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Interim Definitions for Old-Growth Douglas-Fir and Mixed-Conifer Forests in the Pacific Northwest and California

Old-Growth Definition Task Group

Abstract

Interim definitions of old-growth forests are provided to guide efforts in land-management planning until comprehensive definitions based on research that is currently underway can be formulated. The basic criteria for identifying old-growth Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) and mixed-conifer forests in western Washington and Oregon and California are given.

Keywords: Old growth, old-growth stands, mixed stands, Coniferae, Pacific Northwest, California.

Introduction

Old-growth forests are of increasing interest in the Pacific Northwest. The acreage of such forests in the Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) region has declined from approximately 15 million acres at the time of settlement to 5 million acres at present (Society of American Foresters 1984). Almost all the remaining acreage is on Federal lands and about 80 percent is unreserved and potentially available for logging. Concerns are emerging about old-growth forests and their various functions, such as providing habitat for wildlife. Consequently, disposition of old-growth forests has become an important and controversial issue in land-use planning on National Forests and Bureau of Land Management lands.

Consideration of the issue has been hampered by different concepts of old-growth forests. For example, economists often view any forest past financial maturity as "overmature" or "old" in contrast with biological or esthetic definitions. Uniform definitions of old-growth forests are essential for a variety of purposes, including inventories to estimate the remaining acreage. Research is underway that will provide objective criteria for old-growth conditions in various forest types. An example is the Old-Growth Wildlife Habitat Research and Development Program and related projects initiated in western Oregon and Washington and northwestern California in 1982.

The Task Group is composed of: J.F. Franklin (chairman), chief plant ecologist, USDA Forest Service, Pacific Northwest Research Station; F. Hall, regional ecologist, USDA Forest Service, Pacific Northwest Region; W. Laudenslayer, regional wildlife ecologist, USDA Forest Service, Tahoe National Forest; C. Maser, research biologist, U.S. Department of the Interior, Bureau of Land Management, Oregon State Office; J. Nunan, silviculturist, USDA Forest Service, Pacific Northwest Region; J. Poppino, project leader, Forest, Inventory and Analysis for Pacific Coast States, USDA Forest Service, Pacific Northwest Research Station; C.J. Ralph, project leader, USDA Forest Service, Pacific Southwest Forest and Range Experiment Station; T. Spies, research forester, USDA Forest Service, Pacific Northwest Research Station, formerly research associate, Department of Forest Science, Oregon State University.

Working definitions are needed immediately, however, to guide current planning efforts, to restructure inventory procedures, and to clarify issues. To meet this need, the Old-Growth Wildlife Habitat Research and Development Program Steering Committee,[1] a joint effort of the Pacific Northwest and Pacific Southwest Regions of the USDA Forest Service and the Oregon State Office of the U.S. Department of the Interior Bureau of Land Management, created the Old-Growth Definition Task Group. The task group was given the responsibility for developing interim definitions of old growth for use in ongoing management planning and project work.

Definitions of old-growth Douglas-fir and Sierra mixed-conifer forests are presented in this paper. They are based on biological criteria and are generally applicable west of the crest of the Cascade Range and the Sierra Nevada. These definitions are intended for use until more refined definitions emerge from research that is underway.

Methods

The Old-Growth Definition Task Group views old growth as an ecological concept, the third of three basic biological stages in forest development. These forest stages are young, mature, and old; or, as sometimes distinguished by foresters, immature, mature, and overmature. Although transitions between these three stages are gradual, maturation or the transition from youth to maturity for a stand is often indexed in forestry by the culmination of mean annual wood increment (age at which the average yearly increase in volume, based on total stand age, reaches a maximum). In Douglas-fir forests of the Northwest, maturation typically occurs at 80 to 110 years. The mature forest represents a relatively stable stage with substantial continued growth and biomass accumulation, albeit at a slower rate than in the young forest. Transition from the mature to old-growth stage is gradual and not usually apparent in Douglas-fir stands until they are 175 to 200 years old. Development of old-growth conditions is also progressive so that "young" old-growth stands (for example, 250 years of age) display old-growth characteristics, such as decadence in dominant trees, with less frequency and intensity than in stands 500 years old.

The definitions provided here are developed from existing descriptions of old growth and from data bases and the experience and judgment of the task group. Published characterizations of old-growth Douglas-fir forests include those of the Society of American Foresters (1984) and Franklin and Spies (1984), although both are based mainly on Franklin and others (1981). Major unpublished data sets are those of Forsman and others[2] for the Coast Range and Spies[3] for the central and southern Cascade Range of Oregon and Washington and the Coast Range of Oregon. An extensive series of permanent sample plots, extending from the Olympic Peninsula to the southern Sierra Nevada, provide additional data (see footnote 3).

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[1]Committee was chaired by M.A. Kerrick, supervisor, Willamette National Forest, USDA Forest Service.

[2]Manuscript in preparation, "Structure and composition of old-growth, mature, and second-growth forests of Douglas-fir and western hemlock in the Oregon Coast Ranges and Olympic Mountains, Washington," by Eric D. Forsman, Jerry F. Franklin, and E. Charles Meslow. On file with Research Work Unit 4151, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331.

[3]Thomas A. Spies, unpublished data on file with Research Work Unit 4151, Forestry Sciences Laboratory, 3200 Jefferson Way, Corvallis, OR 97331.

Several concepts are central to the development of the definitions. First, plant-community series are used to stratify the descriptions. Characteristics of old-growth Douglas-fir forests vary considerably between the southern Cascade Range (south of lat. 44° to 45° N.), central and northern Cascade Range, and Klamath Mountains. Plant-community series, which consist of plant associations or habitat types with the same major climax tree species (for example, western hemlock (*Tsuga heterophylla* (Raf.) Sarg.)), can be used to distinguish some major variations in old-growth characteristics. The series are a major hierarchical level in the comprehensive plant-community classification being developed for National Forests and Bureau of Land Management lands throughout the Douglas-fir region.

Second, multiple criteria are used rather than a single characteristic, such as size or age of trees. Old-growth forests are too complex in structure and composition to allow simple characterizations. Discrimination between young, mature, and old-growth conditions requires use of several features. Equally important is the need to recognize as many attributes as possible because each might eventually prove important in the functioning of old-growth forests and, hence, to managers interested in old-growth conditions.

Third, these definitions are based on minimal criteria rather than average values. For example, eight large Douglas-firs per acre (20 per ha) is a criterion for old-growth stands on western hemlock sites (table 1) although most stands typically contain 15 to 45 trees, depending on age and history. Any old-growth attribute exhibits a range of levels over a sample of stands. We chose levels for characteristics that were in the low to very low range so that the definition would encompass nearly all the old-growth stands for which we have data. Even at these minimum levels, old-growth values still generally lie outside the range of values found in most, if not all, young and mature forests. The minimum values presented should not be taken as levels that are adequate or optimum for specific old-growth functions nor are they close to mean or median values for sampled old-growth stands. Subsequent definitions will include considerations of average values and standard deviations as well as minimal values.

Stand area is an important consideration in judging whether an old-growth forest patch is a functional ecological unit, if it otherwise meets the criteria listed in table 1. A minimum stand of 80 acres was the criterion originally included in the definitions. Patches of smaller size were not viewed as viable old-growth units because of their dominance by edge effects (penetration of external environmental influences) and vulnerability to major disturbances such as windthrow. The size criterion was dropped because of objections that minimum acreages for a viable old-growth stand depended on management objectives and the nature of surrounding areas. Minimum acreages to meet objectives of spotted owl habitat may be very different from minimum acreages for elk thermal cover, for example. Acreage necessary to maintain integrity of old-growth stands will be higher when surrounded by clearcuts than for old growth surrounded by partially cut or intact mature forest (Harris 1984). Nevertheless, anyone using these definitions will need to identify a minimal acreage of old-growth stand below which the extent of edge influence (alteration of interior stand conditions) and vulnerability to catastrophe are unacceptable based on management objectives.

Table 1—Interim minimum standards for old-growth Douglas-fir and mixed-conifer forests in western Washington and Oregon and in California[1]

Stand characteristic	Douglas-fir on western hemlock sites (western hemlock, Pacific silver fir)	Douglas-fir on mixed-conifer sites (white fir, Douglas-fir)	Douglas-fir on mixed-evergreen sites (tanoak, Douglas-fir)	Sierra mixed-conifer forests (white fir)
Live trees	2 or more species with wide range of ages and tree sizes	2 or more species with wide age range and full range of tree sizes	Douglas-fir and evergreen hardwood (tanoak, Pacific madrone, and canyon live oak) associates (40 to 60 percent of canopy)	2 or more species with wide age range and full range of tree sizes
	Douglas-fir ≥8 per acre of trees >32-in diameter or >200 years old	Douglas-fir, ponderosa pine, or sugar pine ≥8 per acre of trees >30-in diameter or >200 years old	Douglas-fir or sugar pine ≥6 per acre of trees >32-in diameter or >200 years old	Douglas-fir, sugar pine, or ponderosa pine ≥8 per acre of trees >32-in diameter or >200 years old
	Tolerant associates (western hemlock, western redcedar, Pacific silver fir, grand fir, or bigleaf maple) ≥12 per acre of trees >16-in diameter	Intermediate and small size classes are typically white fir, Douglas-fir, and incense-cedar, singly or in mixture	Intermediate and small size classes may be evergreen hardwoods or include a component of conifers (e.g., Douglas-fir or white fir)	Intermediate and small size classes are typically white fir with Douglas-fir or incense-cedar or both in some stands
Canopy	Deep, multilayered canopy	Multilayered canopy	Douglas-fir emergent above evergreen hardwood canopy	Multilayered canopy
Snags	Conifer snags ≥4 per acre which are >20-in diameter and >15 ft tall	Conifer snags ≥1-1/2 per acre that are >20-in diameter and >15 ft tall	Conifer snags ≥1-1/2 per acre that are >20-in diameter and >15 ft tall	Conifer snags ≥3 per acre that are 20-in diameter and >15 ft tall
Logs	Logs ≥15 tons per acre including 4 pieces per acre ≥24-in diameter and >50 ft long	Logs ≥10 tons per acre including 2 pieces per acre ≥24-in diameter and >50 ft long	Logs ≥10 tons per acre including 2 pieces per acre ≥24-in diameter and >50 ft long	Logs ≥10 tons per acre including 2 pieces per acre ≥24-in diameter and >50 ft long

1/ Major series are shown in parentheses.

Interim Definitions

The basic criteria or minimum standards for old-growth Douglas-fir and for Sierra mixed-conifer forest are provided in table 1. Standards are provided for three groups of Douglas-fir site conditions representing different geographical areas and recognizable by plant-community series. Characteristics used are: (1) live trees—number and minimum size of both seral and climax dominants, (2) canopy conditions, (3) snags—minimum number of snags (standing dead trees) of specific size, (4) down logs—minimum tonnage and numbers of pieces of specific size. Values for snag size reflect requirements of primary cavity-nesting animals. Similarly, functional roles of logs require at least some pieces of larger dimensions (see, for example, Harmon and others 1986). Decadence in dominant live trees, such as presence of broken or multiple tops and heart rot, is an important feature of old-growth Douglas-fir stands; it is not included, however, because of difficulties in quantifying decadence.

Old-Growth Douglas-Fir on Western Hemlock Sites

Most old-growth Douglas-fir forests in northwestern Oregon and western Washington are in moist environments characterized by the western hemlock and Pacific silver fir (*Abies amabilis* Dougl. ex Forbes) series. These sites are equivalent to the Western Hemlock Zone and lower elevations in the Pacific Silver Fir Zone (Franklin and Dyrness 1973).

Two or more species must be present that together provide a full range of tree sizes (table 1). Eight or more large (>32-in diameter) or old (>200 years) Douglas-firs must be present per acre. The age alternative to size is to accommodate low-quality sites where Douglas-firs are unable to attain large diameters even in three or four centuries. One or more shade-tolerant associates—western hemlock, Pacific silver fir, western redcedar (*Thuja plicata* Donn ex D. Don), grand fir (*Abies grandis* (Dougl ex D. Don) Lindl.), or bigleaf maple (*Acer macrophyllum* Pursh)—must be present and collectively provide at least 12 trees per acre with a minimum diameter of 16 inches. Bigleaf maple is particularly characteristic of the Coast Range in Oregon, although it may also be important to stands at low elevations in the Cascade Range and Olympic Mountains.

It is important to distinguish old-growth forests in the Douglas-fir region from old-growth Douglas-fir forests; the latter are simply a subset of the former. By definition, Douglas-fir has to be a significant component for a stand to qualify as old-growth Douglas-fir. The task group chose a minimum of eight Douglas-firs per acre based on characteristics of stands up to 650 years of age. Stands in which trees exceed 700 years are sometimes distinguished as "super old growth." Douglas-fir density is typically well below eight per acre in such stands so that, by the task group's definition, they are old-growth forests dominated by some other species, often western hemlock or western redcedar. The scattered Douglas-firs give the "super old-growth" forest much of their distinctive character, however.

When Douglas-fir is not present at required levels on habitats belonging to the western hemlock or Pacific silver fir series, either because of historical absence (level of establishment in original stand) or stand antiquity (lost through successional processes), a stand may still qualify as old growth but of some type other than Douglas-fir. For example, if Douglas-fir has been replaced successionally by western hemlock, the stand probably represents an old-growth western hemlock forest. Similarly, western redcedar is often the dominant tree in old-growth stands on moist to wet sites.

The Douglas-fir old-growth criteria in table 1 can be modified for use with other species or types. The major change is replacement of Douglas-fir as the dominant species. For example, Sitka spruce (*Picea sitchensis* (Bong.) Carr.) or western redcedar can be substituted for Douglas-fir to provide interim definitions of old-growth Sitka spruce and western redcedar forests. In old-growth western hemlock or Pacific silver fir forests, these species would dominate all size classes including the requisite eight trees per acre over 32 inches in diameter.

Snag and log criteria in table 1 are substantially less than values typically encountered in old-growth stands. This accommodates the low levels found occasionally in old-growth stands in the Oregon Coast Range. Mean log values in 250- and 500-year-old Douglas-fir stands are about 20 and 35 tons per acre, respectively (see footnote 3). Snag levels are also low in many Coast Range stands because wind is the predominant agent of mortality; levels may actually fall below four snags per acre in some of these stands.

Old-Growth Douglas-Fir on Mixed-Conifer Sites

Douglas-fir is an important component of the mixed-conifer forests found in southwestern Oregon and northern California (Franklin and Dyrness 1973). The white fir (*Abies concolor* (Gord. & Glend.) Lindl. ex Hildebr.) and Douglas-fir series characterize these environments, which are substantially drier than those typified by the western hemlock series.

Douglas-fir, sugar pine (*Pinus lambertiana* Dougl.), and ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) are considered functionally interchangeable as pioneer dominants in old-growth mixed-conifer forests. Literally, however, a stand in which more than 50 percent of the large trees are pine is more appropriately called an old-growth pine stand rather than an old-growth Douglas-fir stand. The minimum diameter of 30 inches reflects poorer average site conditions than are typical of the western hemlock series. Although the shade-tolerant white fir or incense-cedar (*Libocedrus decurrens* Torr.), or both, may be present in old-growth stands, Douglas-fir is both the climax and the pioneer species on some sites. Hence, the species composition of the smaller size classes of trees is not stipulated.

Douglas-fir or the pines can be successionally replaced by white fir in the absence of fire or other disturbances on some sites. The resulting forest would be considered old-growth white fir, although structurally it would have numbers of large trees, snags, and logs similar to those of old-growth mixed-conifer forest.

Old-Growth Douglas-Fir on Mixed-Evergreen Sites

Much of the Douglas-fir found in the Klamath Mountains region is part of a mixed-evergreen forest formation (Franklin and Dyrness 1973). These forests are composed of conifers, including Douglas-fir and sugar pine, and evergreen hardwoods typified by tanoak (*Lithocarpus densiflorus* (Hook & Arn.) Rehd.), Pacific madrone (*Arbutus menziesii* Pursh), and canyon live oak (*Quercus chrysolepis* Liebm.). Port-Orford-cedar (*Chamaecyparis lawsoniana* (A. Murr.) Parl.), grand or white fir, or ponderosa pine may also occur in these stands. The tanoak and Douglas-fir series are most representative of these sites (Atzet and Wheeler 1984).

Douglas-fir and sugar pine are considered functionally interchangeable as the pioneer conifer dominant in these old-growth forests (table 1). As with mixed-conifer sites, a forest in which more than 50 percent of the large trees are sugar pine is more appropriately called an old-growth sugar pine stand than an old-growth Douglas-fir stand. The conifer crowns typically emerge above a continuous canopy of evergreen hardwoods. Smaller tree sizes may be composed of either hardwoods or conifers, which will most likely be Douglas-fir.

Old-Growth Sierra Mixed-Conifer Forests

Old-growth mixed-conifer forests in the Sierra Nevada resemble those described for Douglas-fir on mixed-conifer sites (table 1). Douglas-fir, sugar pine, and ponderosa pine all function as pioneer dominants. Most of these stands belong to the white fir series; white fir is the major tolerant associate and dominates in the small-size classes. Incense-cedar can also be an important associate, especially on drier sites.

Stands of giant sequoia (*Sequoiadendron giganteum* (Lindl.) Buchholz) are a part of the Sierra mixed-conifer forest but are of a totally different dimension; their size characteristics lie far beyond the values in table 1.

Conclusions

These criteria for identifying old-growth forests are based on limited sampling and minimal values; that is, the lowest values generally encountered rather than mean values. Comments on these definitions are solicited by the Director, Pacific Northwest Research Station, USDA Forest Service, P.O. Box 3890, Portland, OR 97208. They will assist in developing a refined classification of old-growth Douglas-fir forests that will include averages and ranges for various old-growth characteristics.

Metric Equivalents

1 inch (in)	=	2.540 centimeters (cm)
1 foot (ft)	=	0.305 meter (m)
1 acre	=	0.405 hectare (ha)
1 ton	=	0.907 metric ton (t)
1 ton/acre	=	2.240 metric tons/hectare (t/ha)

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