 2) requires reporting of the following standard attributes:

I. Live Trees in Main Canopy; Trees per Acre:

A. R-5 Site Classes 1,2,3 (High-moderate):

Number of plots: n = 144
Beginning of Old Growth stage: 150 - 180 years.
Stable Old Growth reached at: 230 years.
Stand Basal Area: Mean = 159; standard dev. = 47; typical range = 120-187.
Average total tree canopy cover = 60%. Typical range = 50-70%.

a. Trees ≥ 21"dbh:

mean = 31.9 sd = 12.9 90% of stands = 15 trees per acre including 3 trees per acre ≥ 30" dbh (see b. below)

Typical range: 22-40 trees per acre ≥ 21" dbh
Basal area of ≥ 21" trees: mean = 131; sd = 46; min = 74; typical range = 100-160

b. ≥ 30"dbh:

median = 7.3 lower interquartile = 3.0

Typical range: 3-11 trees per acre ≥ 30" dbh
Basal area of ≥ 30" trees: median = 47; min = 20; typical range = 20-80

Largest trees are Dunning's Ponderosa Pine Tree Classes 3,4,5,7. (USDA Forest Service 1957)

B. R-5 Site Classes 4,5 (Low)

Number of plots: n = 81
Beginning of Old Growth stage: 200 years.
Stable Old Growth reached at: 330 years.
Stand Basal Area: mean = 128; standard dev. = 49; typical range = 93-153
Average total tree canopy cover = 50%. Typical range = 35-65%

a. ≥ 21"dbh:

mean = 26.4 sd = 10.5 90% of stands = 13 trees per acre

Typical range: 18-34 trees per acre ≥ 21" dbh
Basal area of ≥ 21" trees: mean = 100; sd = 42; min = 46; typical range = 67-127

b. >30"dbh:

median = 4 lower interquartile = 1

Typical range: 1-7 trees per acre ≥ 30" dbh
Basal area of ≥30" trees: median = 27; minimum = 7; typical range = 7-54

Note: 30"+ trees may be absent in old growth stands in the lowest site classes. In these cases use the definition for 21"+ trees.

## II. Variation in Tree Diameters

One output of the FIA-MATRIX program is number of trees in each of seven DBH classes (1-4", 5-10", 11-14", 15-20", 21-28", 29-38", 39+"). Variation in tree diameters was evaluated in two ways: a. by calculating a diversity measure, Hill's N2 number, using the diameter classes as "species", and (b) by calculating the variance of tree diameters in the seven diameter classes.

### a. Hill's N2

Hill's N2 diversity number is considered to be a reasonably robust measure of species diversity, and is more interpretable than other diversity indices (Magurran, 1988; Ludwig & Reynolds 1988). Hill's N2 is expressed in units of species (diameter class) numbers. The number measures the "effective number" of species (diameter classes) present in a sample. When the data are partitioned into old growth and non-old growth classes using the minimum large tree number descriptors, the N2 number is significantly different (P = .01) between the two groups. Stands classified as old growth in the data have significantly higher numbers of "effective species" (tree diameter classes represented) than younger stands.

Hill's N2 is calculated for each plot by taking the reciprocal of Simpson's Lambda:

Lambda = Eni(ni-1)/N(N-1), where ni = frequency of trees in each of seven diameter classes, and N = the total number of individual trees in each plot.

Hill's N2 in old growth stands: (n = 252)

mean = 2.4 sd = 0.6

Hill's N2 in non-old growth stands (n=61)

mean = 2.0 sd = 0.6

b. Variance of diameters

The calculated variance of tree diameters was a more robust indicator of variation in tree diameter than Hill's N2 in discriminant analysis. The variance of diameters was calculated as:

$$\text{variance of diameters} = \frac{Efi*xi^2 - (Efi*xi)^2/Efi}{Efi - 1}$$

where fi = frequency of trees in each diameter class, xi = median diameter for each diameter class (Old Growth Definition Team 2, 1991).

Variance of diameters of old growth stands was significantly higher (P = .01) than the variance of non-old growth stands.

Average variance of old growth stands: 64.3
Average variance of non old-growth stands: 29.6

Smoothed scatterplots suggested a direct relationship between increased numbers of large trees (≥ 21" and ≥ 30") and increased Hill's N2 and diameter variance. Numbers of small trees and the variance measures are inversely related, that is, as numbers of small trees (1"-11") in stands increase, Hill's N2 and diameter variance both decrease.

Higher levels of variance in older stands compared to younger stands has been observed in other studies (Spies and Franklin, 1991).

## III. Dead Trees

A subset of ecosystem classification plots was examined for snag and log characteristics. A large snag is 20" dbh and 20' high. A large log is 20" at the large end and at least 20' long.

Results are as follows:

A. Standing snags per acre:

High-Medium sites: n = 36

range = 0-6 median = 0 Typical range = 0-2.

Low sites: n = 19

range = 0-6 median = 0 Typical range = 0-2.

B. Down pieces per acre:

High-Medium sites: n = 36

range = 0-4 median = 2 Typical range = 0-4.

Low sites: n = 19

range = 0-14 median = 2 Typical range = 0-4

Numbers of snags and down logs vary widely in Interior Ponderosa Pine depending on stand history. Stands with a history of frequent low-intensity fires and low mortality from insect and disease pathogens may have few or no snags or logs. Stands that have been excluded from fire and have a history of insect and disease mortality may have high numbers of snags and logs, usually clumped in distribution. The presence of snags and logs affects the relative old-growth value of a stand, but is not absolutely required for old growth designation.

IV. Tree Decadence (Flattening or rounding tops, shortening crowns, large horizontal or drooping branches, large gnarled or twisted branches, forked tops, spike tops, bole or root decay, large fire scars)

Use Dunning's Ponderosa Pine Classes 3,4,5,7.

Greater than or equal to 2 trees/acre, Dunning's Classes 3,4,5,7.

V. Number of Tree Canopies

Greater than or equal to 1.

## 4. LIMITATIONS

This definition is intended to describe the old growth seral stage. No attempt is made to describe optimum conditions for other resources, such as wildlife or recreation. Determining the relative value of an old growth stand for a particular resource is a separate process from determining if the stand displays the ecological old growth characteristics described in this paper.

The minimums are suited for old growth inventory of existing stands only. The means ± one standard deviation (or medians & interquartiles) represent more optimum conditions for old growth than the minimums, and these should be used for "Desired Future Condition" in stand management, particularly where the old growth component is deficient and younger stands are targeted for long-term old-growth recruitment.

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## TABLE 1

### CHARACTERISTICS OF OLD GROWTH
### INTERIOR PONDEROSA PINE FORESTS, SAF 237
### NORTHEASTERN CALIFORNIA

(Numbers are means ± standard deviations unless otherwise indicated)

| | R-5 SITE CLASS 1-3 | R-5 SITE CLASS 4,5 |
|---|---|---|
| 1. LIVE TREES IN MAIN CANOPY | | |
| TREES PER ACRE ≥21" DBH | 31.9 ± 12.9<br>90% OF STANDS:>15 | 26.4 ± 10.5<br>90% OF STANDS:>13 |
| inc TPA ≥30" DBH | ≥ 3 | ≥ 0 |
| STAND BASAL AREA | 159 ± 47<br>INTQ.RNGE:120-187 | 128 ± 49<br>INTQ.RNGE: 93-153 |
| 2. VARIATION IN TREE DIAMETERS | | |
| HILL'S N2 (see text) | 2.4 ± 0.6 | |
| MEAN VARIANCE IN DBH: | 64.3 | |

At least two of the following diameter classes are present:
DBH: 1-4"; 5-10"; 11-14"; 15-20"; 21-28"; 29-38"; 39"+.

| | R-5 SITE CLASS 1-3 | R-5 SITE CLASS 4,5 |
|---|---|---|
| 3. DEAD TREES | | |
| SNAGS ≥20"DBH, ≥ 20' high | ≥ 0<br>INTQ.RNGE:0-2 | ≥ 0<br>INTQ.RNGE:0-2 |
| LOGS ≥20" LARGE END ≥ 20' long | ≥ 0<br>INTQ.RNGE:0-4 | ≥ 0<br>INTQ.RNGE:0-4 |
| 4. TREE DECADENCE | | |
| DUNNING'S TREE CLASSES 3,4,5,7 | ≥ 2 PER ACRE | ≥ 2 PER ACRE |
| 5. NUMBER OF TREE CANOPIES | ≥ 1 | ≥ 1 |
| 6. TOTAL TREE CANOPY COVER: | 60% ± 10 | 50% ± 15 |