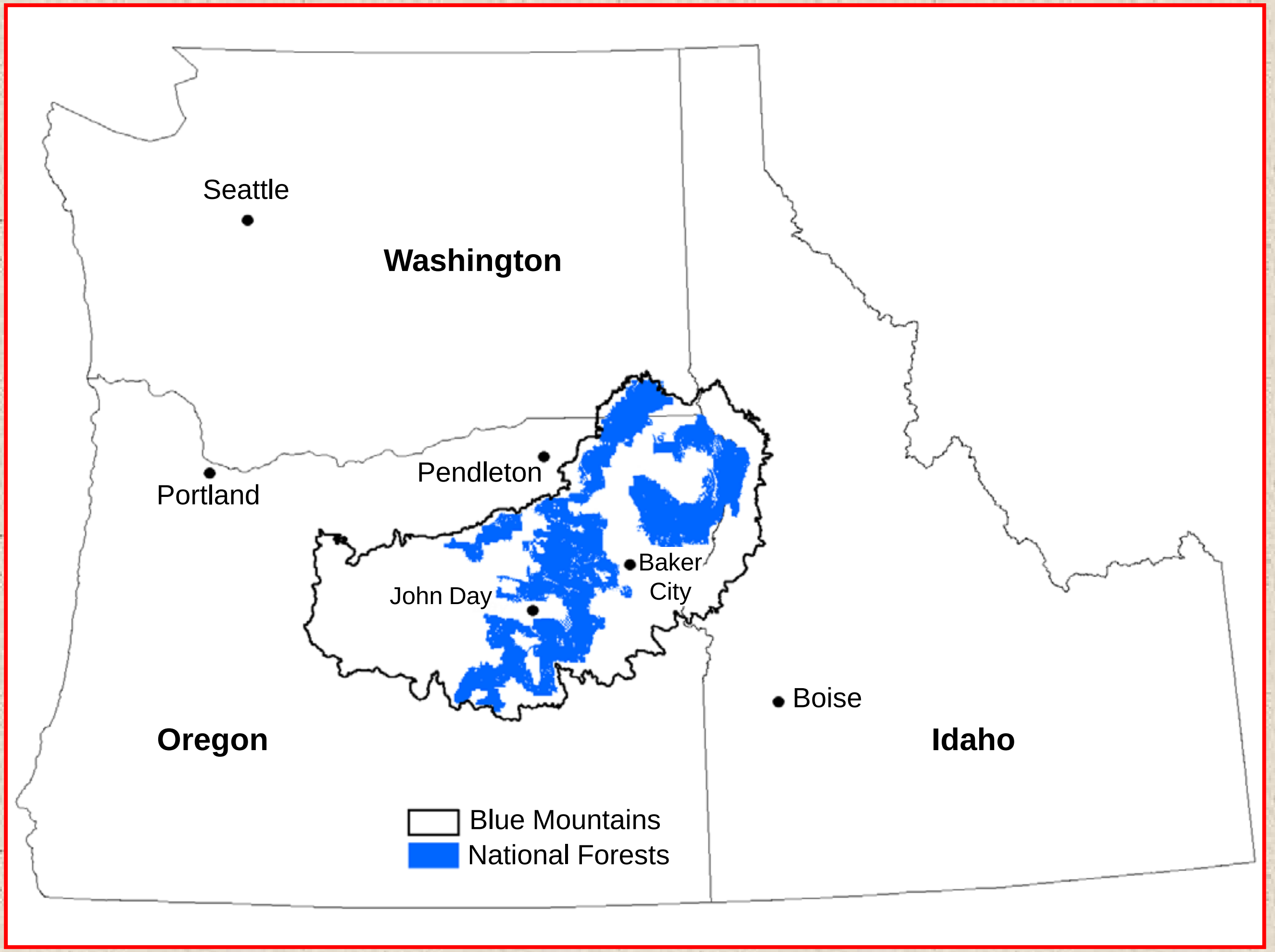
Development of suggested stocking levels for the Blue Mountains



Dave Powell; Forest Silviculturist
Umatilla National Forest, Pendleton, OR

United States Department of Agriculture

Forest Service

Pacific Northwest Research Station

Research Note PNW-RN-513 April 1994

Suggested Stocking Levels for Forest Stands in Northeastern Oregon and Southeastern Washington[1]

P.H. Cochran, J.M. Geist, D.L. Clemens, Rodrick R. Clausnitzer, and David C. Powell

Abstract

Catastrophes and manipulation of stocking levels are important determinants of stand development and the appearance of future forest landscapes. Managers need stocking level guides, particularly for sites incapable of supporting stocking levels presented in normal yield tables. Growth basal area (GBA) has been used by some managers in attempts to assess inherent differences in site occupancy but rarely has been related to Gingrich-type stocking guides. To take advantage of information currently available, we used some assumptions to relate GBA to stand density index (SDI) and then created stocking level curves for use in northeastern Oregon and southeastern Washington. Use of these curves cannot be expected to eliminate all insect and disease problems. Impacts of diseases, except dwarf mistletoe (*Arceuthobium campylopodum* Engelm.), and of insects, except mountain pine beetle (*Dendroctonus ponderosea* Hopkins) and perhaps western pine beetle (*Dendroctonus brevicomis* LeConte), may be independent of density. Stands with mixed tree species should be managed by using the stocking level curves for the single species prescribing the fewest number of trees per acre.

Keywords: Forest health, growth basal area, mountain pine beetle, stand density index, stressed sites, Oregon—northeast, Washington—southeast.

Introduction

Concerns about forest health east of the crest of the Cascade Range in Oregon and Washington have highlighted the need for site-specific information for a range of management practices, including stocking level control. Unfortunately, several insect pests and disease problems in northeastern Oregon and southwestern Washington cannot be prevented or controlled by density management. For example, spruce beetle (*Dendroctonus rufipennis* Kirby), western spruce budworm (*Choristoneura occidentalis* Freeman), Douglas-fir tussock moth (*Orgyia pseudotsugata* McDunnough), and laminated root rot (*Phellinus weirii* (Murr) Gilbertson) attack trees regardless of stand density. Thinning, however, is a

[1] Contribution of the Stressed Sites Cooperative in northeastern Oregon, an informal team formed to implement existing science and stimulate applied research.

P.H. COCHRAN is a research soil scientist, Pacific Northwest Research Station, Silviculture Laboratory, 1027 NW Trenton Avenue, Bend, OR 97701; J.M. GEIST is a research soil scientist, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850; D.L. CLEMENS is a silviculturist, Pine Ranger District, Wallowa-Whitman National Forest, Halfway, OR 97834; RODRICK R. CLAUSNITZER is an assistant area ecologist, Malheur, Umatilla, and Wallowa-Whitman National Forests, Box 907, Baker City, OR 97814; and DAVID C. POWELL is a forest silviculturist, Umatilla National Forest, 2517 SW Hailey Avenue, Pendleton, OR 97801.

Suggested stocking levels for the Blue Mountains are provided in a Research Note published in April 1994.

Concepts and Principles

Characteristics of a good index of stand density (Daniel et al. 1979):

- Quantitative.
- Easily applied or calculated.
- Independent of site quality.
- Independent of stand age.
- Independent of forest stand dynamics.

PERFECTING A STAND-DENSITY INDEX FOR EVEN-AGED FORESTS[1]

By L. H. Reineke

Associate Silviculturist, California Forest Experiment Station, Forest Service, United States Department of Agriculture

Stand density index was first presented by Lester Henry Reineke in the Journal of Agricultural Research on April 1, 1933. He used size-density data for 14 forest types from across the U.S., and discovered that fully-stocked, even-aged stands of a given diameter had about the same trees per acre as other fully-stocked stands for the same species and diameter. And, this relationship occurred ***regardless of site quality or stand age***.

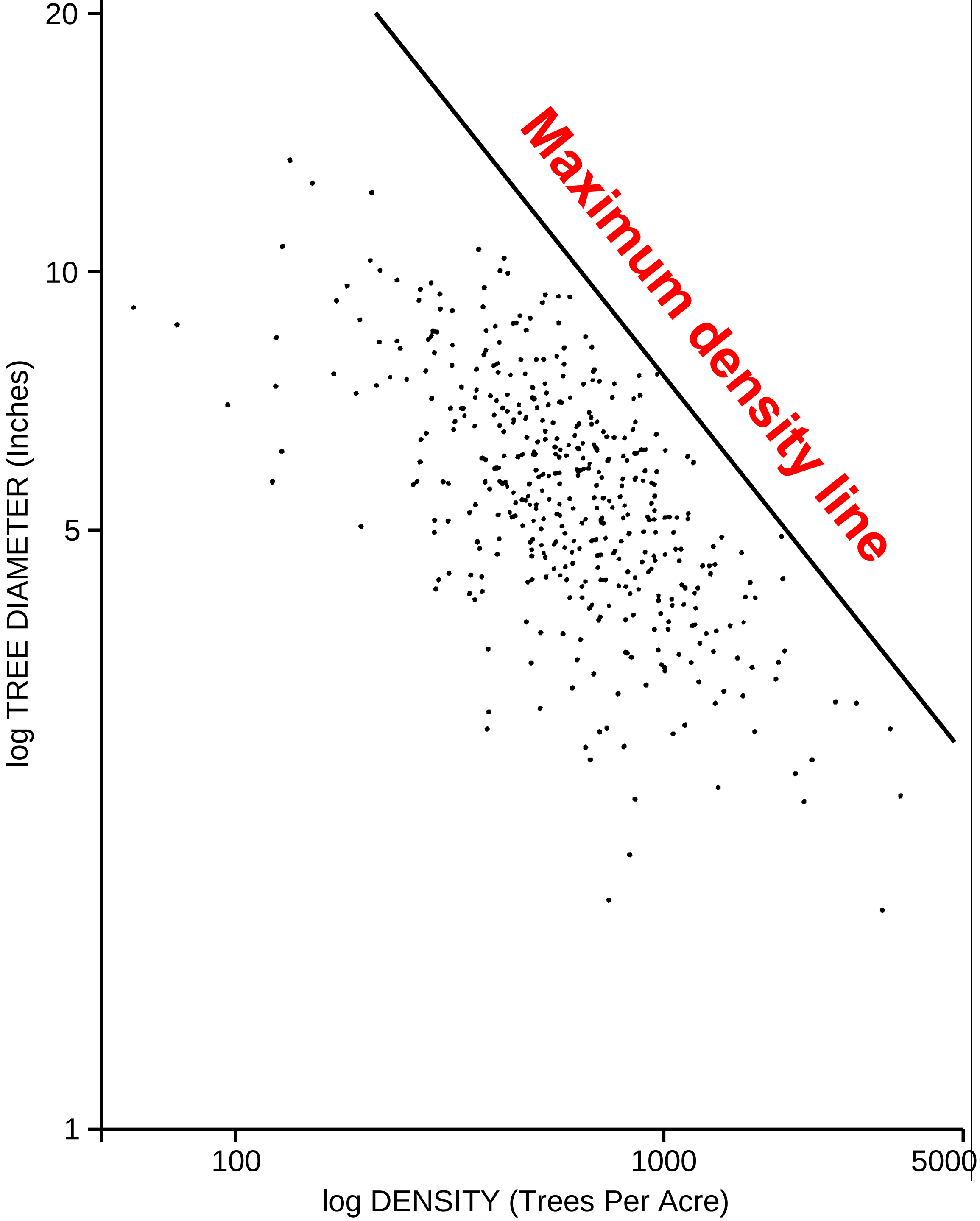
SITE INDEX	STAND AGE	QUAD. MEAN DIAMETER	TREES PER ACRE
70	160	10.0	510
90	100	10.0	510
130	60	9.9	510
170	50	10.0	510

Source: Barnes 1962 (and adapted from Daniel et al. 1979, specifically table 12.2, page 262 in that source)

Concepts and Principles

Stand Density Index: an expression of relative density as a relationship between number of trees and quadratic mean diameter.

- Stand density index (SDI) is indexed to a quadratic mean diameter (QMD) of 10 inches.
- SDI ***indexes*** existing density to what it was, or will be, at a reference size (QMD) of 10 inches.
- The indexing feature allows different stands to be compared on a common basis (10” QMD).



Reineke plotted data for well-stocked stands, generating a scatterplot where each dot is one stand's QMD and density. He drew a line skimming the outer data points, reflecting maximum density. He proposed we use a maximum density of 1,000 trees/acre (at 10" QMD) and a boundary line slope of 1.605, **for all tree species**.

Concepts and Principles

Since Reineke's work in 1933, it has been discovered that:

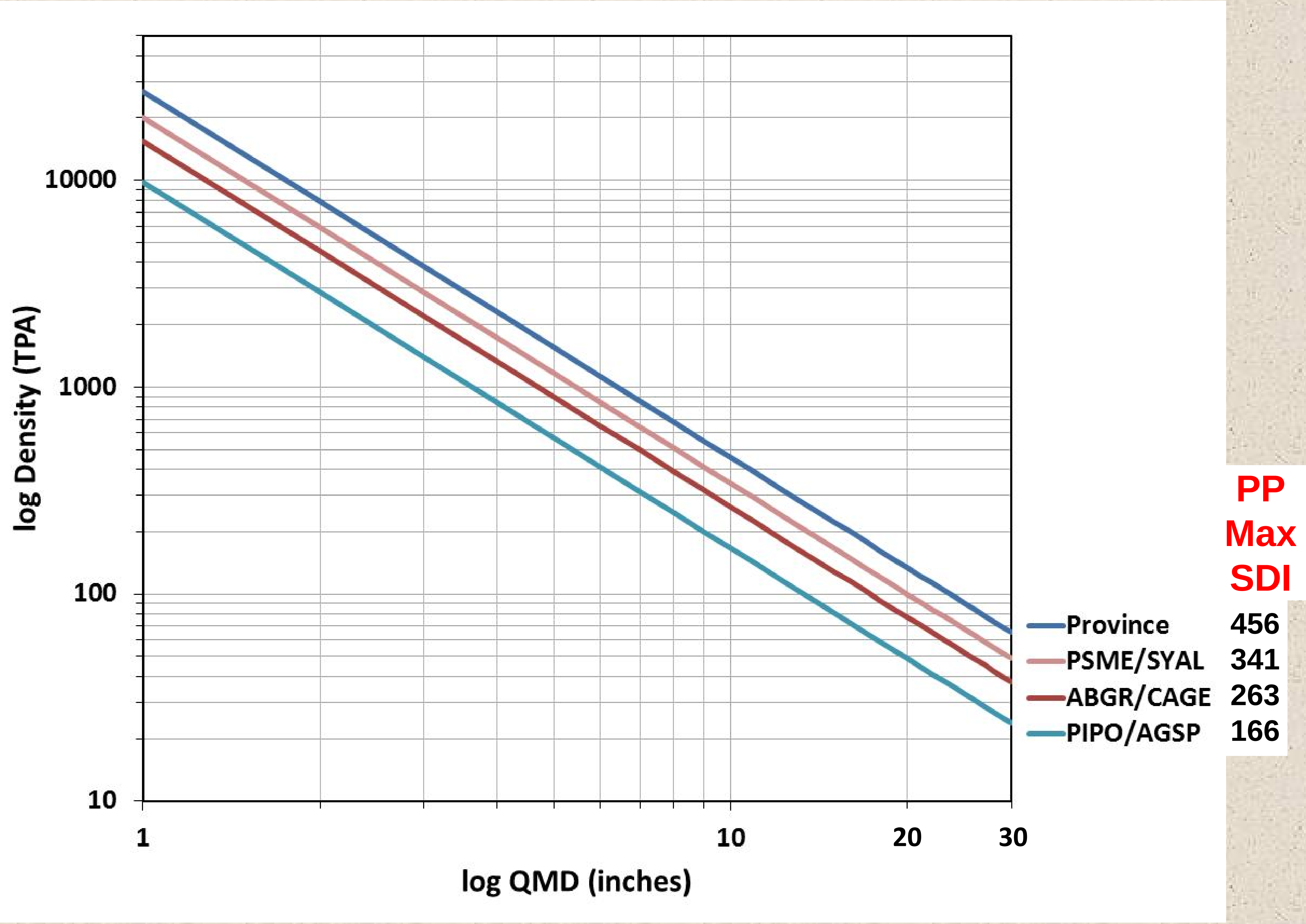
- Slope of the boundary line is more variable than he thought (<u>not</u> just 1.605).
- Slope of the boundary line varies by species, cohort (dominants have a steeper slope), conifer versus broadleaf, shade tolerance, **and biophysical environment**.
- Intercepts vary to same extent as the slopes.

Intercept, slope factor, and maximum density SDI values for primary conifers of the Blue Mountains.

TREE SPECIES	INTERCEPT VALUE	SLOPE FACTOR	MAXIMUM DENSITY
Ponderosa pine	9.97	1.77	456
Douglas-fir	9.42	1.51	475
Western larch	10.00	1.73	512
Lodgepole pine	9.63	1.74	346
Engelmann spruce	10.13	1.73	586
Grand fir	10.31	1.73	700
Subalpine fir	10.01	1.73	520
Reineke 1933	**10.00**	**1.605**	**595-800**

Intercept shows where the maximum density line hits the vertical axis. Slope is the steepness of the maximum density line. Maximum density values are for the Blue Mountains province. Reineke 1933 is included for comparison purposes.

Important – biophysical environment maximums!



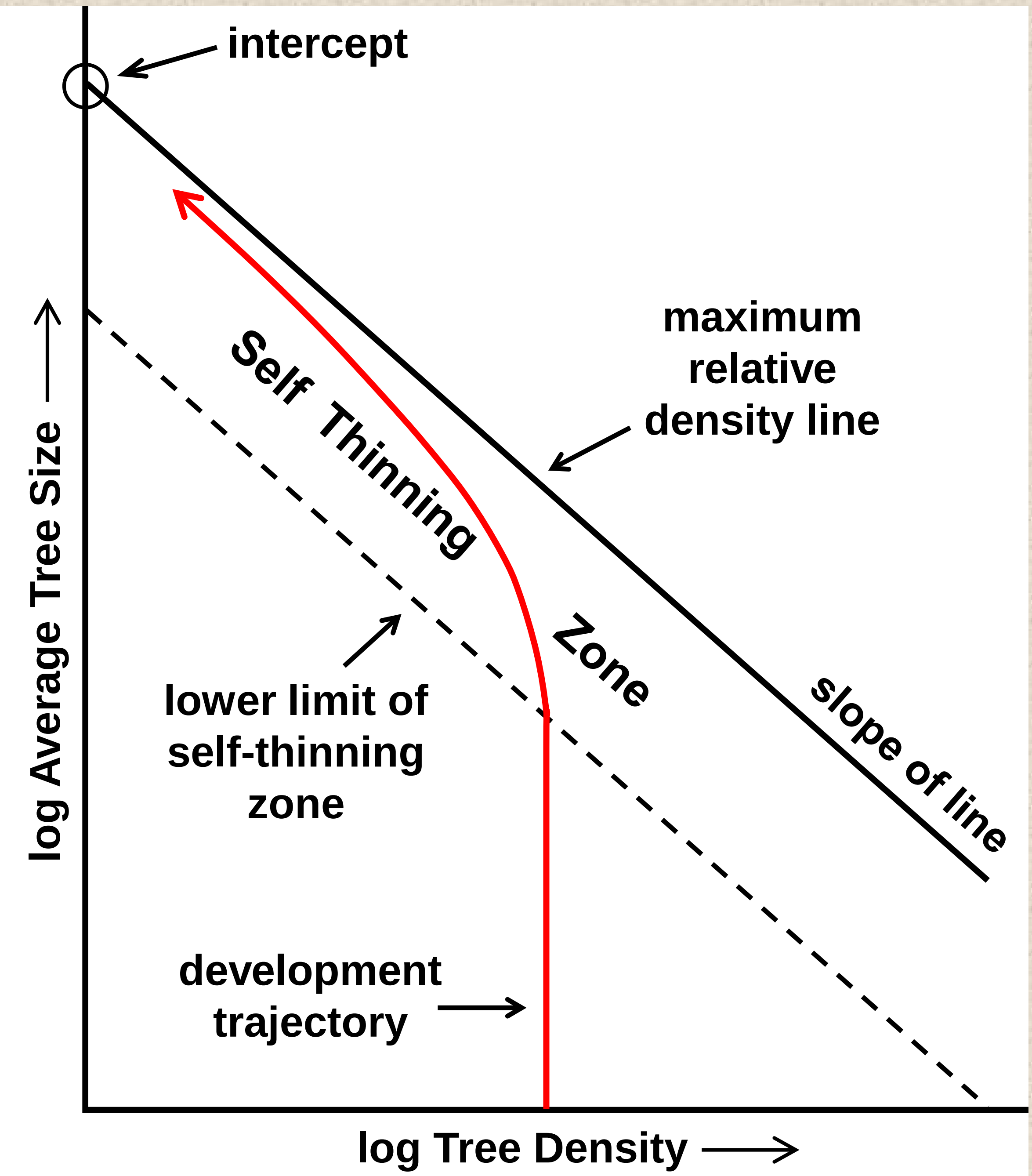
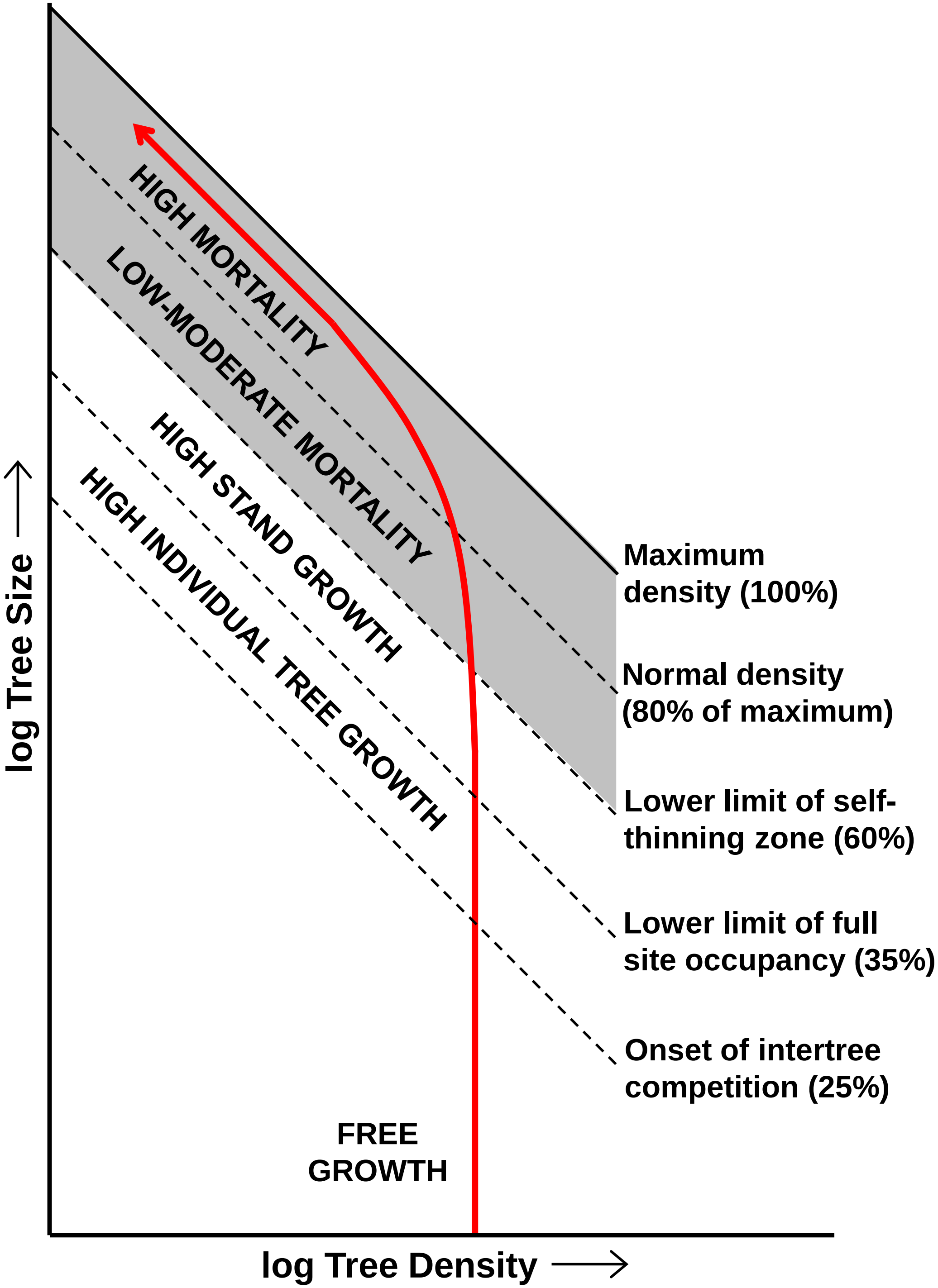


Diagram of self-thinning concepts. Many stocking systems use maximum relative density as a reference level. The development trajectory shows an even-aged stand that enters the self-thinning zone, when its trajectory bends left and stays below maximum density. **Stands will not breach the maximum density boundary**.

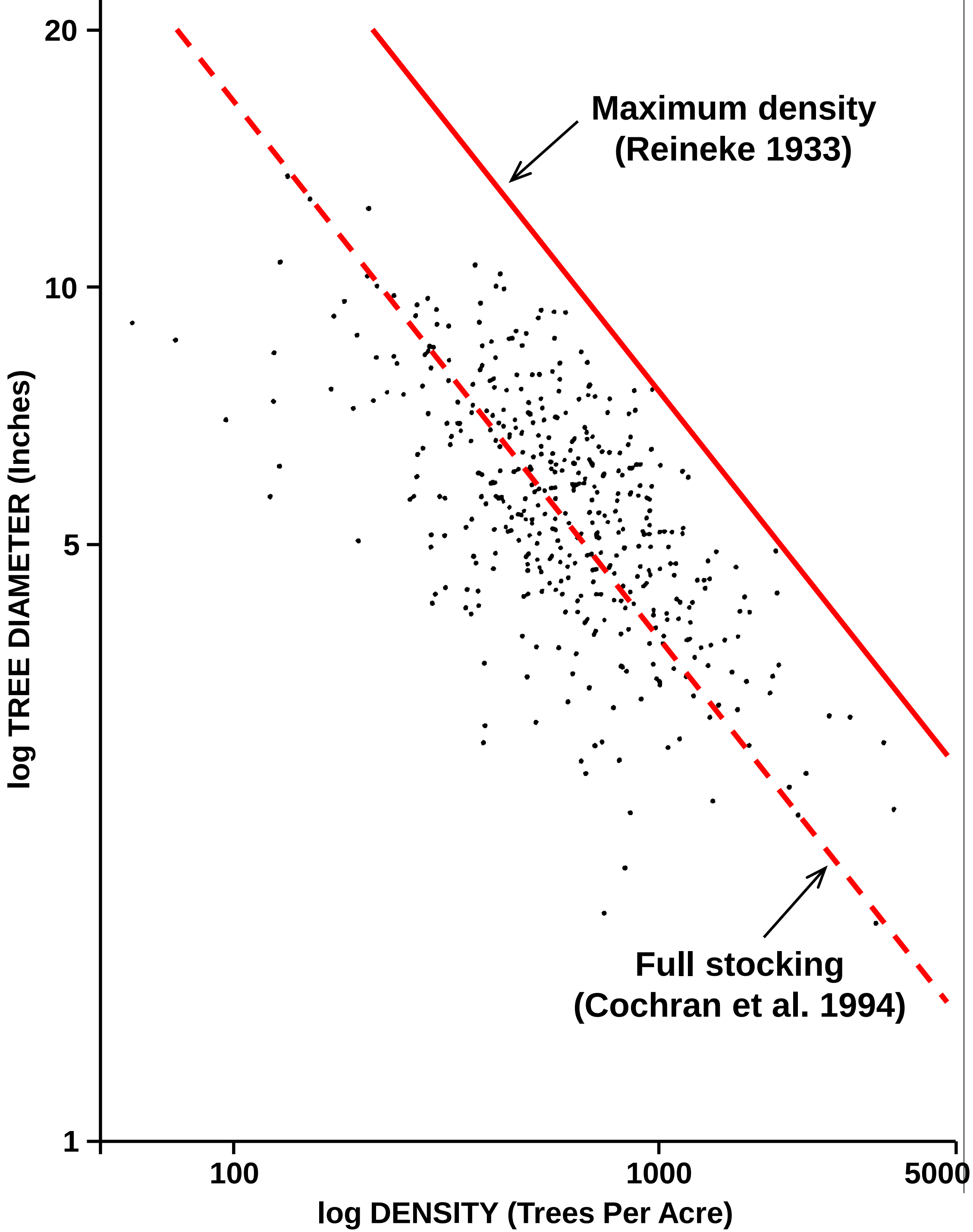


This slide has the same layout as the last one, but the name of each stocking threshold is shown, along with its percentage of maximum density. The solid line at the top is maximum density. Dashed lines show stocking thresholds. Gray shading shows the self-thinning zone. Zones between the thresholds show growth and mortality relationships.

Let’s quantify the density management zones shown in the previous slide for three species on the GF/big huckleberry plant association (% of max SDI).

Free Growth 0-25%	High Tree Growth 25-35%	High Stand Growth 35-60%	Low-Mod Mortality 60-80%	High Mortality 80-100%

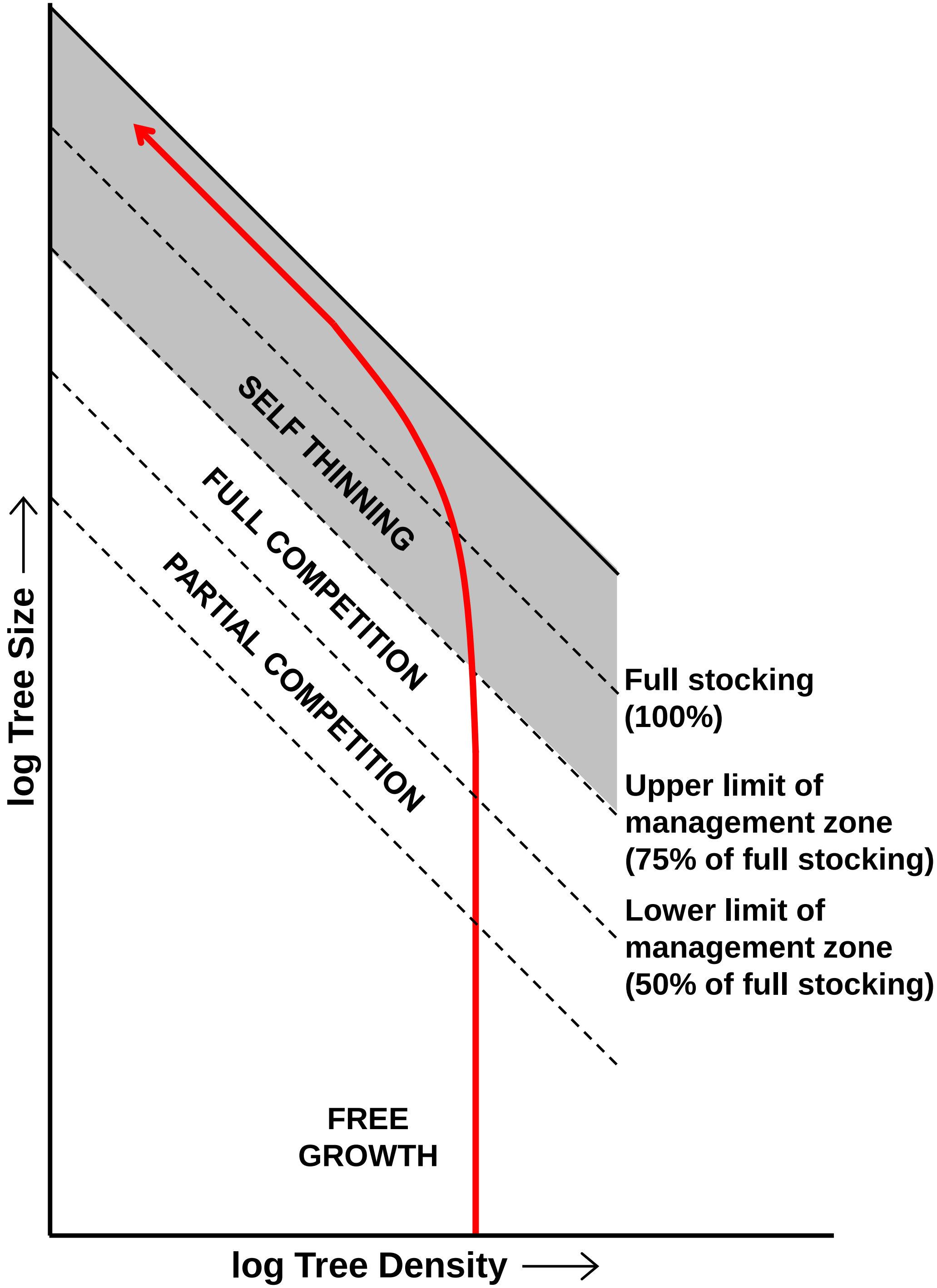
Western larch (maximum SDI is 512 on GF/big huckleberry)				
0-128	128-179	179-307	307-410	410-512
Douglas-fir (maximum SDI is 475 on GF/big huckleberry)				
0-119	119-166	166-285	285-380	380-475
Grand fir (maximum SDI is 569 on GF/big huckleberry)				
0-142	142-199	199-341	341-455	455-569



Reineke (1933) used maximum density as a reference level; Cochran et al. (1994) used full stocking (normal density) as a reference level.

USFS policy allows local stocking guides to be based on one of 3 reference levels:

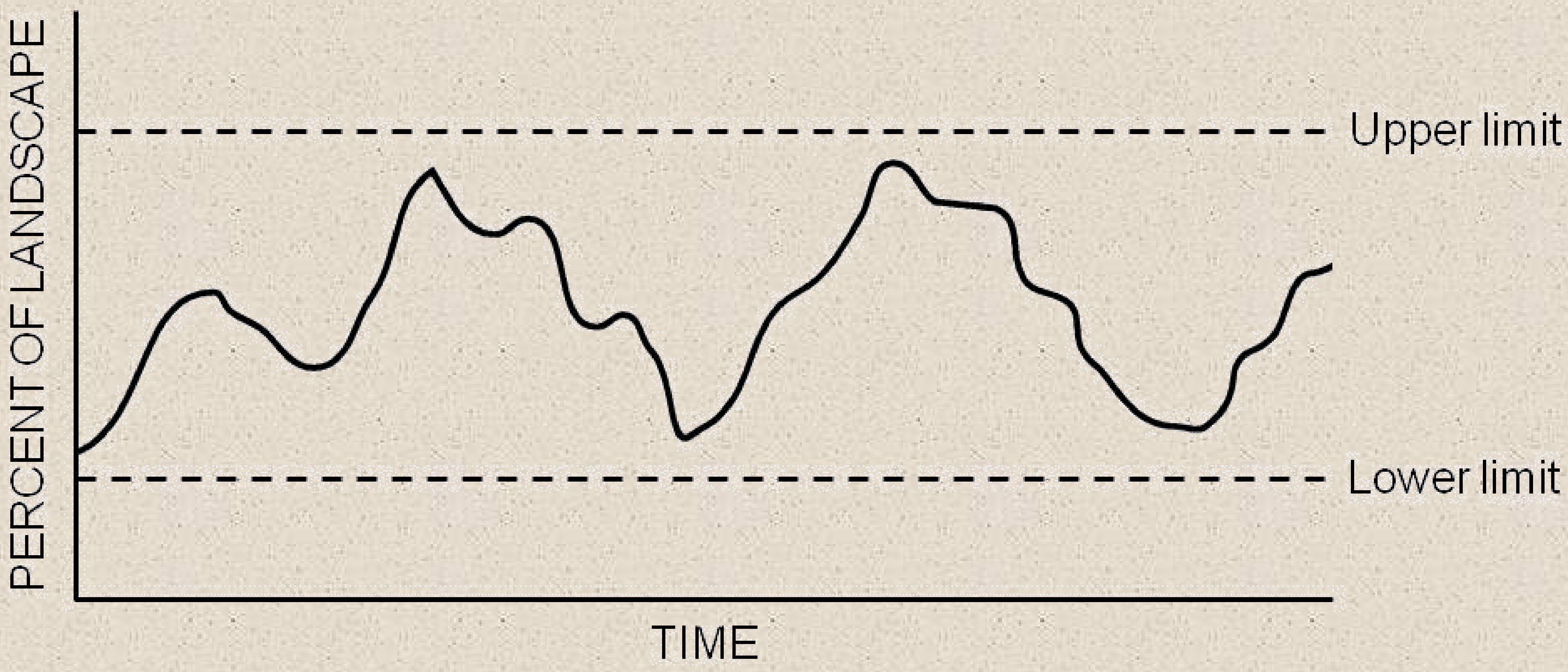
- Maximum density
- Normal density
- Minimum density

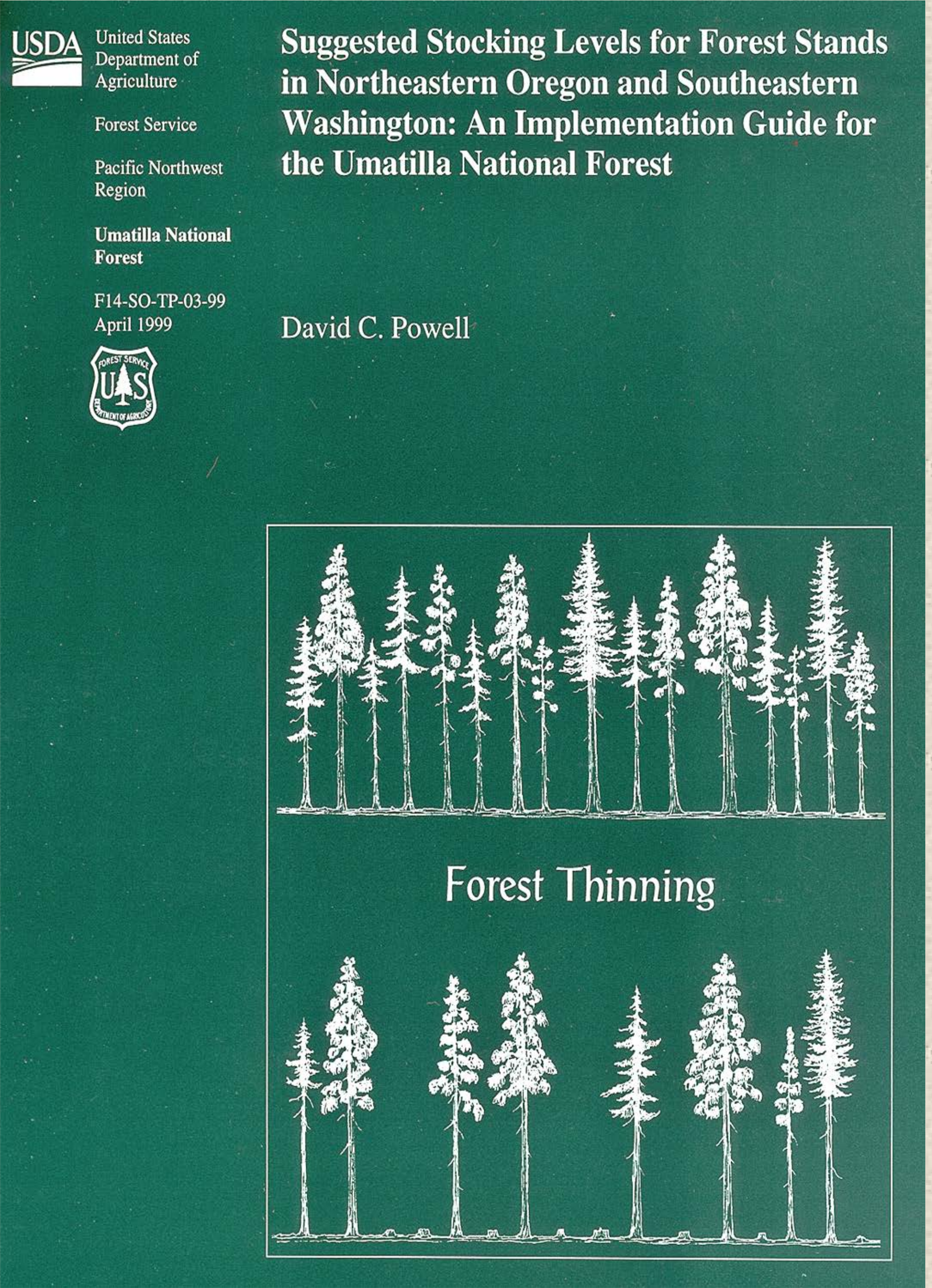


In Cochran et al. 1994, a goal was to avoid the self-thinning zone. A management zone was defined, and its upper limit (ULMZ) was set at the lower limit of the self-thinning zone: any stand maintained below the ULMZ would avoid self-thinning mortality. For all species except ponderosa and lodgepole pines, the **ULMZ is 75% of full stocking**. The ULMZ for pines was adjusted for bark-beetle risk. The lower limit of the management zone or **LLMZ is 67% of the ULMZ** for all 7 species.

The “Management Zone”

You can think of the management zone like the range of variation: if stands could spend all of their time between the upper and lower limits of the management zone, they would be happy, fulfilled, resilient, productive, and fire-safe!

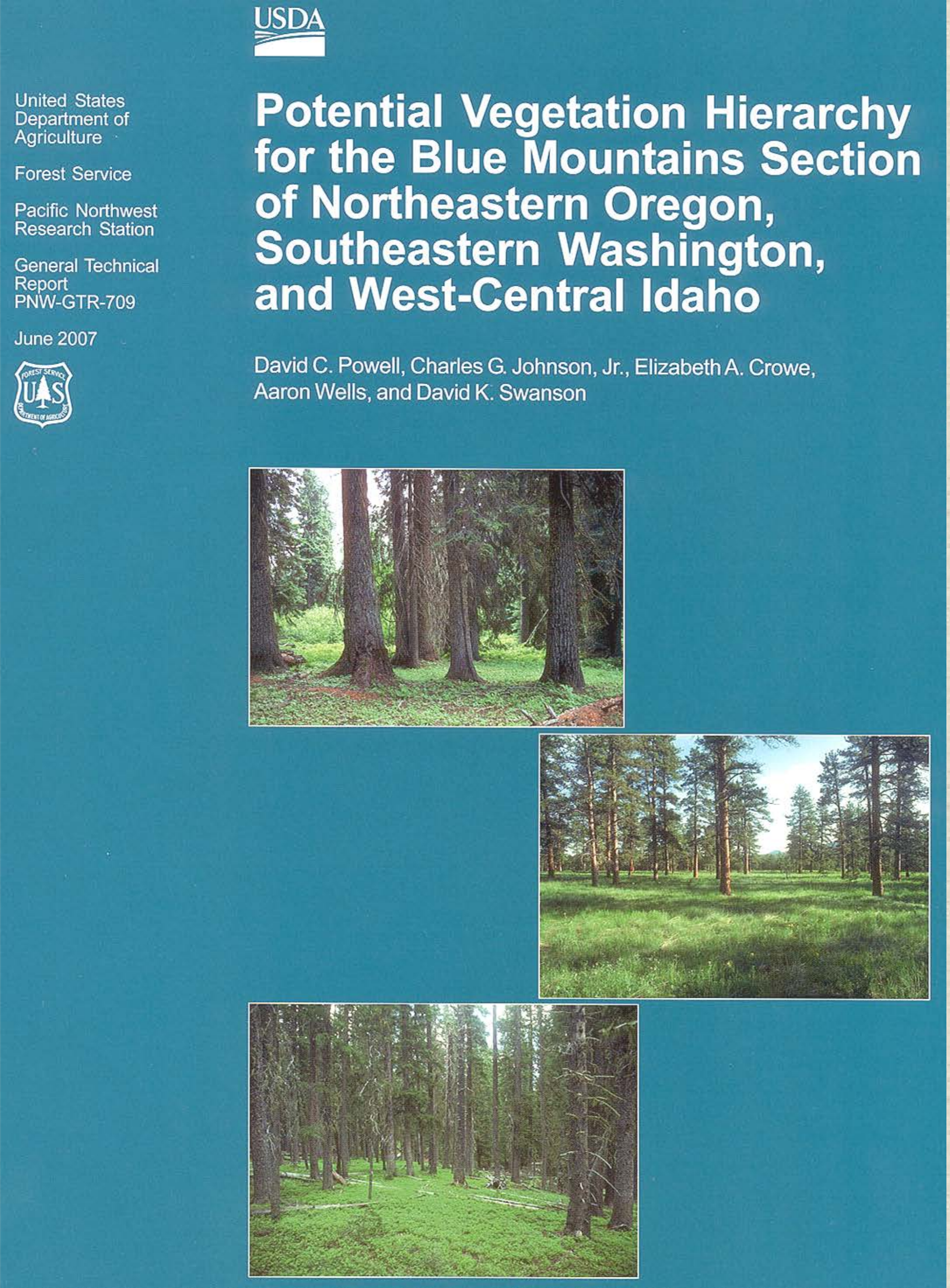




After the research note was published in 1994, users asked for more information to help apply the stocking levels:

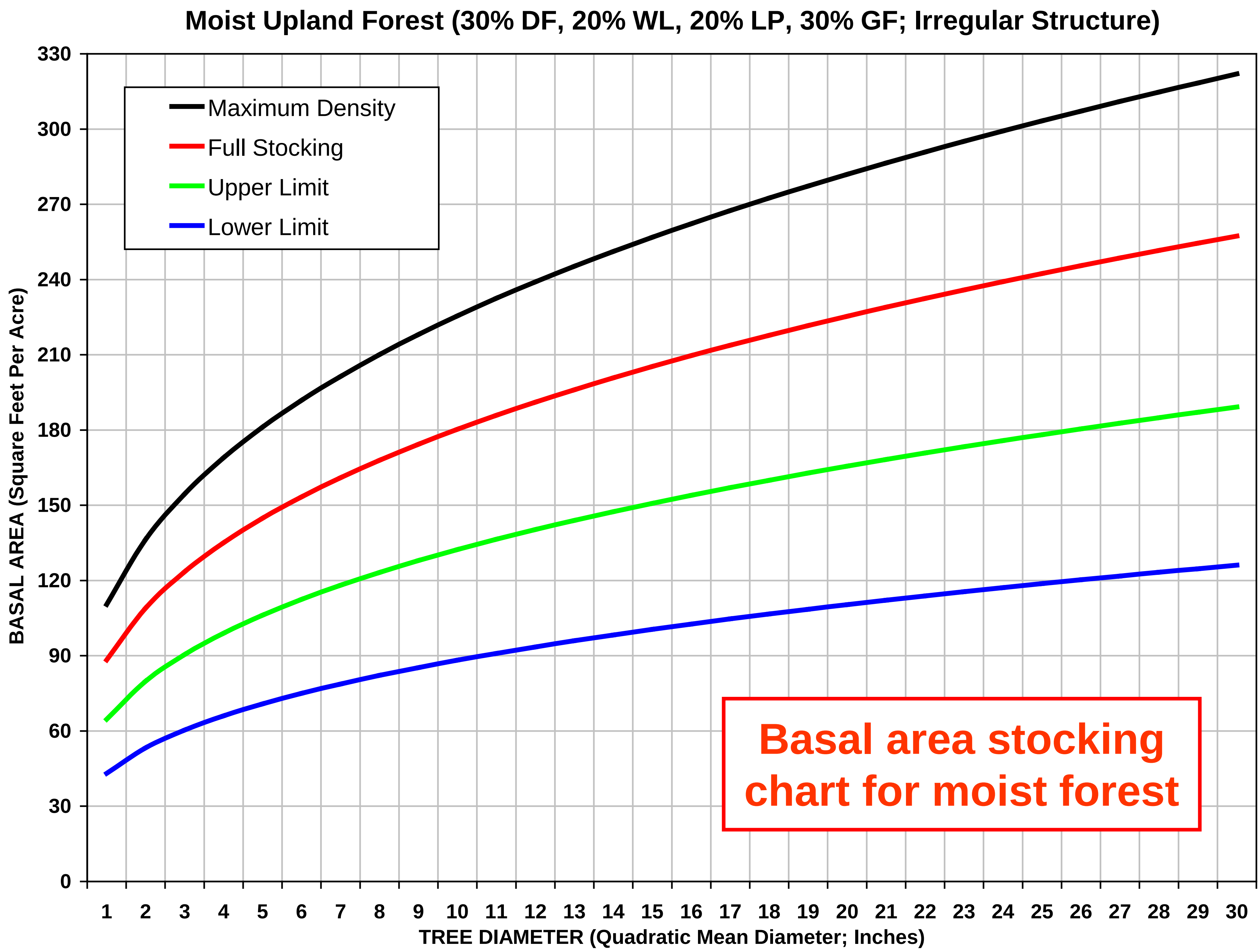
- SDI values for the ULMZ
- SDI values for the LLMZ
- Basal area for all levels
- Data for irregular stands
- Data for uneven-aged stands
- Data for range of QMDs
- Data by canopy cover
- Data by intertree spacing

So, an implementation guide was published in 1999 to provide the additional information.



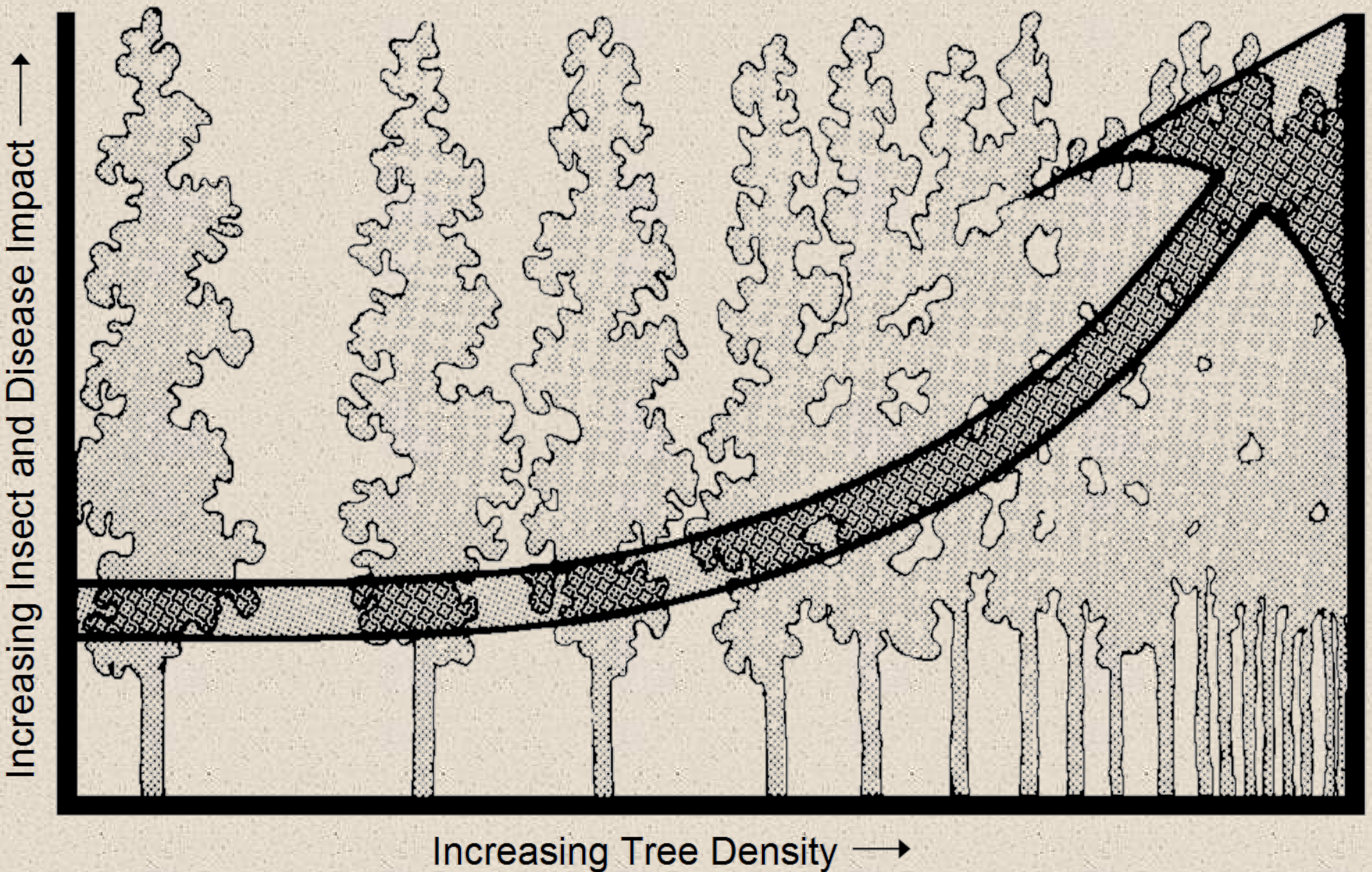
Mid-Scale Stocking Data

The Blue Mountain national forests spent more than a decade working with our area ecologists to develop a system for assigning the 507 potential vegetation types (plant associations, plant community types, and plant communities) to plant association groups (PAG) and potential vegetation groups (PVG). **This GTR provides tables showing how all 507 ecoclass codes for the Blues were assigned to PAGs and PVGs.**


Moist Upland Forest (30% DF, 20% WL, 20% LP, 30% GF; Irregular Structure)
Maximum Density
Full Stocking
Upper Limit
Lower Limit
Basal area stocking chart for moist forest
BASAL AREA (Square Feet Per Acre)
TREE DIAMETER (Quadratic Mean Diameter; Inches)
0
30
60
90
120
150
180
210
240
270
300
330
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30

Density Management and Disturbance

Many studies have shown that insect and disease impact varies directly and predictably with changes in stand density.



The implementation guide discusses insects and diseases affected by stand density (mountain pine beetle susceptibility was used to modify suggested stocking levels for ponderosa pine and lodgepole pine).

Insects and Diseases Affected By Stand Density
Armillaria root disease (Filip et al. 1989)
Douglas-fir beetle (Weatherby & Thier 1993)
Douglas-fir tussock moth (Filip et al. 1996)
Fir engraver (Hessburg et al. 1994)
Indian paint fungus (Filip et al. 1992)
Mountain pine beetle (Mitchell et al. 1983)
Spruce beetle (Schmid and Frye 1976)
Western pine beetle (Miller and Keen 1960)
Western spruce budworm (Carlson et al. 1985)

Many studies have shown that fire risk and fuel loading varies directly and predictably as stand density changes.

ESTIMATING CROWN FIRE SUSCEPTIBILITY FOR PROJECT PLANNING

David C. Powell

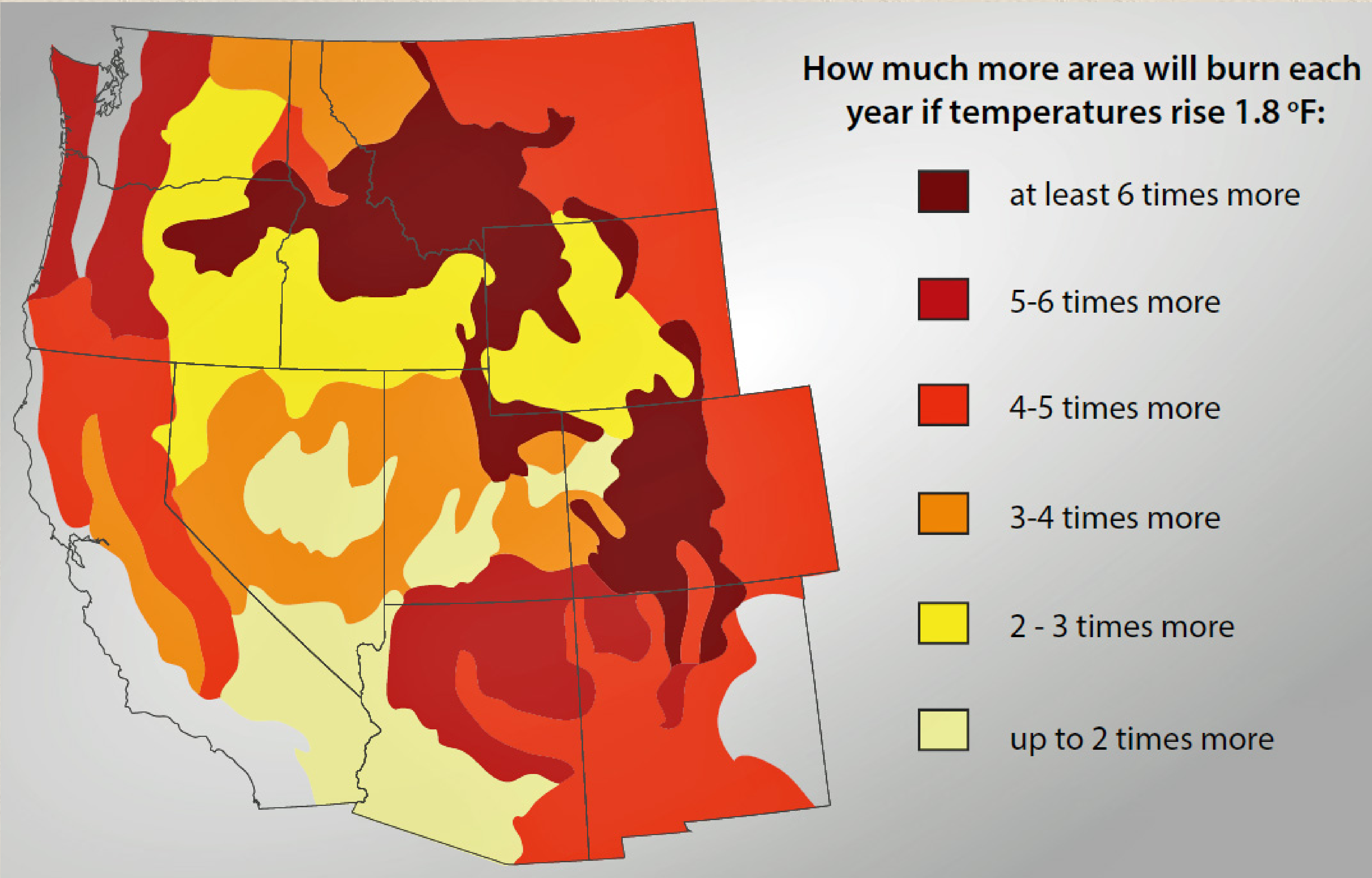
Fire managers traditionally recognize three types of fire (Pyne and others 1996):

- Ground fires burning in organic materials such as peat;
- Surface fires burning in herbs and other fuels lying on or near the ground surface; and
- Crown fires burning in elevated canopy fuels.

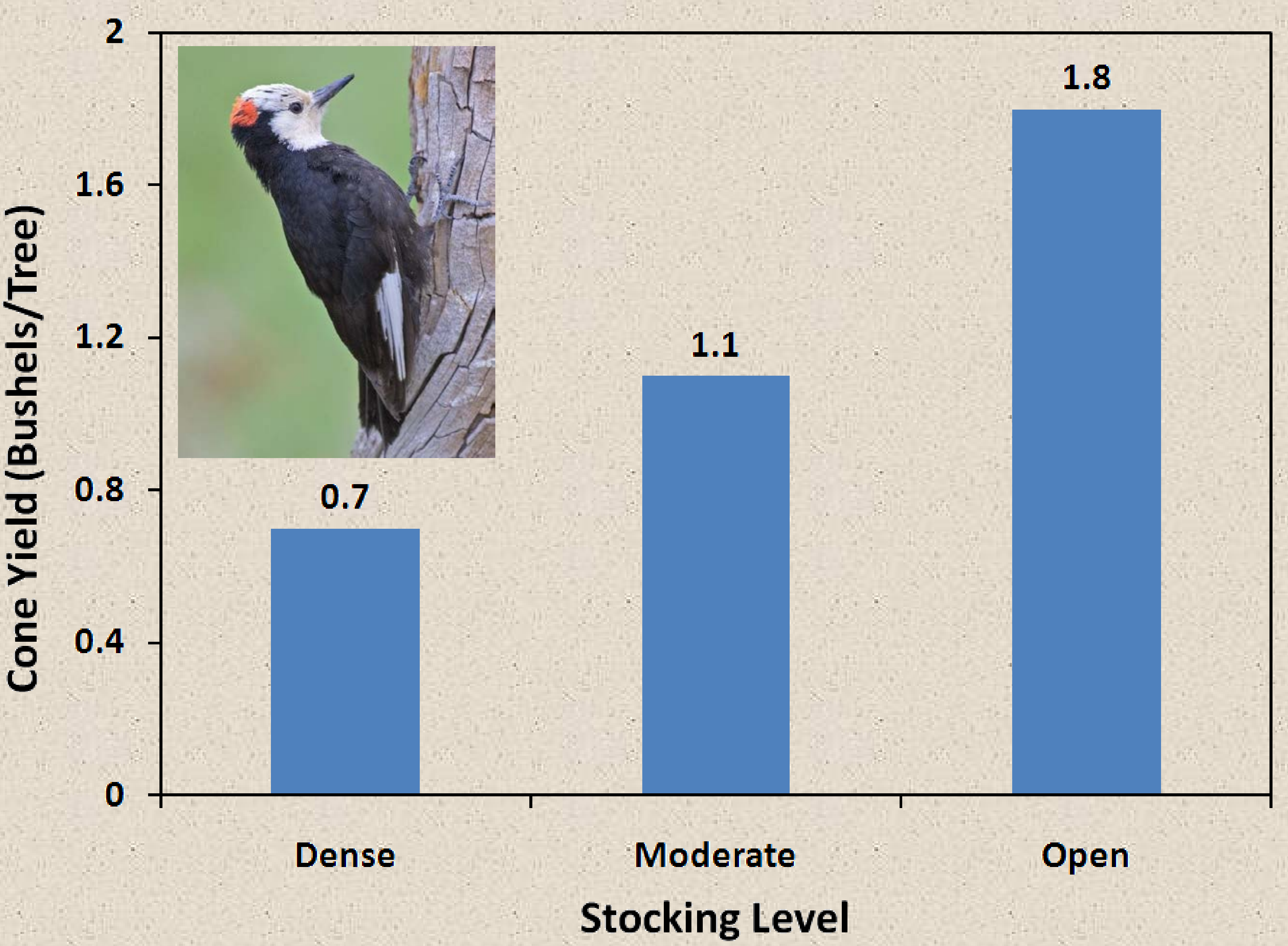
When considering fire effects on vegetation and other ecosystem components, crown fire is acknowledged to be the most severe of the three fire types. Although crown fire is normal and expected for fire regimes III, IV, and V (Schmidt and others 2002), a large amount of crown fire is neither normal nor expected for the dry forests of fire regime I (Agee 1993). (See box on following page for more details on

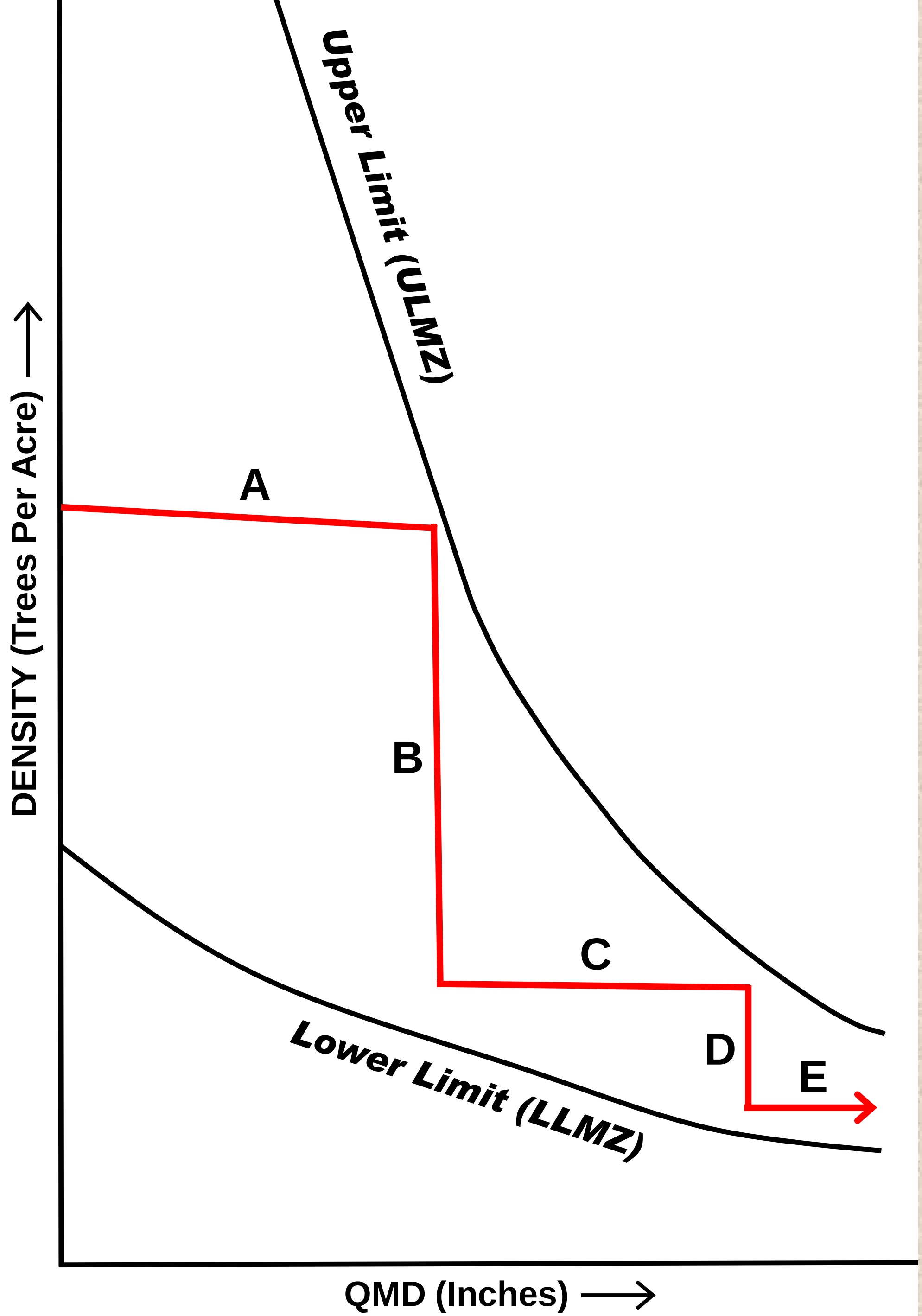
Crown fire in the Blue Mountains, OR, showing the long flame lengths and high fireline intensity typically produced by crown fire. Photo: David Powell, Umatilla National Forest.

Why do we need to be concerned about fire?
Take a gander at this climate change prediction!



Lower Stand Density = More PP Seed = Better White-Headed Woodpecker Habitat (Pearson 1912, Krannitz & Duralia 2004)





A typical thinning regime based on the upper and lower limits of a management zone. Initial density begins in the management zone, and growth causes stand QMD to move toward the upper limit (segment A); a thinning is then completed to drop the trajectory toward the lower limit (segment B is the thinning). Same process occurs for segments C, D, and E.