HISTORICAL LANDSCAPES AND FOREST STRUCTURES

Russell T. Graham

ABSTRACT

The Inland Northwest's (144.2 million acres) complex topography, interacting with continental and maritime air masses, creates a highly variable climate resulting in a variety of forest settings. Historically, 19% of the area was covered by dry forests (e.g., ponderosa pine, Douglas-fir), 18% covered by moist forests (e.g., western white pine, western hemlock), and 10% by cold forests (e.g., Engelmann spruce/subalpine fir, lodgepole pine). Before successful fire exclusion, 75% of the moist forests and 90% of the cold forests were burned by crown and a combination of crown and surface fires (mixed). In contrast, 20% of the dry forests were burned by mixed and lethal fires and 80% were burned by nonlethal surface fires. These native fires, along with other disturbances, maintained 29% of the moist forests, 23% of the cold forests, and 18% of the dry forests in early-seral vegetation. Mid-seral vegetation dominated 41% of the moist forests, 53% of the cold forests, and 30% of the dry forests. Late-seral vegetation, with multiple canopies, occurred over 19% of the moist forests, 15% of the cold forests, and 12% of the dry forests. These seral stages contained small diameter (< 12 inches) trees ranging from 500 per acre in the dry forests to over 10,000 per acre in the cold forests. Conservatively, 36% of the Inland Northwest, or approximately 52.6 million acres, likely contained a large component with small trees. Since the early 1900s, mid-seral structures dramatically increased in the moist forests, with grand fir and western hemlock replacing western white pine which was lost to harvesting and blister rust. Because of fire exclusion and harvesting in the dry forests, mid-seral structures, consisting of true and Douglas firs, increased replacing ponderosa pine. These changes, along with an increase in early-seral structures in the cold forests, have resulted in small trees currently occurring on 62.1 million acres or 43% of the Inland Northwest.

Keywords: current landscapes, small diameter trees, cold forests, moist forests, dry forests, forest change

FOREST SETTINGS OF THE INLAND NORTHWEST

The Inland Northwest (144.2 million ac) has complex topography defined by the Bitterroot, Selkirk, Cabinet, Salmon River, Lemhi, Steens, Purcell, Cascade, and Blue mountain ranges with elevations over 5,000 feet (Fig. 1). Within these ranges the valley bottoms can be low (750 ft) and the topography steep. This rough and complex topography results in a variety of forest settings ranging from steep slopes in narrow V-cut canyons to gentle rolling slopes in wide river valleys. During the Pleistocene, alpine glaciers shaped many of the canyons and valleys throughout the area. Now these glaciated landscapes are covered with a mantle of glacial till often compacted on the valley floors. Much of the fine silt outwashed by the glaciers was redeposited by winds leaving deep layers of loess deposits over many landscapes. Some 15,000 to 12,000 years ago Glacial Lake Missoula repeatedly filled and emptied flooding much of northern Idaho and eastern Washington removing topsoil and redistributing the surface sand, silt, and gravels. The eruption of prehistoric Mt. Mazama (Crater Lake, OR) about 7,000 years ago deposited a fine textured layer of ash up to 25 inches thick across the area. The granitic and metasedimentary rocks, ash, and loess deposits throughout the area are continually being modified by disturbance events giving rise to a wide variety of soils (Quigley et al. 1996).

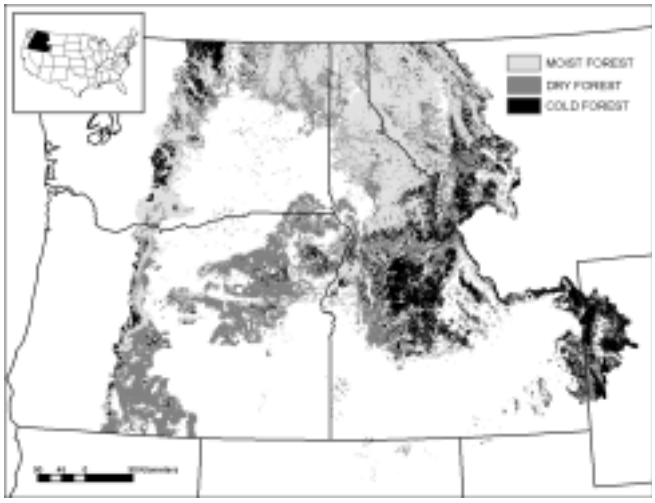

Figure 1.—Historical extent of the forests of the Inland Northwest (144.2 million acres). The cold forests containing subalpine fir and Engelmann spruce potential vegetation types (PVTs) occupied 14.4 million acres (10%) of the area, the dry forests containing ponderosa pine, Douglas-fir, and dry grand fir PVTs covered 27.4 million acres (19%), and the moist forests containing the moist grand fir/white fir, western redcedar, and western hemlock PVTs occupied 25.9 million acres (18%) (Hann et al. 1997).

Moist marine air originating from the Pacific Ocean moderates temperatures within the Inland Northwest, while continental dry and cold air from the east brings cold weather in winter and hot weather in the summer. The interaction of these air masses brings convective precipitation and lightning in summer, warm wet periods in the winter, and dry Arctic air brings damaging frosts in winter and cool periods in summer. These air masses along with the heterogeneous and rugged topography create a highly variable climate, which in turn, supports mosaics of compositionally and structurally diverse forests. Historically

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(1850-1900), 19% (27.4 million acres) of the Inland Northwest (144.2 million acres) was covered by dry forests, with 30% of them occurring below 4,000 feet and the remainder occurring at higher elevations. Moist forests covered 18% (25.9 million acres) of the region. The cold forests historically made up 10% of the area with 99% of them growing at elevations exceeding 4,000 feet (Fig. 1) (Hann et al. 1997).

MOIST FORESTS

Moist forests are the most productive of those occurring within the Inland Northwest and are located in the Northern and Southern Cascade Mountains in Washington and Oregon, Northern Idaho, western Montana, and the northern portion of central Idaho (Fig. 1). Western redcedar (*Thuja plicata*) (inland and eastern Cascades), western hemlock (*Tsuga heterophylla)* (inland and eastern Cascades), and the moist grand fir (*Abies grandis*)/white fir (*Abies concolor*) (inland and eastern Cascades) potential vegetation types (PVTs) typify these settings. They generally occur at elevations between 1,500 and 5,500 feet. The climate of these settings is typically mild with the majority of the precipitation falling from November through May, with amounts ranging from 20 to 60 inches (Graham 1990; Foiles et al. 1990).

Historically, fire regimes within the moist forests were highly variable. Nonlethal surface fires occurred at relatively frequent intervals (15–25 yrs) within 25% of the moist forests (Table 1). Lethal crown fires burned about 25% of the moist forests every 20–150 years but occasionally extended to 300 year intervals. The mixed fire regime (a combination of crown and surface fires) occurred across 50% of the moist forests at 20- to 150-year intervals with some lethal events occurring at 300-year intervals. Fires typically started burning in July and were usually out by early September. Most fires were small but occasionally large fires did occur with 74% of fires killing a portion of the canopy (Hann et al. 1997).

The biophysical settings and native fires allowed the moist forests of the Inland Northwest to develop a lush and complex suite of vegetation. The majority of the conifers occurring within the Inland Northwest with the exception of white bark pine (*Pinus albicaulis*), alpine larch (*Larix lyalii*), and the junipers (*Juniperus* spp.), and their dryland associates, grow in the moist forests. Depending on the disturbance history, the vegetation complexes ranged from early to late-seral and occurred within a landscape mosaic possessing all possible combinations of species and seral stages.

Historically, 29% of the moist forests were occupied by early-seral vegetation typified by lodgepole pine (*Pinus contorta*), western larch (*Larix occidentalis*), ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), and western white pine (*Pinus monticola*) (Table 2, 3). In general these species would regenerate and develop after fires killed the high forest cover. As these forests developed, tree classes would differentiate, with diameters ranging from 2 to 24 inches and most often mixes of these species would dominate the high forest cover for long periods (Table 4). Also during this time grand fir/white fir, western hemlock, and western redcedar would start occupying the smaller tree diameter classes (Table 3) (Haig et al. 1941).

Table 1.—Historical (1850-1900) and current (1991) fire regimes (nonlethal, lethal, mixed) of the Inland Northwest, the proportion of the cold, dry, and moist forests the fires burn, and the intervals at which the fires occur (Hann et al. 1997).

Forest	Historical fires (1850-1900)		Current fires (1991)	
	Area (%)	Intervals (Yrs)	Area (%)	Intervals (Yrs)
		Nonlethal surface		
Moist	25	15-25	10	75-100
Cold	10	30-100	10	75-100
Dry	80	< 20	45	40-80
		Lethal crown		
Moist	25	20-150 (300)[1]	60	75-100 (300)[1]
Cold	30	30-100	30	300
Dry	15	> 70	20	> 80
		Mixed surface/crown		
Moist	50	20-150 (300)[1]	30	75-100 (300)[1]
Cold	60	25-100	60	300
Dry	5	20-70	35	40-80

[1] Occasionally the fire return interval would extend to 300 years in these settings.

Table 2.—Historical (1850-1900) and current (1991) forest structures of the Inland Northwest and their proportion occurring in the cold, dry, and moist forests (Hann et al. 1997).

Forest	Forest Structural Classes by Percent				
	Grass/ forb	Early-seral	Mid-seral	Late-seral single story	Late-seral multi-storied
			Historical (1850-1900)		
Moist	0	29	41	11	19
Cold	0	23	53	8	15
Dry	19	18	30	22	12
			Current (1991)		
Moist	0	20	69	3	8
Cold	0	33	45	8	9
Dry	1	18	57	7	16

Table 3.—Examples of historical (1850-1900) species compositions of the moist forests within the Inland Northwest by structural classes (Haig et al. 1941).

Species	Forest Structural Classes by Percent		
	Early-seral	Mid-seral	Late-seral multi-storied
Lodgepole pine	3	1	0
Western larch	6	8	0
Ponderosa pine	0	9	0
Western white pine	44	45	14
Douglas-fir	3	12	0
Western hemlock	17	3	29
Grand fir	20	14	22
Western redcedar	7	4	35
Engelmann spruce	0	4	0

Mid-seral stages occupied 41% of the moist forests and were dominated by western white pine, Douglas-fir, and grand fir/white fir (Table 2, 3). Lodgepole pine, ponderosa pine, and western larch were less abundant in these mid-seral structures, while the closed canopy conditions and minimal forest floor disturbance of the mixed fire regime allowed western hemlock and western redcedar to become more abundant. In some settings the mixed fire regime allowed the mid-seral stage to move into late-seral stages. In general, tree diameters of this mid-seral condition ranged from 5 to 25 inches (Table 4) (Haig 1932; Hann et al. 1997).

Nineteen percent of the moist forests historically contained late-seral vegetation with multiple canopies and 11% contained late-seral vegetation with a single canopy (Table 2) (Hann et al. 1997). The late-seral stages of moist forests tended to be dominated by western hemlock and western redcedar with grand fir/white fir and western white pine being frequent associates (Table 3) (Haig et al. 1941). The mixed fire regime that historically occurred in these late-seral multi-canopied forests would maintain a highly diverse forest with tree ages ranging from 80 to over 420 years (Marshall 1928). Tree diameters in these multi-canopied forests were highly variable ranging from 2 to over 32 inches often containing over 4,000 trees per acre (Table 4) (Haig 1932; Daubenmire and Daubenmire 1968).

COLD FORESTS

Within the Inland Northwest, cold forests are a major component at high elevations which only occupy about 10% of the area. They occur primarily in northern Idaho, central Idaho, and in the Northern Cascades Mountains of Washington (Fig. 1). Growing seasons in cold forests are short, ranging from approximately 90 days at the lower elevations to just a few weeks at the higher elevations, and frosts can occur any time of the year. These forests are limited by poorly developed soils, and in some areas limited by moisture. Nearly all (99%) of the cold forests occur over 4,000 feet, but cold air drainage allows some cold forests to extend below 4,000 feet (Hann et al. 1997).

On settings dominated by subalpine fir (*Abies lasiocarpa*), mean annual temperatures range from 25–40°F. Precipitation generally ranges between 24 and 75 inches with the majority falling in the form of snow and sleet. Snow comes early and stays late and can reach depths over 500 inches on settings in the Cascade Mountains with lesser amounts where lodgepole pine persists (central Oregon and central Idaho) (Alexander et al. 1990). The soils supporting the cold forest are relatively young. They were covered by extensive mountain glaciers during the Pleistocene and have been free of ice less than 12,000 years. At the higher elevations, most soil parent material is alluvium or glacial tills, but soil surfaces range from very weakly weathered (cobbly with no organic layers) to thick soils composed primarily of organic materials.

The potential vegetation types dominating the cold forests include subalpine fir (with and without Engelmann spruce (*Picea engelmannii*), mountain hemlock (*Tsuga mertensiana*), and white bark pine and alpine larch PVTs

Table 4.—Examples of historical (1850-1900) diameter distributions of the moist forests within the Inland Northwest (Haig 1932, Daubenmire and Daubenmire 1968).

Forest structure and species	Diameter classes (inches)								
	0-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32+
	Trees per acre								
Early-seral	18	21	21	22	13	5	-	-	-
Mid-seral	-	4	20	25	26	20	5	-	-
Late-seral multi-storied									
W. hemlock	2100	44	11	44	44	22	11	11	11
W. redcedar	33	33	44	44	44	22	-	11	11
Grand fir	2100	-	-	11	-	-	-	-	-
Engelmann spruce	11	11	-	-	-	-	-	-	-
Douglas-fir	22	-	-	11	-	-	-	-	-
W. white pine	22	-	-	11	-	-	-	-	-
Total late-seral	4288	88	55	121	88	44	11	22	22

occurring at the highest elevations. Western larch and lodgepole pine are early-seral species in the subalpine fir/Engelmann spruce PVT, Douglas-fir and western white pine are mid-seral species, and western redcedar, grand fir, Engelmann spruce, and subalpine fir are late-seral. The mixes of these species occurring in the subalpine fir/Engelmann PVT are highly dependent on elevation (and associated climate) and disturbance frequency and type.

Depending on the physical setting, the cold forests of the Inland Northwest historically (1850-1900) burned at 25- to 100-year intervals. Approximately 10% of these forests were burned by nonlethal surface fires, every 30–100 years. Lethal crown fires burned 25–30% of the cold forests every 30–100 years with the longer intervals occurring in moist areas. During the short fire season (~ 60 days) a mixed fire regime burned about 60% of the cold forests at 25- to 100-year intervals, with occasional large fires occurring every 100 years (Table 1) (Hann et al. 1997).

Primarily in the subalpine fir PVT, fire maintained 23% of the cold forest in early-seral vegetation. In these areas lethal fires created ideal conditions (e.g., large, ~10 acre openings, burned over and mineral soil surfaces) for the regeneration of lodgepole pine. Extremely dense stands of lodgepole pine would develop, and without subsequent disturbance, they dominated settings for a 100 years or more. Under these conditions mean diameters likely ranged from 4 to 8 inches (Cole and Edminster 1985).

Historically, mid-seral structures occupied about 53% of the cold forests (Hann et al. 1997). A mixed fire regime in these forests along with periodic wind, floods, snow, and other small scale disturbances allowed uneven-aged and patchy stands to develop. Engelmann spruce, western redcedar, grand fir, mountain hemlock, and subalpine fir would readily regenerate in a variety of canopy conditions (gaps), giving rise to dense stands with many canopy layers. Trees in these mid-seral forests would range from two to over twenty inches with subalpine fir and Engelmann spruce dominating the small diameter classes and western white pine and Douglas-fir dominating the larger diameter classes (Elzinga and Shearer 1997). In the absence of lethal fires, the warmer forest settings containing lodgepole pine were readily succeeded by Engelmann spruce and subalpine fir.

Historically, late-seral multi-storied forests occupied 15% of the cold forests (Table 2) (Hann et al. 1997). They were dominated by subalpine fir and Engelmann spruce in all diameter classes with lodgepole pine and Douglas-fir intermittent associates. Tree densities over 11,500 trees per acre were common in these stands and the diameters of the subalpine fir and Engelmann spruce ranged from 1 to 28 inches. Occasionally, a few large, fire resistant Douglas-firs would be interspersed throughout these multi-storied forests (Franklin and Mitchell 1967). Nonlethal surface fires would encourage single canopies of subalpine fir, Engelmann spruce, or lodgepole pine to develop over approximately 8% of the cold forests. In some of the drier and colder portions of the cold forests a single canopy of lodgepole pine could persist for hundreds of years (Table 2).

Table 5.—Examples of historical (1850-1900) diameter distributions of the dry forests within the western United States.

Forest structure and species	Diameter classes (inches)						
	0-8	8-12	12-16	16-20	20-24	24-28	28+
	Trees per acre						
Early and mid-seral ponderosa pine multi-storied							
Avery et al. (1976)[1]	8	3	5	5	5	3	3
Meyer (1938)[1]	-	1	3	7	11	15	20
Reynolds et al. (1992)[1]	2	2	4	5	6	6	-
Late-seral ponderosa pine single story (PP PVT)[2]			11	55	55	-	-
Late-seral multi-storied (DF PVT)[2]							
Douglas-fir	239	200	11	43	11	-	11
Ponderosa pine	-	-	-	-	-	11	-
Late-seral multi-storied (GF PVT)[2]							
Grand fir	54	54	22	11	-	11	11
Douglas-fir	-	-	-	33	-	-	-
Ponderosa pine	-	-	-	-	-	11	-
Lodgepole pine	-	11	11	11	11	-	-
Total late-seral multi-storied	54	65	33	55	11	22	11

[1] Ponderosa pine diameter distributions from Avery et al. (1976) and Reynolds et al. (1992) were used for the southwestern United States and distributions from Meyer (1938) were used for the western United States.

[2] Inland Northwest diameter distributions for the ponderosa pine (PP), Douglas-fir (DF), and grand fir (GF) potential vegetation types (PVT) were adapted from Daubenmire and Daubenmire (1968).

DRY FORESTS

Within the Inland Northwest, approximately 30% of the dry forests occur below 4,000 feet with 70% occurring over 4,000 feet. They occupy settings in northeastern Washington, northeastern Oregon, central and southern Idaho, and south-central Oregon (Fig. 1). Soil parent material includes granites, metasediments, glacial till, basalts, and others. In areas where erosion has occurred, nutrients deficiencies can limit forest development. Vegetation in these types is usually limited by water availability and is often subject to drought. Douglas-fir (dry), ponderosa pine, grand fir/white fir (dry), and lodgepole PVTs dominate these settings. Western larch is always an early-seral species while grand fir/white fir and Douglas-fir are late-seral species, but ponderosa and lodgepole pine can play both roles depending on the PVT (Hann et al. 1997).

Fire, insects, diseases, snow, ice, and competition historically thinned these forests and surface fires provided opportunities for regeneration. Prior to suppression, wildfires burned these systems at < 20- to 70-year intervals. Historically, 80% of the dry forests were burned by nonlethal surface fires, 5% were burned by mixed fires, and 15% were burned by lethal crown fires (Table 1) (Hann et al. 1997).

In concert, these disturbances, historically maintained 19% of the dry forests in a grass, forb, and shrub stage for long (100's of years) periods (Table 2). Eighteen percent of these forests contained early-seral ponderosa pine with diameters ranging from 2 to over 28 inches depending on the setting and the disturbance frequency (Table 5) (Meyer 1938; Avery et al. 1976; Reynolds et al. 1992). As these multi-storied forests aged, they developed mid-seral structures and occupied approximately 30% of the dry forests (Table 2). Twelve percent of the dry forests contained stands (300–500 trees per acre) dominated by late-seral Douglas-fir and grand fir/white fir with multiple canopies. Tree diameters in these stands ranged from 2 to over 28 inches (Table 2, 5). Often, large, widely spaced (~100 trees per acre) ponderosa pines dominated 22% of the dry forests with the plurality of diameters ranging from 12 to 24 inches (Table 2, 5) (Daubenmire and Daubenmire 1968; Hann et al. 1997). But in some settings Douglas-fir and grand fir/white fir complexes would occupy the late-seral single storied forests.

HISTORICAL FORESTS WITH SMALL DIAMETER TREES

Historically, the Inland Northwest most likely included 13 million acres of cold forests, 23 million acres of moist forests, and 16 million acres of dry forest that contained small diameter trees (52.6 million acres or 36% of the area) (Table 6). Depending on the setting and the disturbances and their frequencies, the early-, mid-, and late-seral multistoried structures contained many small (< 12 inches) diameter trees. Four to six thousand small grand fir, western hemlock, and western redcedar per acre occupied the smaller diameter classes in the moist forests while more than 10,000 lodgepole pine, subalpine fir, and/or Engelmann spruce dominated the smaller diameter classes in the cold forests (Haig et al. 1941; Cole and Edminster 1985). Primarily because of the lower productivity in the dry forests compared to the moist and cold forests, fewer trees occupied the smaller diameter classes. However, there were likely hundreds of small diameter grand fir/white fir, Douglas-fir, ponderosa pine, or lodgepole pine per acre present in these early-, mid-, and late-seral multi-storied dry forests (Table 5).

CURRENT FORESTS

Land use changes in the last 100 years minimally impacted the amount forests occurring within the Inland Northwest. Agriculture, urban, and industrial uses replaced approximately 1.5 million acres of the dry forests, but the extent of the moist and cold forests remained similar to historical amounts (Hann et al. 1997). Fire control efforts have had little impact on fires burning the cold forests with 10% of them currently burned by nonlethal fires, 60% by mixed fires, and 30% by lethal fires. In contrast, fire suppression did change the moist and dry forests. Surface fires now burn 10% of the moist forests compared to 25% of the area that burned historically, mixed fires now burn 30% of the moist forests compared to 50% of the area that burned historically, and 60% of the moist forests are now burned by crown fires compared to 25% of the area that burned historically (Table 1). Frequent surface fires historically burned 80% of the dry forests and they now burn 45% of the area. Thirty-five percent of the dry forests are currently burned by mixed fires compared to 5% of the area that was burned by mixed fires historically. Similarly, crown fires now burn 20% of the dry forests compared to 15% of the area that crown fires burned historically. In addition to the significant changes in the amount of area burned in the dry forests, the fire return intervals have been significantly lengthened compared to those occurring historically (Hann et al. 1997).

Table 6.—Forest area historically (1850-1900) and currently (1991) containing small diameter trees (< 12 inches) within the forests of the Inland Northwest.

Forest structure	Forest		
	Moist	Cold	Dry
	Acres (millions)		
	Historical		
Early-seral	7.6	3.3	4.9
Mid-seral	10.6	7.8	7.9
Late-seral multi-storied	4.9	2.2	3.4
Total	23.1	13.3	16.2
	Current		
Early-seral	5.2	5.0	4.7
Mid-seral	17.9	6.9	14.5
Late-seral multi-storied	2.1	1.4	4.4
Total	25.2	13.3	23.6

The combination of fire suppression, harvesting, and the introduction of white pine blister rust (*Cronartium ribicola*) has led to an increase in the area and amount of small diameter trees occurring in the Inland Northwest. Primarily because of harvesting and to a lessor degree lethal fires, the greatest changes occurring in the cold forests over the last 100 years was the increase in early-seral structures (Hann et al. 1997). Small diameter lodgepole pine are the most common component of these early-seral stages. Likewise, small diameter subalpine fir dominate the lower canopy layers of the mid-seral and late-seral multi-canopied cold forests. Mid-seral forests now dominate the moist forest of the Inland Northwest. More important than fire exclusion, white pine blister rust devastated the moist forests removing western white pine, an early- to mid-seral species. Grand fir/white fir now occupy many settings that historically supported western white pine, and western hemlock and western redcedar prevail in the lower canopies. Thousands of small diameter trees per acre can occur in these mid-seral moist forests, eventually developing into late-seral forests with multiple canopies. Within the dry forests, successful fire exclusion and harvesting allowed dense stands of early-, mid-, and late-seral vegetation to develop. These settings often contain dense stands of small ponderosa pine, Douglas-fir, or grand fir/white fir vegetation complexes. In addition, small diameter trees now occupy all but one percent of the dry forests that were historically (19%) covered by grasses, forbs, and shrubs (Table 2).

CURRENT FORESTS WITH SMALL TREES

As with the historical forests, the current early-, mid-, and late-seral multi-storied structural stages contain hundreds to thousands of small (< 12 inches) diameter trees per acre. Even with aggressive harvesting and numerous wildfires, the amount of cold forests within the Inland Northwest containing small trees remained constant between historical and current times (13.3 million acres) (Table 6). In the moist forests, partially attributed to the substantial increase in the area occupied by mid-seral structures, there are now 2.1 million more acres containing small diameter trees than occurred historically. The largest increase in area containing small trees has occurred in the dry forests. Primarily because of fire exclusion, nearly 24 million acres of the dry forests currently contain small trees compared to 16 million acres that occurred historically. Most likely over 62 million acres (44%) of the Inland Northwest now contain small diameter trees compared to the 52 million acres (36%) of the area that contained small trees historically.

SUMMARY

Small trees were always a component of the forests within the Inland Northwest. Historically wildfires, the major disturbance of the area, regenerated small trees on tens of thousands of acres each year. The forest type and the subsequent native disturbances (nonlethal fires, wind, snow etc.) determined the amount, species, and character of the small trees occurring in these native forests. Moreover these disturbances along with the inherent productivity of the forest setting, would determine how these small trees would develop and how long it would take for them to grow into large trees. These disturbances, along with management activities, will determine how the small trees currently occurring on 62 million acres of Inland Northwest forest will develop. In the absence of extensive disturbances, creating new regeneration, the amount of small trees occurring the Inland Northwest will likely decrease as these forests grow. Instead of developing into forests dominated by large ponderosa pine and western white pine they will most likely develop into late-seral multi-storied forests dominated by grand fir, western hemlock, subalpine fir, and western redcedar.

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Author

Russell T. Graham
Research Forester
USDA Forest Service
Rocky Mountain Research Station
1221 S. Main
Moscow, ID 83843