# Chapter 3
# Affected Environment

Chapter 3 of this final environmental impact statement describes the affected environment for the six resource management plans of the planning area that are being revised.

### In this chapter:

# Summary of Major Changes between Draft and Final EIS/RMP

**Forest Structure and Spatial Pattern**

- The section (formerly called Ecology) was re-titled to better reflect the content of the analysis.
- Additional discussion of average historic conditions was added to clarify the historic period being referenced.
- Additional discussion of hardwood-dominated stands was added to describe available data.
- Explanation of the threshold value for the connectance index was added.

**Carbon Storage**

- A section describing carbon storage on BLM-administered lands was added.

**Socioeconomics**

- A discussion of non-market and non-timber related economics was added.

**Timber**

- Additional explanation regarding changes in timber inventory over time was added.

**Botany**

- Changes to special status species category names, species rankings, and additions and removals of species to the BLM special status species list were made based on revisions by Oregon BLM to the special status species policy.
- 82 of the 324 species listed in the Draft EIS were removed from the special status species list, and 49 new species were added to the list.

**Invasive Plants**

- The representative invasive plant species distributions and invasive plant distribution categories were updated.

**Wildlife (Northern Spotted Owl)**

- The narrative for the northern spotted owl was revised for consistency with the revised analyses in Chapter 4.
- The evaluation of suitable habitat was augmented to show the actual locations, sizes, and spatial arrangements of habitat blocks.
- The scale for evaluating dispersal between and within habitat blocks was modified according to current science.
- The analysis of "areas of concern" was refined.
- Evaluations were added to address the impact of wildfire to habitat and risks associated with the declining spotted owl population.

**Wildlife (other than Northern Spotted Owl)**

- The range of the marbled murrelet was modified to reflect a needed correction in the Medford District. Also, discussion related to structurally complex forest greater than 200 years of age was included to differentiate this habitat component from overall nesting habitat.

- The definition of potential bald eagle nesting habitat was modified to include only those forested stands within 2 miles of, and within line-of-sight of, foraging habitat.
- The narrative describing fisher natal habitat was revised to include a discussion of those structurally complex stands greater than 200 years of age, separate from the overall discussion of natal habitat.
- The land bird narrative was revised to better incorporate information from the Partners-in-Flight conservation strategies for land bird habitat in westside forests, nonforested habitat, and habitat in Eastside Management Lands. Also, the discussion of legacy components (i.e., snags, coarse woody debris, and green tree retention) was expanded.
- The special status species narrative was revised to facilitate effect analysis based on five broad categories of habitat types: (1) westside forest habitats; (2) habitat on the Eastside Management Lands (i.e., east side of the Klamath Falls Resource Area); (3) non-forested habitats; (4) riparian habitats; and (5) forest floor habitats.
- The cover discussion in the deer and elk narrative was revised to discuss hiding cover, not thermal cover.

**Water**

- Adjustments were made to the peak flow analysis.

**Fish**

- National Marine Fisheries Service Critical Habitat Analytical Review Team (CHART) information and maps were added.
- A comparison of fish distribution and high intrinsic potential streams was added.
- A comparison of high intrinsic potential stream locations and CHART watersheds was added.
- Adjustments were made to the large wood delivery model.
- A correlation between forest stand conditions and nutrient input was added.
- The description of current scientific information regarding the thresholds at which the effects of fine sediment occur for aquatic habitat and fish species was expanded to include sub-lethal effects and thresholds.
- Additional information on the current amount of fine sediment in stream channels in the planning area and on BLM-administered lands was added.
- The amount of turbidity impaired streams was updated for BLM-administered lands.
- The description of stream temperature standards was expanded to include ODEQ's Cold Core Water Habitat criterion.
- A summary of aquatic restoration that occurred from 1995-2004 was added.

**Fire and Fuels**

- Discussions of Fire Regime and Fire Regime Condition Class were expanded
- Information about Fire Regimes and Fire Regime Condition Classes was updated with the latest available Landfire information.
- Wildland Urban Interface mapping and information were updated and adjusted to include those areas under approved Community Wildfire Protection Plans as of January 1 2008.
- The discussions about weather effects and Burning Index were updated.

**Air**

- Terminology and mapping for Air Quality Management Areas were changed to incorporate changes in the State Air Quality Management Implementation Plan that took effect on January 1 2008.
- A graph showing past emissions by all landowners (both PM 10 and PM 2.5) was added.
- Estimated treatment acres were updated.

**Recreation**

- The total number of eligible wild and scenic rivers was reduced from the 101 river segments reported in the draft EIS to 57 in this final EIS. The draft EIS, in error, listed 44 rivers as eligible for designation that had already been studied and found not suitable for designation.
- The number of existing recreation sites and trails was refined to reflect a more accurate listing of the recreation features in the planning area. This resulted in the addition of 14 recreation sites and 5 trails.

**Soils**

- An estimate of the number of acres of residual compaction in the planning area was added.
- A section describing soil heating caused by wildfire or prescribed burning was added.
- The section on soil productivity was updated to include definitions of soil productivity and long-term impairment. The relationship of soil carbon and soil nitrogen was expanded to better describe their importance to long-term soil productivity.

**Grazing**

- The results of rangeland health assessments were updated.

**Areas of Critical Environmental Concern**

- Tables were modified to correct omissions and errors in the draft EIS.

**Cultural Resources**

- Cultural site occurrence was changed from district-based, to physiographic and drainage-based to more accurately show how humans used resources and land in the prehistoric period.
- Coastal shelf site types and presence of significant sites on BLM-administered land were added.
- Historic logging and mining site location predictors were added.
- Site numbers in the table were updated. Sites identified as historic sites in Klamath Falls Resource Area were reassigned to the archaeological sites category.

**Lands, Realty, Access, and Transportation**

- Data about land tenure zones and communication sites was corrected.
- Information about the proposed Palomar and Rub gas pipelines was included.

**Energy and Minerals**

- The description of geologic terrains was improved, and errors in the district-specific and summary tables of known and inferred mineral and energy occurrence potential were corrected.

# Introduction

*Chapter 3* describes the affected environment. The description of the affected environment is designed to support and facilitate the understanding of the analysis of environmental consequences presented in *Chapter 4*. The amount of information provided in this chapter is proportionate to the importance, scope, and sensitivity of the environmental consequences and is no longer than necessary to understand the analysis.

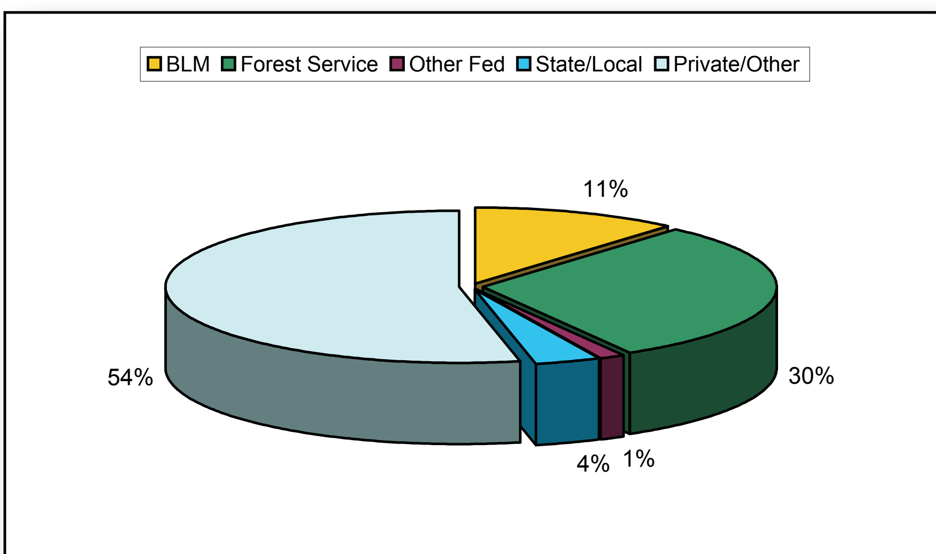
## Planning Area

The planning area for the six resource management plans that are being revised includes the public lands and resources administered by the Salem, Eugene, Roseburg, Coos Bay, and Medford Districts, and the Klamath Falls Resource Area of the Lakeview District. See *Map 3-1 (BLM-administered lands within the planning area).*

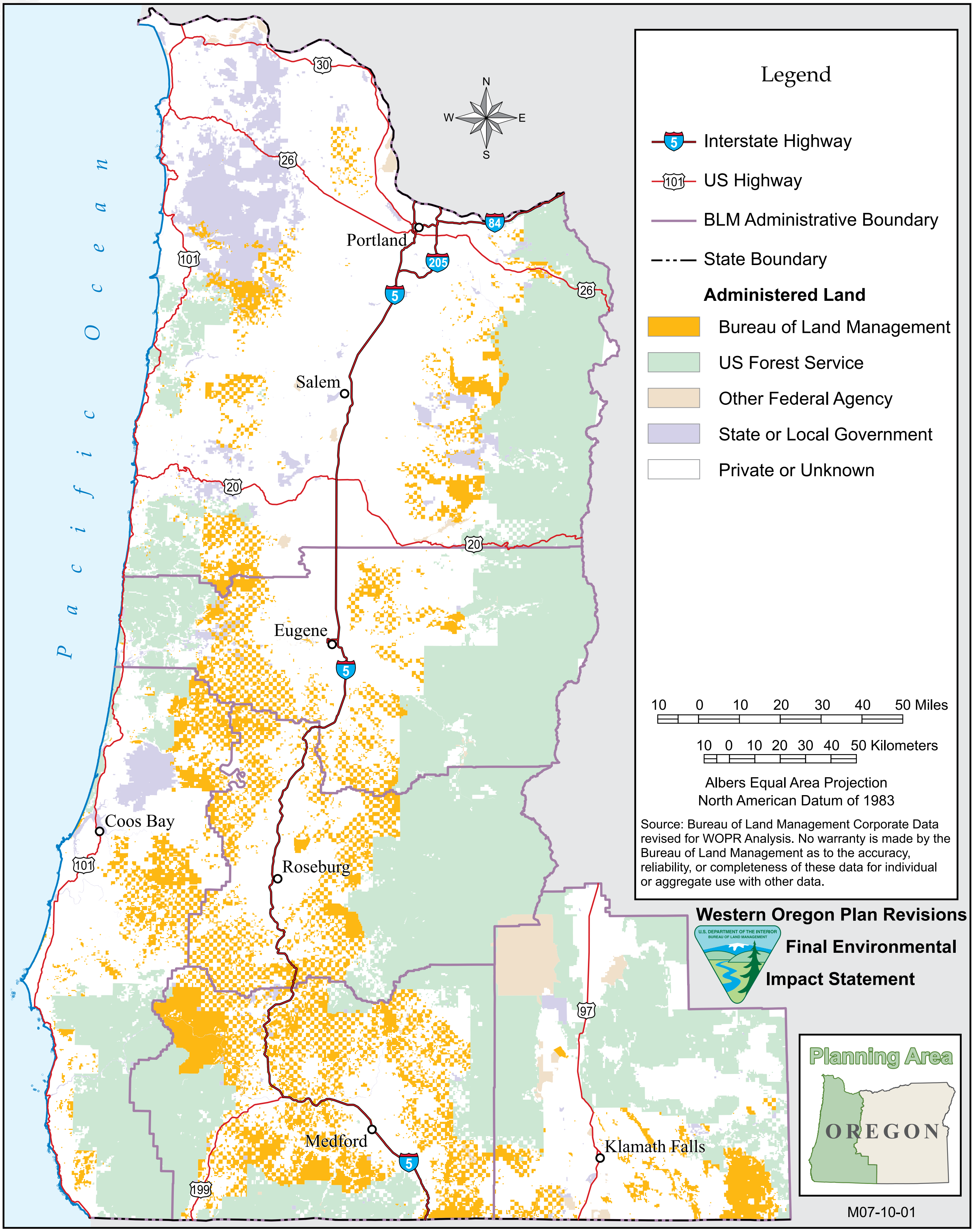
The entire planning area includes approximately 22 million acres, but only approximately 2.6 million acres are public lands administered by the BLM. The BLM-administered lands represent only about 11% of the planning area. The majority of lands within the planning area are owned and managed by private landowners and other government agencies. See *Figure 3-1 (Major ownerships within the planning area).*

There are five physiographic provinces within the planning area. See *Figure 3-2 (Physiographic provinces within the planning area).* Physiographic provinces vary by the type and structure of their vegetation and the differences in their hydrology, geology, and other processes (e.g., fire-return intervals) (FEMAT 1993).

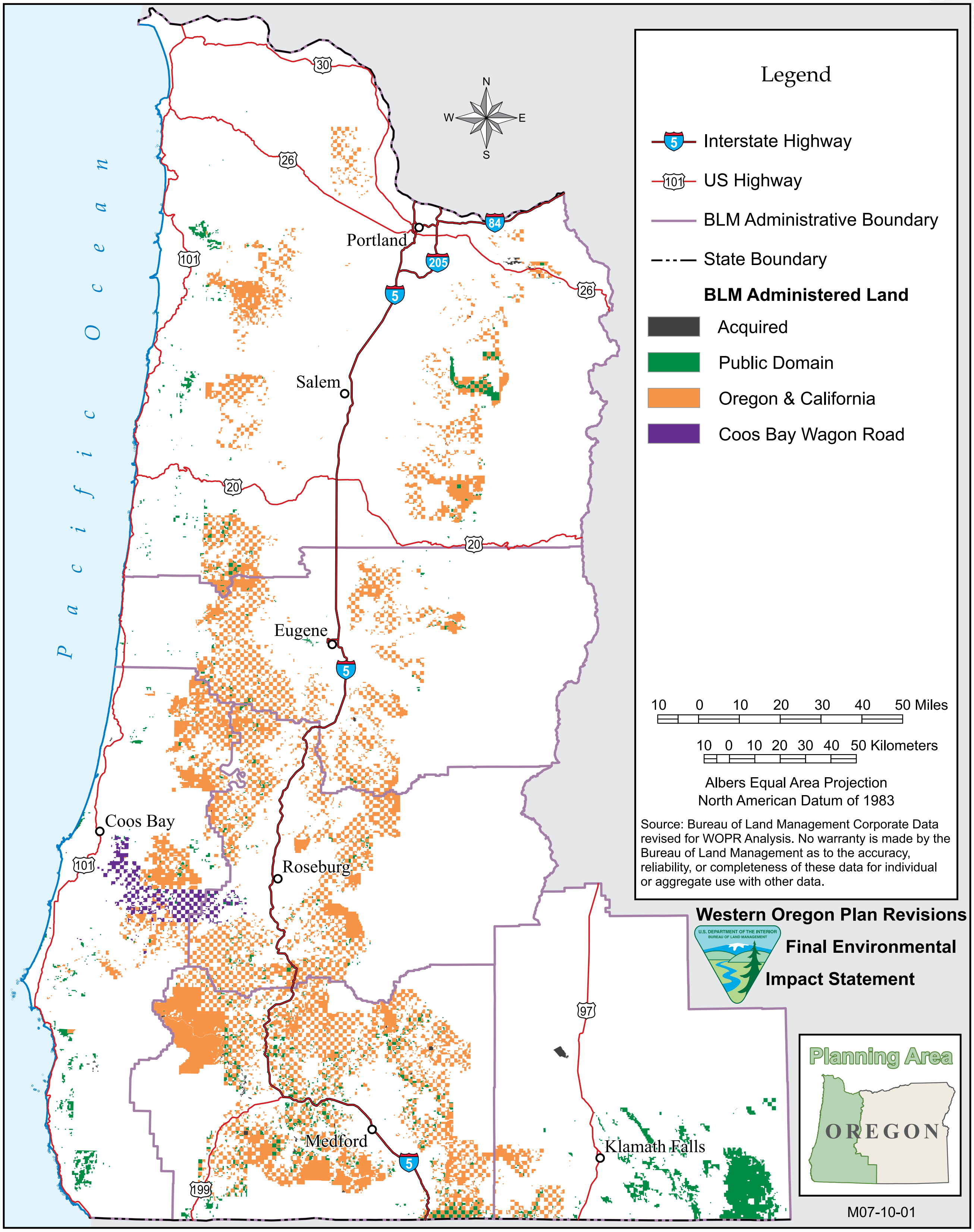
**Figure 3-1.** Major Ownerships Within The Planning Area



Map 3-1. BLM-Administered Lands Within The Planning Area



## Map 3-2. Public Domain And O&C Lands Within The Planning Area



# Land Ownerships Within the Planning Area

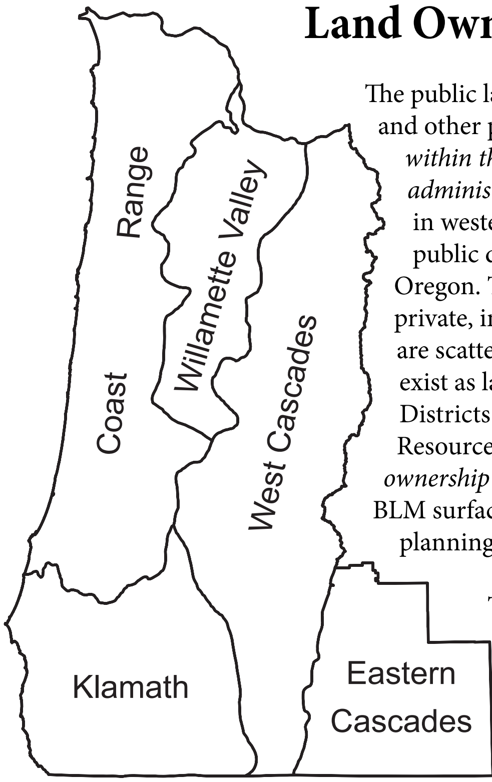



**Figure 3-2. Physiographic Provinces Within The Planning Area**

The public lands in Oregon include the O&C lands, public domain lands, and other public lands. See *Map 3-2 (Public domain and O&C lands within the planning area)* and *Table 3-1 (Legal status of the lands administered by the BLM within the planning area)*. The O&C lands in western Oregon are managed differently than the other public and public domain lands of Oregon that are located mostly in eastern Oregon. The O&C lands are mostly scattered and intermingled with private, industrial forest lands. About half of the public domain lands are scattered and intermingled with O&C lands, and the other half exist as larger blocks in the Salem, Coos Bay, and Lakeview BLM Districts (with the majority being concentrated in the Klamath Falls Resource Area of the Lakeview District). See *Figure 3-3 (BLM surface ownership by legal authority within the planning area)* for the amount of BLM surface ownership by source of administrative authority within the planning area.

The O&C land pattern has a checkerboard character that results from the grid of the Public Land Survey System. The O&C lands are generally located in the odd-numbered sections, and the intermingled private lands are in the even-numbered sections. A section in the checkerboard is normally one mile on a side and encloses approximately 640 acres. The BLM administers approximately 2.6 million acres of these checkerboard parcels of public land within the approximately 22 million acres that comprise the planning area.

*Figure 3-4* illustrates the intermingled checkerboard pattern of the BLM and private land ownerships. The BLM-administered lands in the figure are within the squares that contain the small polygons. Note that many parcels of BLM-administered lands are smaller than a square mile and are disconnected and isolated from other BLM-administered lands. The dark green areas in the image are older forests, and the brown areas are recently harvested units.

**Public Land Survey System**

For details about this system of subdividing and identifying public domain lands, see the following website: http://nationalatlas.gov/articles/boundaries/a_plss.html

**Table 3-1. Legal Status Of Lands Administered By BLM Within The Planning Area**

| BLM District | O&C Lands and Coos Bay Wagon Road Lands | Public Domain Lands | Other Public Lands | Total |
|---|---|---|---|---|
| | | (acres) | | |
| Salem | 349,300 | 51,600 | 2,100 | 403,000 |
| Eugene | 304,200 | 10,500 | 400 | 315,100 |
| Roseburg | 406,500 | 19,800 | 0 | 426,300 |
| Coos Bay | 279,400 | 41,800 | 1,500 | 322,700 |
| Medford | 764,900 | 96,100 | 4,800 | 865,800 |
| Klamath Falls Resource Area (Lakeview District) | 46,900 | 174,800 | 3,200 | 224,900 |
| **Totals** | **2,151,200** | **394,600** | **12,000** | **2,557,800** |

[a]Federal lands acquired by purchase or donation under an authorization other than the Federal Land Policy and Management Act.

**Figure 3-3.** BLM Surface Ownership By Legal Authority Within The Planning Area

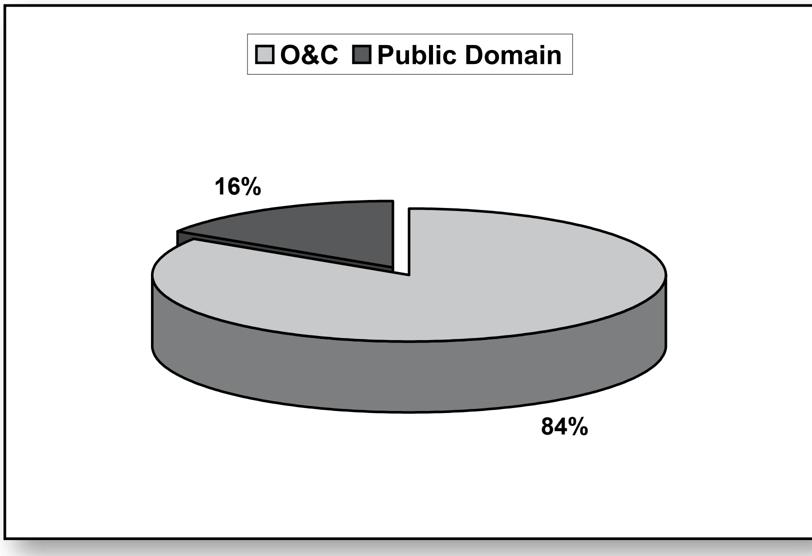
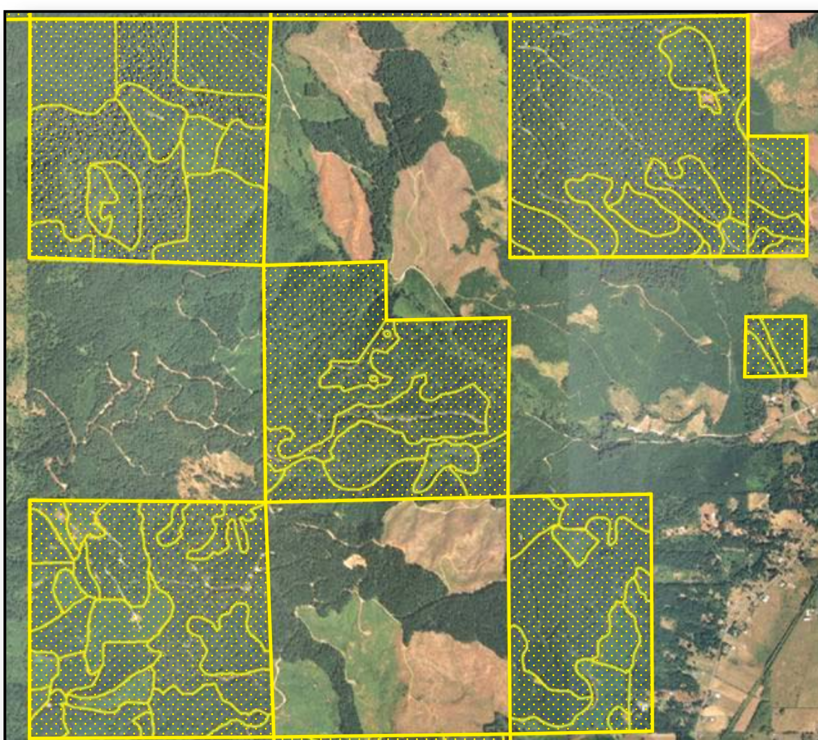



**Figure 3-4.** Sample Portion Of The Intermigled Checkerboard Of Private And BLM-Administered Lands



# Land Management

The existing land management plans for the individual national forests and BLM districts (including the six districts within the planning area) that are west of the Cascade Range in Washington, Oregon, and northern California incorporate the management direction contained in the Northwest Forest Plan. Most, but not all, of the planning area falls within the Northwest Forest Plan area. See *Figure 3-5 (Areas of the Northwest Forest Plan and the planning area)*.

The current vegetation condition of the private, state, and federal lands within the planning area was calculated using the 1996 satellite data from the Interagency Vegetation Mapping Project. This data includes the major fire and regeneration harvesting data that is available as of 2002. The vegetative condition of non-BLM lands varies from nonforest, to all four of the forest structural stage classifications (stand establishment, young, mature, and structurally complex).

**Figure 3-5. Areas Of The Northwest Forest Plan And The Planning Area**


The intensity of the land management activities across all ownerships within the planning area is partly indicated by the number of miles of roads that exist per square mile (i.e., road density). See *Figure 3-6 (Road density across all land ownerships within the planning area)*.

The BLM has also developed a geospatial database of the lands and resources it administers. This geographic information system contains data regarding various resources, including forests, streams, roads, recreation, and wildlife. This information was captured from on-the-ground surveys and aerial and satellite photography. See *Figure 3-7 (Example of geospatial data from the Forest Operations Inventory database)*.

*Figure 3-7* shows aggregated sections within individual forest stands. Non-BLM lands are not mapped. The areas mapped in the figure represent a

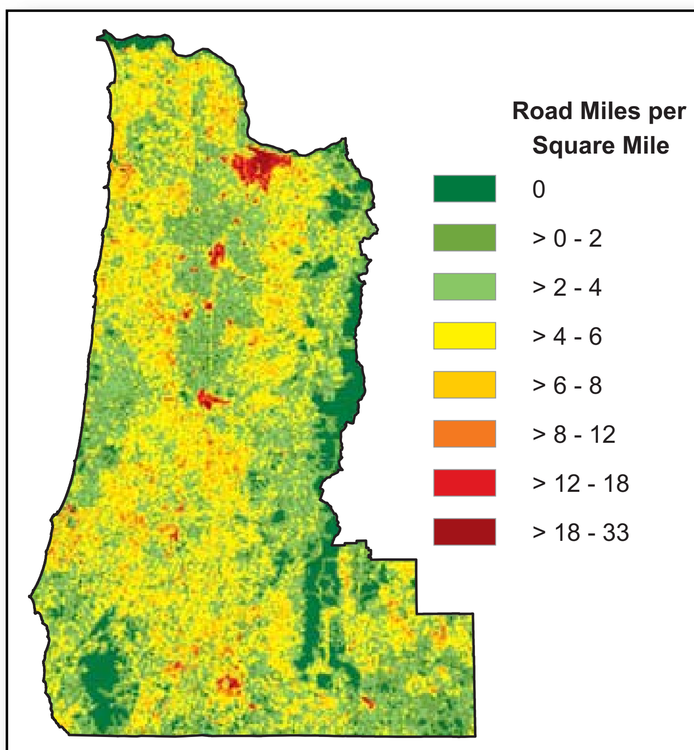
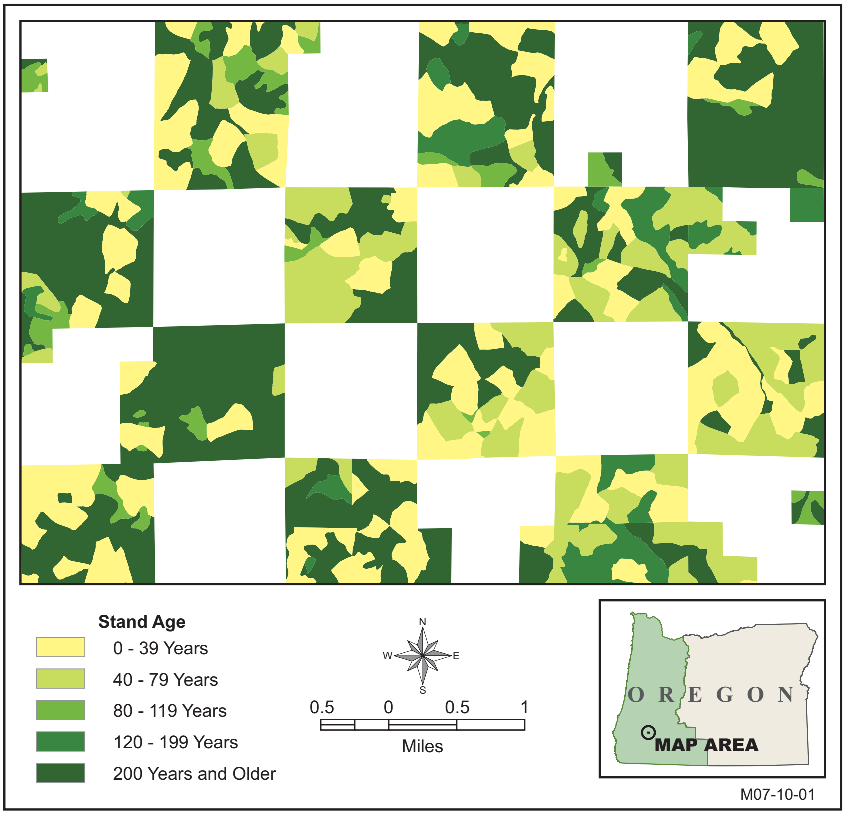



**Figure 3-6. Road Density Across All Land Ownerships Within The Planning Area**

somewhat typical BLM landscape, which is a mixture of older stands and younger stands that that have been harvested and replanted. These stands are intermixed on a larger landscape with private timber management, agriculture, and urbanization. The BLM manages more than 80,000 mapped individual stands.

**Figure 3-7. Example Of Geospatial Data From The Forest Operations Inventory Database**




Watersheds are also useful as a unit of measure for summarizing certain natural resources. There are 260 fifth-field watersheds, each averaging 87,000 acres in size, located all or partially within the planning area. For a discussion of watersheds, see the *Water* section in *Chapter 3*. See *Figure 3-8 (Fifth-field watersheds within the planning area)* for the size and distribution of these watersheds within the planning area.

The BLM in western Oregon is rarely the predominant landowner within a fifth-field watershed. See *Figure 3-9 (Two example watersheds showing various BLM ownership patterns)*. *Figure 3-9* shows that BLM ownership at the fifth-field watershed level ranges from a few scattered parcels to large areas. Therefore, activities on adjacent lands have implications for the management of BLM lands. The BLM's ability to influence resource outcomes often depends on the amount and location of its land ownership in relation to a particular resource. In this example, management of BLM-administered lands is more likely to affect fish populations in the Evans Creek watershed than in the Eagle Creek watershed.

More than half of the BLM lands are located within fifth-field watersheds where the BLM-administered lands comprise less than one-third of the watershed. By contrast, most of the lands managed by the Forest Service are in large, contiguous blocks. See *Figure 3-10 (BLM, Forest Service, and private ownership as a percent of the fifth-field watersheds within the planning area)*, which illustrates the comparative proportion of land ownership at the fifth-field watershed scale for the BLM, Forest Service, and private landowners. In only 8 of the 260 fifth-field watersheds within the planning area do the BLM-administered lands comprise the majority of the watershed.

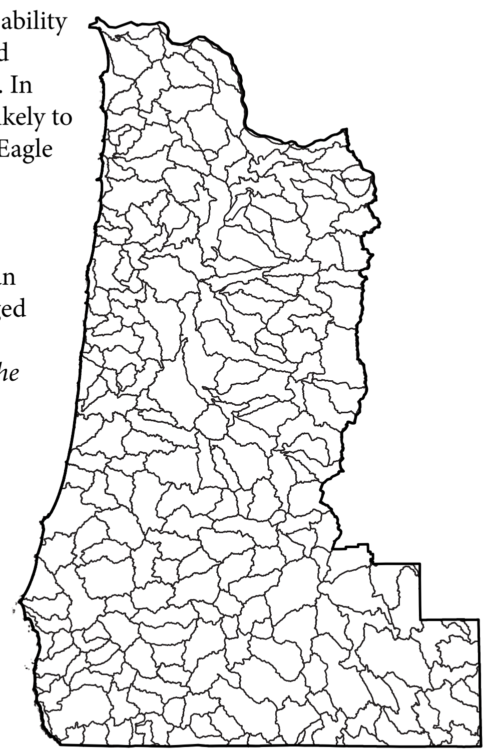


**Figure 3-8. Fifth-Field Watersheds Within The Planning Area**

**Figure 3-9. Two Example Watersheds Showing Various BLM Ownership Patterns**

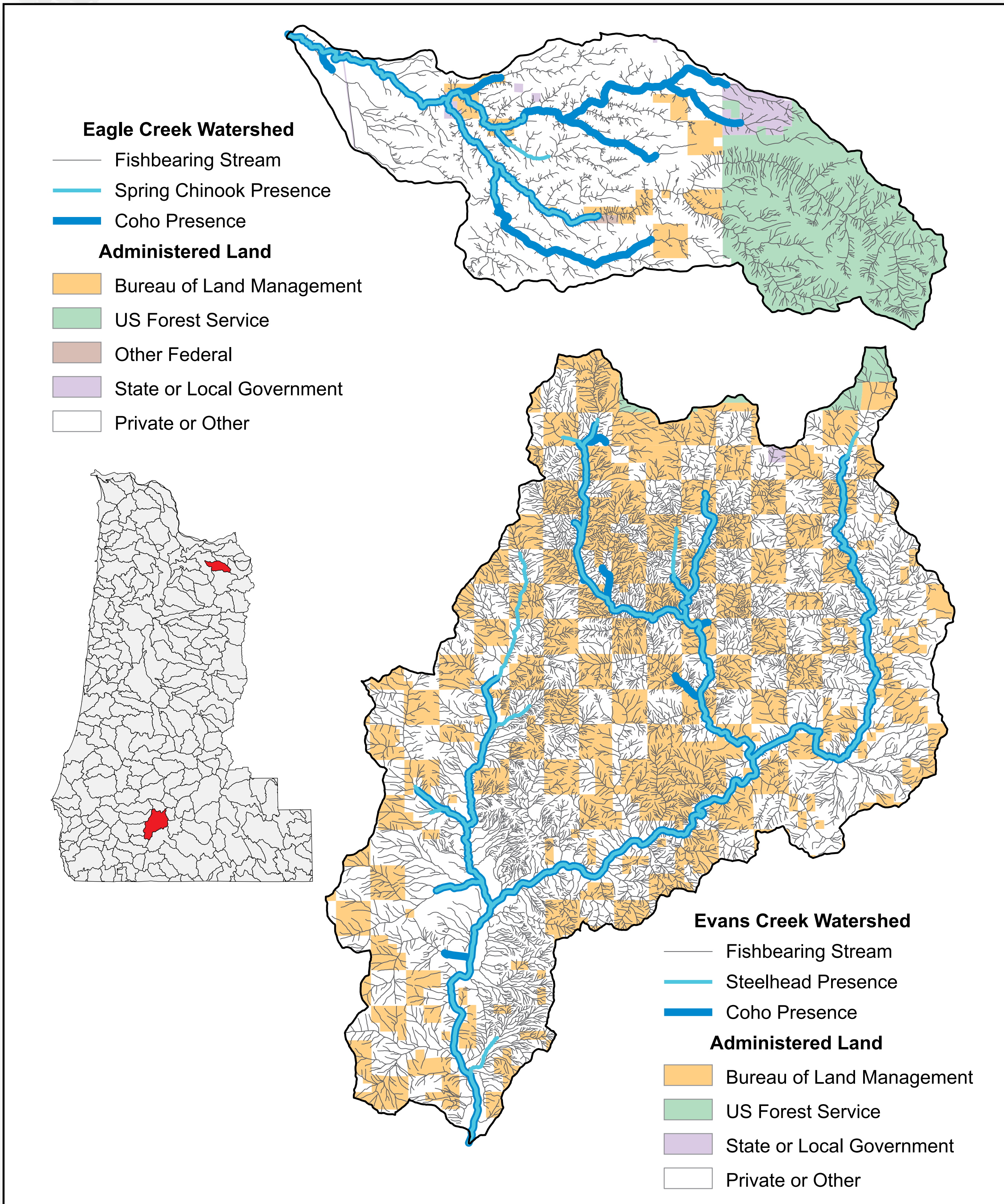
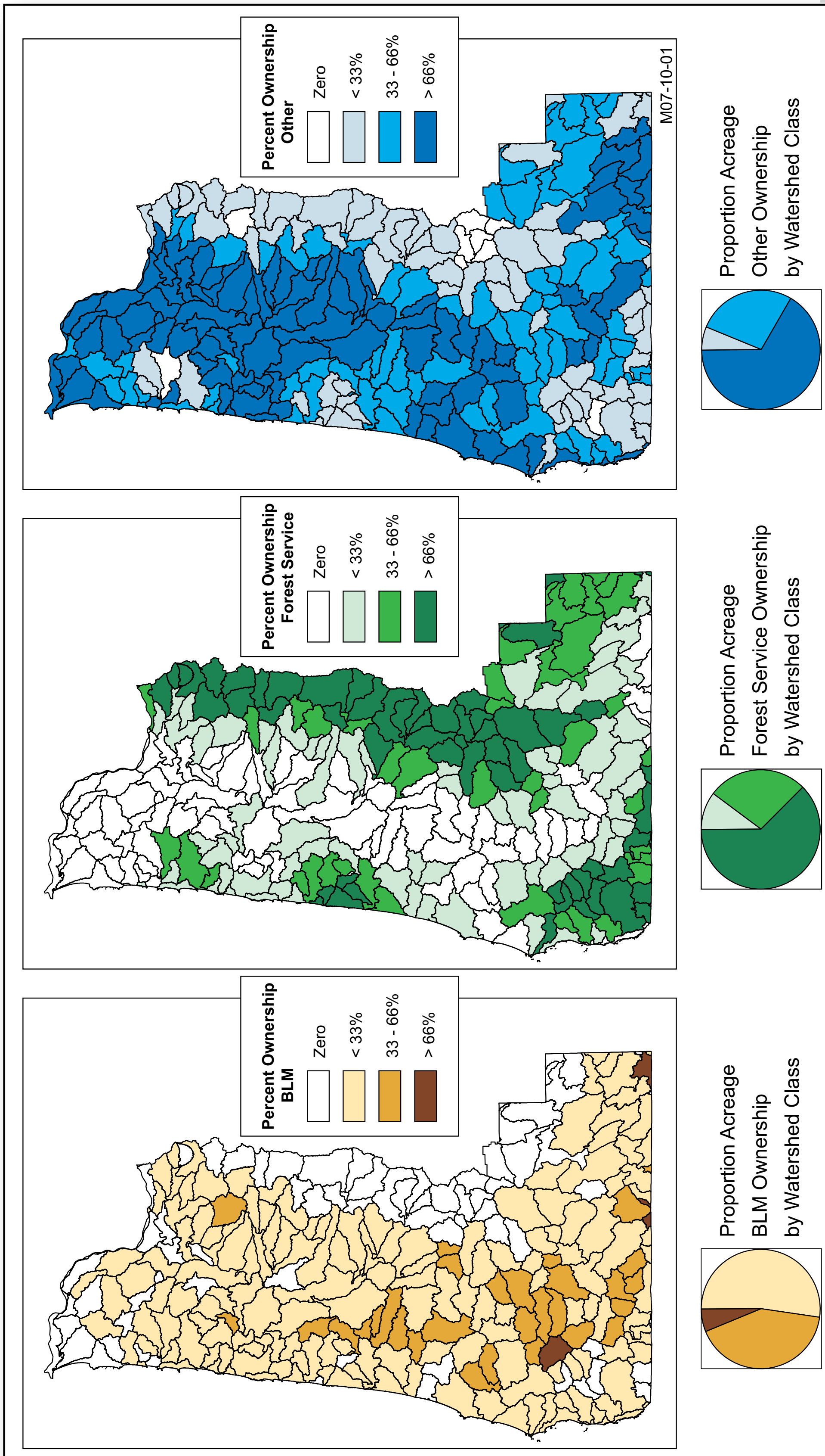


**Figure 3-10. BLM, Forest Service, And Private Ownership As A Percent Of The Fifth-Field Watersheds Within The Planning Area**



# Forest Structure and Spatial Pattern

**Key Points**

- The abundance of stand establishment forests is above the average for historic conditions.
- Stand establishment forests created by timber harvesting usually lack the habitat complexity and legacy components typical of stand establishment forests following natural disturbances.
- Stand establishment forests have declined on federally managed forests over the past decade and are becoming restricted to nonfederal lands.
- The abundance of young forests is above the average for historic conditions.
- Young forests on BLM-administered lands are predominately high-density, even-aged stands that are developing along a trajectory fundamentally different from that experienced by most of the existing structurally complex forests on BLM-administered lands.
- The abundance of mature and structurally complex forests within the planning area is below the average for historic conditions.
- The growth of forests into a mature and structurally complex forested condition has far outpaced the loss of mature and structurally complex forests from harvesting and wildfires within the planning area over the past 10 years.

This section of *Chapter 3* analyzes the ecological condition of conifer forests. Forest stands can be described by their structure, composition, and function. This analysis will focus on forest structure, because structure is the most easily analyzed, responds most predictably and apparently to management actions, and is closely related to many of the issues for analysis.

Structural development of conifer stands in the Pacific Northwest is a complex and continuous process. Pacific Northwest conifer forests are notable for the potential longevity and massive size of live trees and the enormous accumulations of coarse woody debris. Forest structure in the Pacific Northwest continues to develop for tremendously long time spans, perhaps even a millennium in the absence of stand-replacing disturbances (Spies 2004, Franklin et al. 2002). Therefore, there is more complexity in classifying the later stages of structural development in the conifer forests of the Pacific Northwest than in most forested regions.

The report titled *Forest Ecosystem Management: An Ecological, Economic, and Social Assessment* (FEMAT 1993) described ecological conditions throughout the range of the northern spotted owl. The FEMAT report described the history of forest management in the region (pp. II-2 and II-3), the terrestrial forest ecosystems with an overview of biological communities and ownership patterns (pp. IV-3 to IV-8), and the current forest conditions with an emphasis on the structure, composition, and processes of late-successional forests (pp. IV-8 to IV-12, IV-27 to IV-31). Those descriptions are incorporated by reference and the following paragraphs summarize them.

**FEMAT (Forest Ecosystem Management Assessment Team)**

The 1993 presidentially assigned team of scientists, researchers, and technicians from seven federal agencies that created the report used as the basis for the Northwest Forest Plan.

The final supplemental environmental impact statement (FSEIS)(USDA USFS and USDI BLM 1994b) for the Northwest Forest Plan also analyzed ecological conditions within the range of the northern spotted owl.

The Northwest Forest Plan FSEIS relied partly on the FEMAT report, which was included as an appendix to the Northwest Forest Plan FSEIS. The Northwest Forest Plan FSEIS provided some additional discussion within each of the descriptions incorporated below, and those analyses are incorporated by reference (pp. 3&4-11 to 3&4-29).

The FEMAT report and the Northwest Forest Plan focused on "late-successional and old-growth forest" (USDA USFS and USDI BLM 1994b, pp. I-4 to I-6). As defined in the FEMAT report and the Northwest Forest Plan, the concept of late-successional forest included both mature and old-growth forests (FEMAT p. IX-19, USDA USFS and USDI BLM 1994b, Glossary 9). The FEMAT report and the Northwest Forest Plan developed a management plan that was "based on returning the federal landscape toward an extent of old-growth forest more in line with what was here before widespread logging on federal lands. The historical extent was assumed to be adequate to sustain the native biological diversity associated with older forest" (Spies 2006, p. 83).

Late-successional forests are heterogeneous in structure and diverse in composition and function (FEMAT, pp. IV-28 to IV-31). Since publication of the FEMAT report in 1993, research has continued to refine scientific understanding of the development of existing late-successional forests. There are multiple developmental pathways to late-successional forest structure and composition across the region (Franklin and Van Pelt 2004, Spies 2004, Franklin et al. 2002). Research reconstructing the stand development of late-successional forests on BLM-administered lands in western Oregon suggests that large, old-growth trees generally developed under low stand densities (Spies 2006, Poage and Tappeiner 2002, Sensenig 2002, Tappeiner et al. 1997). In contrast, research done by Winter et al. (2002) that involved reconstructing a late-successional stand in western Washington concluded that the stand initiated under high-density conditions. Although the research by Winter et al. (2002) represents only a single stand, its contrasting finding to the above research suggests there may be strong regional differences in development of late-successional forest conditions. The large data set from BLM-administered lands within the planning area makes the conclusions from Poage and Tappeiner (2002) and Tappeiner et al. (1997) more relevant to this analysis.

The FEMAT report and the Northwest Forest Plan FSEIS described the role of silviculture, including the use of stand thinning, to accelerate development of late-successional forest structural characteristics and to reduce the risk of stand-replacing fire (FEMAT, pp. IV-33 to IV36; USDA USFS and USDI BLM 1994b, pp. 3&4-45, 3&4-47, 3&4-49). The Northwest Forest Plan FSEIS observed that late-successional forest development in young, managed stands may be retarded, or not occur at all, without silvicultural treatment (USDA USFS and USDI BLM 1994b, p. 3&4-49). Research in the last decade has reinforced the potential roles of silviculture and has provided a more detailed understanding of the effects of thinning on forest resources (Franklin et al. 2006, Spies 2006, Hayes et al. 2003, Muir et al. 2002, and Carey 2000). The monitoring report titled *Northwest Forest Plan–The First Ten Years (1994-2003): A Synthesis of Monitoring and Research Results* (commonly known as the *Monitoring Synthesis Report*) affirmed conclusions in the FEMAT report and the Northwest Forest Plan that thinning would restore ecological diversity and reduce the potential for loss from high-severity fires (Spies 2006:110-111).

# Forest Structure and Spatial Pattern at the Regional Scale

The analysis in this section of *Chapter 3* (*Forest Structure and Spatial Pattern*) will not provide a new analysis of forest conditions at the scale of the Northwest Forest Plan, which is the range of the northern spotted owl. The discussions below will summarize previous analyses and monitoring results and provide the context for this analysis, which is conducted at the scale of the planning area and physiographic provinces. The discussions below at the regional scale use the forest stage terminology (e.g., late-successional forest) of the original analyses rather than the structural stage classification terminology that was developed in this analysis.

The Northwest Forest Plan FSEIS evaluated the abundance of late-successional forest by comparing abundance under each alternative to estimates of historic conditions (USDA USFS and USDI BLM 1994b, pp. 3&4-36, 3&4-37):

- a "long-term average" of 65% of the region in late-successional forest, and
- a "long-term average low" of 40% of the region in late-successional forest.

The Northwest Forest Plan FSEIS estimated that there were 8.55 million acres of late-successional forest (described as medium and large conifer), which is approximately 35% of the 24.5 million acres of federally managed lands within the range of the northern spotted owl in 1994 (USDA USFS and USDI BLM 1994b, p. 3&4-27). The monitoring report titled *Northwest Forest Plan–The First Ten Years (1994-2003): Status and Trend of Late-Successional and Old-Growth Forest* (commonly known as the *Late-Successional Forest Monitoring Report*), using a similar definition but a remotely sensed data source, concluded that there were 7.87 million acres of late-successional forest on federally managed lands in 1994, and concluded that the plan was founded on valid assumptions about the extent of the remaining older forests (Moeur et al. 2005). The *Late-Successional Forest Monitoring Report* contains detailed descriptions of the abundance and distribution of late-successional forest by different measures, and those descriptions are incorporated by reference (Moeur et al. 2005, pp. 44-110).

**Physiographic province**

A region of the landscape with distinctive geographical features. There are five within the planning area:

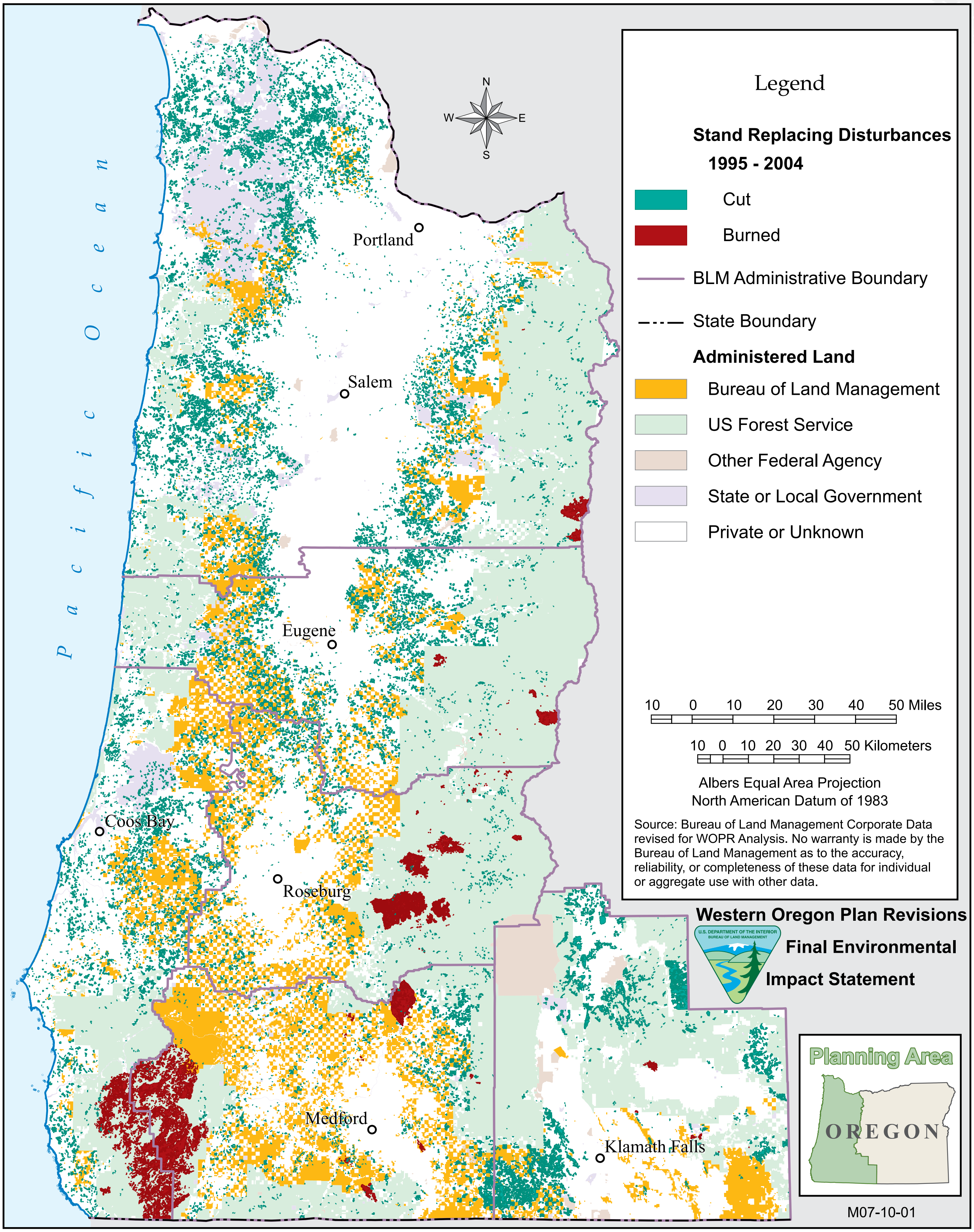
- Coast Range
- Eastern Cascades
- Klamath
- West Cascades
- Willamette Valley

Since 1994, there has been a net increase of late-successional forest approximately twice the increase anticipated in the Northwest Forest Plan FSEIS (Spies 2006; Moeur et al. 2005, pp. 39, 85-100, 104-106; USDA USFS and USDI BLM 1994b, p. 3&4-42). Growth of forests into the lower size range of late-successional forests has far outpaced losses of late-successional forest from harvesting and wildfire. See *Map 3-3 (Stand Replacing Disturbances, 1995-2004).* Harvesting of late-successional forest has been far below the amount anticipated in the Northwest Forest Plan FSEIS: 0.2% of late-successional forest was harvested over the past decade, compared to 3% anticipated in the Northwest Forest Plan FSEIS (Moeur et al. 2005, p. 106). Loss of late-successional forest from wildfire in total has also been less than the amount anticipated in the Northwest Forest Plan FSEIS: 1.8% of late-successional forest was lost to wildfire over the past decade, compared to 2.5% anticipated in the Northwest Forest Plan FSEIS (Spies 2006, pp. 84, 89). However, losses from wildfire have been higher in the Klamath Province. For additional discussion of wildfire, see section *Introduction - Incomplete or Unavailable Information - Natural Disturbance and Salvage* in *Chapter 4*.

At least 1.7 million acres of existing late-successional forests are in fire-adapted vegetation types that are characterized by high fire frequency and low fire severity in the Eastern Cascades and Klamath Provinces, and up to 1 million acres are in dry mixed conifer types in the West Cascades Province. The *Late-Successional Forest Monitoring Report* and the *Monitoring Synthesis Report* identified that this large acreage of late-successional forest that is susceptible to catastrophic wildfire may be a concern, and concluded that the possibility of major losses of late-successional forest in fire-prone ecosystems cannot be ignored (Spies 2006; Moeur et al. 2005, pp. 100-102, 107-108).

Nonfederal forests within the range of the northern spotted owl are predominately young, even-aged, managed stands, and provide mostly early and mid-successional forest habitat. The Northwest Forest Plan FSEIS characterized typical management on nonfederal forest lands as including timber harvesting in a stand's fifth or sixth decade (USDA USFS and USDI BLM 1994b, pp. 3&4-5 - 3&4-8). Since 1994, harvest rotations on forest industry lands have generally shortened (Nonaka and Spies 2005; Kennedy 2005, pp. 110-117; Alig et al. 2000, p. 9). The Northwest Forest Plan assumed that nonfederal forests would contribute

**Map 3-3. Stand Replacing Disturbances, 1995-2004**



little to late-successional goals, but the *Monitoring Synthesis Report* acknowledged that this assumption may not have been correct, and that nonfederal lands, especially state lands, provide substantial late-successional forest (Spies 2006, p. 108).

The implementation of the Northwest Forest Plan reduced harvest levels on federally managed forests from recent historic levels. The vast majority of harvests and subsequent creation of early successional habitat is now occurring on nonfederal lands. The *Monitoring Synthesis Report* acknowledged that the Northwest Forest Plan did not explicitly provide for the biological diversity that is associated with early successional habitats. The *Monitoring Synthesis Report* observed that nonfederal lands cannot be assumed to provide for these elements of biological diversity because of the lack of diverse, early successional habitat with structural legacies on nonfederal lands (Spies 2006, p. 109).

The FEMAT report and the Northwest Forest Plan FSEIS provided a brief, qualitative evaluation of the existing spatial patterns of late-successional forests. Those analyses stated that what little late-successional forest remained on private and state lands occurred in small, isolated patches, and that most late-successional forests on federal forests are highly fragmented by harvested areas and young stands (FEMAT, p. IV-12; USDA USFS and USDI BLM 1994b, p. 3&4-29). The Northwest Forest Plan FSEIS evaluated the spatial patterns of alternatives by the connectivity of late-successional forest—measuring the distances between late-successional forested patches (USDA USFS and USDI BLM 1994b, pp. 3&4-38 to 3&4-40). The Northwest Forest Plan FSEIS concluded that implementation of the Northwest Forest Plan would likely result in "moderate to strong" connectivity among late-successional forests (Spies 2006; USDA USFS and USDI BLM 1994b, pp. 3&4-44 and 3&4-46). However, that analysis did not project the retention or development of late-successional forests within the harvest land base unless explicitly reserved through the standards and guidelines (USDA USFS and USDI BLM 1994b, pp. 3&4-42 and 3&4-43).

# Forest Structure and Spatial Pattern at the Planning Area Scale

Forest conditions at the scale of the planning area are discussed in terms of the structural stages of forests and physiographic provinces. See *Figure 3-11 (Percent of BLM-administered land within each of the physiographic provinces within the planning area)* and *Figure 3-12 (Physiographic provinces and BLM lands within the planning area)*.

Forests are classified in this analysis by four structural stage classifications:

- stand establishment
- young
- mature
- structurally complex

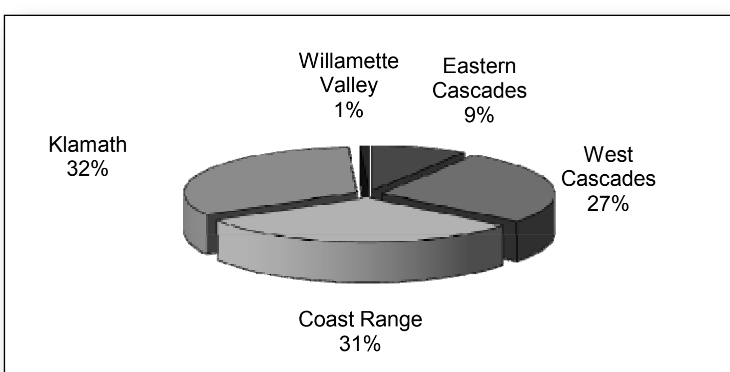
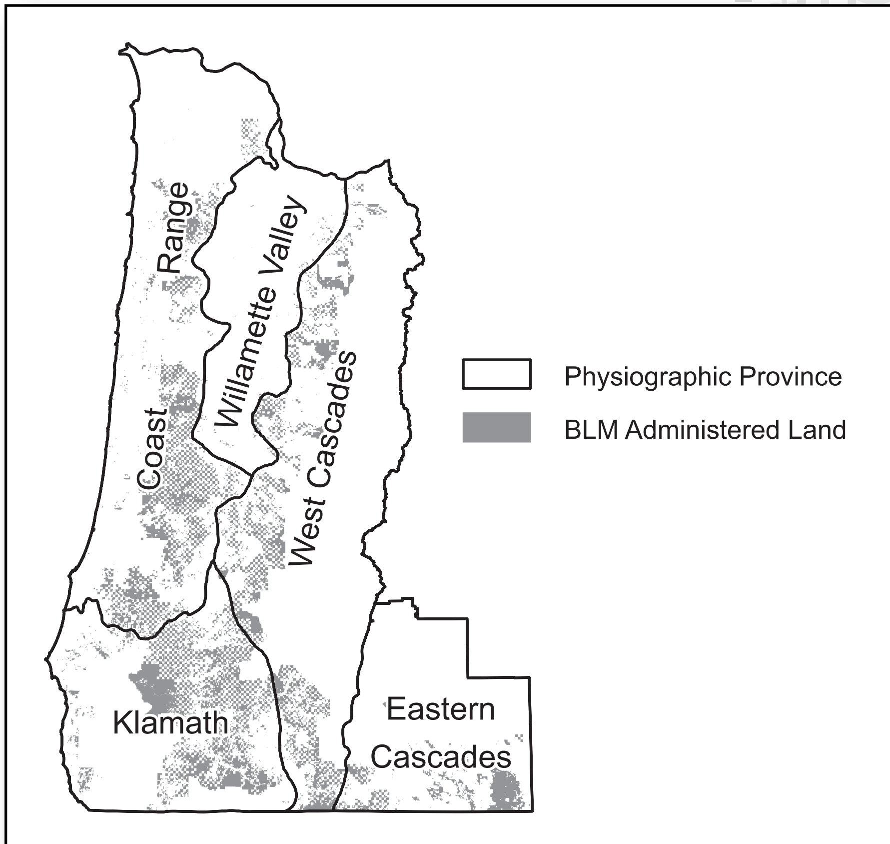



**Figure 3-11.** Percent Of BLM-Administered Land Within Each Of The Physiographic Provinces Within The Planning Area.

**Figure 3-12.**
**Physiographic Provinces And BLM Lands Within The Planning Area**




These four structural classes are further subdivided by additional structural descriptors. See *Table 3-2 (Structural stage subdivisions)*. Most discussions in this section will only use the four classes described above. The subdivisions are applied only to BLM-administered lands and are used in this section only where needed to address specific analytical questions. A detailed description of the structural classifications is provided in *Appendix B - Forest Structure and Spatial Pattern.*

This classification uses only measures of live trees. The dynamics of coarse woody debris and snags are integral to ecological definitions of late-successional forests, and there is an increasing understanding of the importance of dead wood in early-successional forests (Franklin et al. 2002, Spies and Franklin 1988). However, this classification does not include measures of dead wood because there is an inadequate inventory of dead wood (Spies 2006), a high variability of dead wood levels in unmanaged forests (Spies and Franklin 1991), and difficulty in modeling future creation of dead wood from such disturbances as fire or wind (Kennedy 2005: 97-160).

The stand establishment structural stage describes the early-successional conditions of a forest following such disturbances as timber harvesting or wildfires. This classification is comparable to the cohort establishment stage in Franklin et al. (2002). This classification is subdivided based on whether the new forest includes trees from the previous forest (with or without structural legacies). See *Figure 3-13 (Stand establishment forest with structural legacies)*. Natural disturbances within the planning area typically do not kill all trees within a stand, and surviving trees have important influences on stand development (Franklin et al. 2002, Aber et al. 2000).

**Table 3-2. Structural Stage Subdivisions**

| Structural Stages | Subdivisions | Descriptions |
|---|---|---|
| Stand Establishment | Stand Establishment without Structural Legacies | Very young forest (< 50 feet tall) without larger trees |
| | Stand Establishment with Structural Legacies | Very young forest (< 50 feet tall) with some larger trees |
| Young | Young without Structural Legacies | Taller than stand establishment, but still small (< 20 inches dbh) and without larger trees |
| | Young with Structural Legacies | Taller than stand establishment, but still small (< 20 inches dbh) and with some larger trees |
| Mature | Mature with Single-Layered Canopy | Larger trees (> 20 inches dbh) with little variation in tree size |
| | Mature with Multi-layered Canopy | Larger trees (> 20 inches dbh) with more than one canopy layer |
| Structurally Complex | Existing Old Forest[a,b] | Stands currently 200 years or older |
| | Developed Structurally Complex[c] | Larger trees (> 20 inches dbh) with some very large trees (> 40 inches dbh) and more than one canopy layer |

**Notes:**

[a]Stands identified in the current inventory as 200 years or older remain in this subdivision in the future unless harvested.

[b]A subset of this subdivision (Existing Very Old Forest, which represents stands that are 400 years or older) is also identified based on current inventory. The assignment of ages to these unmanaged stands is imprecise, but represents the only available data across BLM-administered lands within the planning area.

[c]Forests are classified in this subdivision if they have the structural attributes identified but are not 200 years or older in the current inventory. It includes stands that currently have the attributes of structurally complex stands and those stands that develop the attributes of structurally complex stands in the future.

Young forests approximate small conifer forests as used in the FEMAT report and the Northwest Forest Plan. This classification is subdivided, like stand establishment, based on whether the young forest includes trees from the previous forest. See *Figure 3-14 (Young forest without structural legacies)*. Young forests with structural legacies develop from stand establishment forests that have structural legacies. Young forests with structural legacies typically develop directly into mature forests with multi-layered canopies, whereas young forests without structural legacies typically develop into mature forests with a single-layered canopy.

Mature forests are defined similarly to mature forests as described in the FEMAT report and the Northwest Forest Plan

**Figure 3-13.** Stand Establishment Forest With Structural Legacies

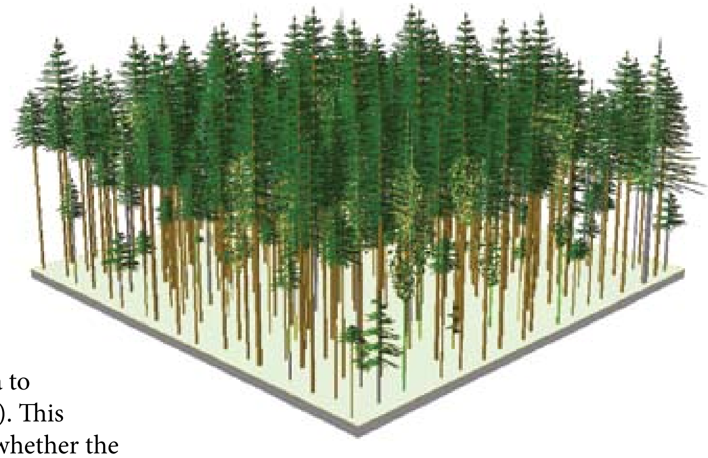


**Figure 3-14.** Young Forest Without Structural Legacies

(although the definition in this analysis uses a lower threshold for the density of large trees in the southern portion of the planning area to reflect the generally lower site quality). This classification is subdivided based on whether the forest has a single-layered or multi-layered canopy. See *Figure 3-15 (Mature forest with multi-layered canopies)*. Development of multiple canopy layers may arise from development of a new cohort of shade-tolerant trees below an older overstory, or from prolonged or continuous tree regeneration in open young forests. This classification uses the diversity of tree diameters as a surrogate for direct modeling of tree crowns. (Development of continuous tree canopies may also arise from canopy trees re-establishing lower branches as the stand becomes more open. This process would not be detected by the subdivision in this classification. However, this process is typically associated with later stages of stand development, and therefore is part of the structurally complex structural stage in this classification scheme,)

Mature forests with single-layered canopies typically must develop into mature forests with multi-layered canopies first, before developing into structurally complex forests. This is because one of the defining characteristics of structurally complex forests is multiple canopy layers. Mature forests with multi-layered canopies provide the precursors to structurally complex forests, ensuring a replacement of structurally complex forests that are removed by timber harvesting or natural disturbances. Mature forests with multi-layered canopies would provide more of the functions that are associated with structural complex forests, such as habitat for species that are associated with late-successional forests, than would mature forests with single-layered canopies (Spies 2006, p. 93; Washington State DNR 2005, pp. 9, 10).

Together, mature and structurally complex forests approximate what is termed late-successional forest in the FEMAT report, the Northwest Forest Plan, and the district resource management plans. Structurally complex forests approximate what is termed

- old-growth forests in many analyses (e.g., district resource management plans and environmental impact statements);
- medium and large conifer multistory forests in the FEMAT report; and
- large, multi-storied older forest in the *Late-Successional Forest Monitoring Report* (Moeur et al. 2005).

See *Figure 3-16 (Structurally complex forest)*.

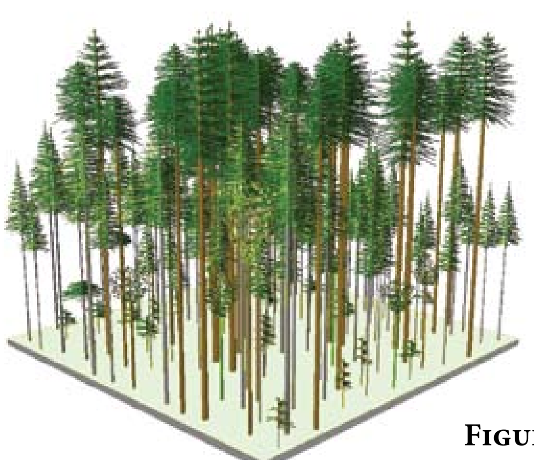
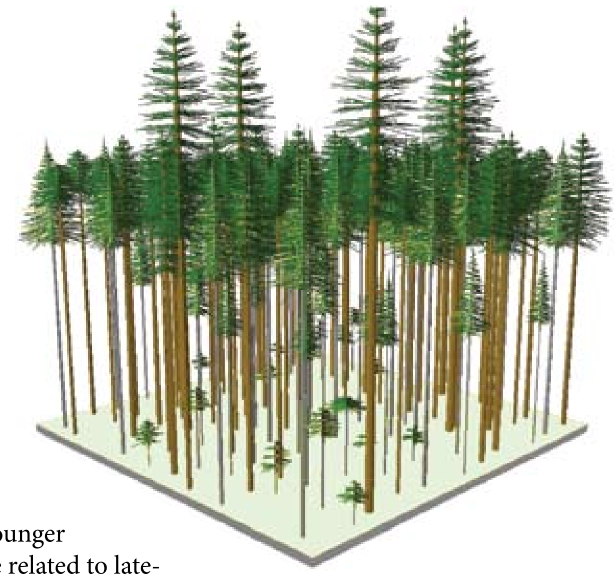


**Figure 3-15.** Mature Forest With Multi-Layered Canopies

**Figure 3-16.** Structurally Complex Forest



The structural development of structurally complex forests is a continuous and variable process, and the structure and composition of very old stands is not equivalent to those of the younger, less developed forests classified as structurally complex (Spies 2006, Washington State DNR 2005, Franklin and Van Pelt 2004, Spies 2004, Franklin et al. 2002). The structural complexity of forests continues to develop for many centuries after meeting the minimum criteria for a structurally complex forest (Franklin et al. 2002). The older, more complex forests provide superior habitat for some species, such as *Nephroma occultum* and *Pseudocyphellaria rainierensis*, that are slow to colonize habitats, are highly sensitive to disturbance, or prefer highly complex canopy structure (USDA USFS and USDI BLM 2004a). However, there is inadequate information to evaluate whether older structurally complex forests would provide superior habitat to younger structurally complex forests for most species that are related to late-successional forests.

This analysis does not classify forests by age alone (though some parts of the analysis use stand age), because stand age alone does not reliably describe the structural conditions of stands (Franklin et al. 2006, Spies 2006, Moeur et al. 2005, Spies and Franklin 1991, Spies and Franklin 1988). The rate of development of several forest structural characteristics that are relevant to the issues in this analysis, such as large individual trees and multiple canopy layers, depends partly on the forest management actions that would differ among the alternatives. This differential rate of structural development would be masked by classifying the forest solely by age. Furthermore, classifying stands by age is problematic in mixed-aged stands. Stand age is used here to distinguish between existing old forest and existing very old forest within the broader classification of structurally complex forests.

There is inadequate information on existing stands to distinguish among levels of complexity among structurally complex forests. Current structurally complex forests are mostly or exclusively unmanaged stands, and the BLM has less stand-level inventory information regarding these stands than for managed stands. Therefore, this classification describes a subdivision of structurally complex forest as existing old forest (stands identified in the current inventory as 200 years or older), and a further subset of this subdivision of existing very old forest (stands identified in the current inventory as 400 years or older). The assignment of ages to these unmanaged stands is imprecise and was usually made based on qualitative and subjective evaluation, but this represents the only available data on stand age across the BLM-administered lands within the planning area. The existing old forest subdivision and existing very old forest subset labels do not directly describe structurally complex stands with the greatest structural complexity. However, without more detailed stand structural information, these forests are most likely to have the most developed structure and the longest time since a disturbance of the structurally complex forests.

Some analyses have evaluated forest structural complexity using an index approach rather than discrete thresholds for classifications (Washington State DNR 2005, Spies and Franklin 1991, Spies and Franklin 1988). An index approach can be effective and informative when used to classify existing conditions at the stand level, if there is an abundance of stand-level data (Spies and Franklin 1991). However, an index approach would produce an analysis of bewildering complexity if used to analyze multiple alternatives modeled into the future.

The structural stages for all lands other than the BLM-administered lands are classified using data from the Interagency Vegetation Mapping Project (IVMP), which uses satellite imagery to classify attributes of forest vegetation. See *Appendix B - Forest Structure and Spatial Pattern. Moeur et al. (2005) discuss the accuracy of mapping forest vegetation from IVMP data and conclude that it provides the best practice for classifying forest vegetation across all ownerships in a region* (Moeur et al. 2005, pp. 18-30, 108, 109, 123-128). Those discussions are incorporated by reference. The BLM-administered lands are classified for both the current and future conditions based on the OPTIONS model outputs rather than IVMP data. For analyses across all ownerships, the four classes of structural stages defined above are reduced to three classes—combining structurally complex and mature, which is equivalent to late-successional forest in other analyses. The IVMP data cannot reliably distinguish between mature and structurally complex forests (Spies 2006; Moeur et al. 2005, pp. 103-104). This analysis will refer to this combined class as mature & structurally complex forest.

## Average Historic Conditions

This analysis compares the abundance and spatial patterns of the structural stages to average historical conditions, as did the FEMAT report and the Northwest Forest Plan FSEIS.

The FEMAT report estimated that 60 to 70% of the region was historically in mature and structurally complex forests (FEMAT, p. IV-51). At the scale of the physiographic provinces (e.g., the Coast Range), the amount of mature and structurally complex forests probably fluctuated between approximately 50% to 85% of the landscape (Spies 2006, Nonaka and Spies 2005, Wimberly 2002, Wimberly et al. 2000, Rasmussen and Ripple 1998). The FEMAT report (with its focus on late-successional forest) did not characterize the abundance or spatial patterns of forest conditions other than for late-successional forests.

This analysis uses descriptions of average historic conditions from Nonaka and Spies (2005) and the draft Rapid Assessment Reference Condition Model (USDA USFS and USDI BLM 2005a). Historic landscape conditions were dynamic, and the abundance of structural stages varied over time. Spies (2006) noted further that "no single point or short period can realistically be used to characterize this dynamic system." However, comparing effects over time under multiple alternatives to a range of conditions would have the following problems:

- There are no existing characterizations of the range of historic conditions that match the geographic scale of the planning area.
- The magnitude of the range of historic conditions is highly dependent upon the spatial scale of analysis, and the range is so wide at fine scales as to be uninformative (Wimberly et al. 2000).
- A comparison to a range of conditions would not provide for a clear comparison of the alternatives.

See *Appendix B - Forest Structure and Spatial Pattern* for the average historical conditions and the historic range of variability). Therefore, this analysis uses average historic conditions rather than a historic range of variability as a benchmark for comparing the effects of the alternatives.

For the entire planning area, this analysis uses average structural stage abundance and spatial patterns from Nonaka and Spies (2005), which modeled historic conditions in the Coast Range. This modeling of historical conditions was parameterized to historical fire regimes prior to Euro-American settlement around the mid-1800s (Nonaka and Spies 2005). Although this research was conducted on only a portion of the planning area, it presents the only available description of historic spatial patterns at a broad scale, and the abundance results are consistent with the region-wide estimates of late-successional forest in the FEMAT report. The age classes in Nonaka and Spies were combined for comparison to the structural stages in this analysis. Average historic conditions adapted from Nonaka and Spies approximately correlate to 5% stand establishment, 15% young, 25% mature, and 55% structurally complex.

Wimberly (2002) also modeled historical ranges of variability in the Coast Range and found slightly different median average values, which would correlate to 17% stand establishment; 21% young; 16% mature; 42% structurally complex. Forest classes were defined differently in Wimberly. Notably, Wimberly defined the early successional forests that correlate to stand establishment forests in this analysis more broadly than Nonaka and Spies defined them. Also, Wimberly assumed that both high-severity and moderate-severity fires reestablished early successional forests, whereas Nonaka and Spies assumed that only high-severity fires reestablished early successional forests (Nonaka and Spies 2005, p. 1737). Finally, comparison of mean averages from one model to median averages from another model is inherently problematic. Neither of these characterizations of average historic conditions is definitive, and this analysis is attempting to make use of average values rather than a range describing the variability of a dynamic system. Using the average historic conditions from Wimberly as a benchmark for the comparison of alternatives would necessarily yield different conclusions about the absolute relationship of the effects of a specific alternative to average historic conditions. However, using a different benchmark for average historic conditions would not alter conclusions about the relative effects of the alternatives.

For individual physiographic provinces, this analysis uses the description of structural stage abundance from the draft Rapid Assessment Reference Condition Model (USDA USFS and USDI BLM 2005a). These models derive historic abundances by modeling disturbance probabilities that are generated from mean fire-return intervals combined with the probabilities of other disturbances (such as wind, insect, and pathogens). These models describe the average amount of the landscape that would be expected in each of the broad vegetation classes, which are roughly equivalent to the structural stages used in this analysis. The Coast Range and West Cascades Provinces are compared to the Douglas fir hemlock wet-mesic model. (Note: Analysis of structural stage abundance by physiographic province splits the small acreage of BLM-administered lands in the Willamette Valley Province at Interstate 5 and combines the resultant portions with the Coast Range and West Cascades Provinces.)

The Klamath Province is compared to the mixed conifer-southwest Oregon model. The Eastern Cascades Province is compared to the dry ponderosa pine-mesic model. These reference condition models provide representative descriptions of common conditions in each province. However, the provinces include other models, some of which describe other patterns of abundance. For example, the Coast Range and West Cascades Provinces include the Douglas fir Willamette Valley foothills model, which describes more stand establishment and young forest (15% and 25%, respectively). The Klamath Province includes the Oregon coastal tanoak model, which describes more young forest (60%).

## Abundance of Structural Stages

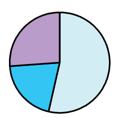
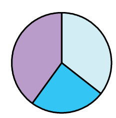
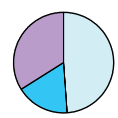
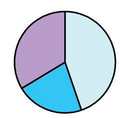
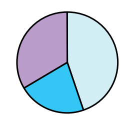
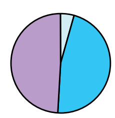
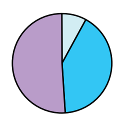
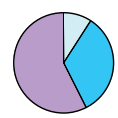
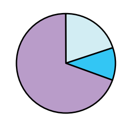
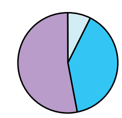
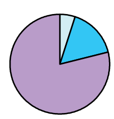
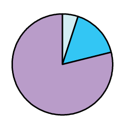
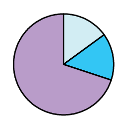
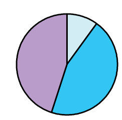
Stand establishment forests currently comprise 48% of the forested lands within the planning area across all ownerships. See *Table 3-3 (Current structural stage abundance on forested lands)*.[1]

Stand establishment forests have declined on BLM-administered and Forest Service lands and are becoming restricted to nonfederal lands. Despite the decline on federal forests, stand establishment forests across all ownerships are still above average historical conditions. Intensive forest management practices on forest industry lands (including site preparation, rapid and dense replanting, and herbicide application) simplify the structure and composition of stand establishment habitat and shorten the time until canopy closure. As a result, stand establishment forests created by timber harvesting lack the habitat complexity and legacy components typical of stand establishment forests following natural disturbances (Spies 2006, Ohmann et al. 2007, Cohen et al. 2002, Franklin et al. 2002, Aber et al. 2000, and Perry 1998).

On BLM-administered lands, stand establishment forests currently comprise 7% of forest-capable lands, which is close to average historical conditions. These forests are predominately (79%) stand establishment forests without structural legacies, resulting from regeneration harvesting before the Northwest Forest Plan.

[1]Current condition structural stage abundance differs slightly among the alternatives because of differences in how the inventory information is assembled for modeling under each alternative. The structural stage classification is made based on the Organon growth and yield curve attributes. The assignment of groupings of stands to specific yield curves varies among the alternatives, which results in slightly different current conditions. In addition, the classification for Alternatives 2 and 3 and the PRMP improved the identification of open water as non forest. The classification for Alternatives 2 and 3 and the PRMP for 2006 are largely similar, except that the classification for the PRMP resulted in the shift of acreage from young with structural legacy to stand establishment with structural legacy in the Medford District and the Klamath Falls Resource Area as a result of new growth curves developed for uneven-aged management. The following descriptions of current conditions use the 2006 data from Alternative 3.

**Table 3-3. Current Structural Stage Abundance On Forested Lands**

| | Coast Range | West Cascades | Klamath | Eastern Cascades | Total |
|---|---|---|---|---|---|
| Stand Establishment (1,000 acres) All (BLM only) | 3,393 (34) | 2,362 (48) | 1,812 (68) | 209 (5) | 7,776 (155) |
| Young (1,000 acres) All (BLM only) | 790 (340) | 1,295 (274) | 441 (278) | 159 (11) | 2,685 (902) |
| Mature & Structurally Complex (1,000 acres) All (BLM only) | 1,487 (370) | 2,694 (311) | 1,225 (427) | 211 (32) | 5,617 (1,140) |
| Total (1,000 acres) All (BLM only) | 5,670 (743) | 6,352 (633) | 3,478 (773) | 578 (49) | 16,078 (2,197) |
| Current Condition Percentage – all ownerships |  |  |  |  |  |
| Current Condition Percentage – BLM-administered lands only |  |  |  |  |  |
| Historical Average Condition of Forested Lands[a] |  |  |  |  | Stand Establishment<br>Young<br>Mature & Structurally |

[a]Source: USDA USFS and USDI BLM 2005a

Young forests currently comprise 17% of the forested lands within the planning area across all ownerships. See *Table 3-3 (Current structural stage abundance on forested lands)*, which is above average historical conditions. Young forests on BLM-administered lands are predominately high-density, even-aged managed stands. Most of these stands were established following timber harvesting and intensive site preparation practices. This management history has created stands with a homogeneous structure, uniform tree composition, and high tree density. These young forests are developing along a trajectory that is fundamentally different from that experienced by most of the existing structurally complex forests on BLM-administered lands (Muir et al. 2002, Poage and Tappeiner 2002, Sensenig 2002, and Tappeiner et al. 1997).

On BLM-administered lands, young forests currently comprise 41% of forest-capable lands. These are predominately (78%) young forests without structural legacies.

Mature and structurally complex forests together currently comprise 35% of forested lands within the planning area across all ownerships. See *Table 3-3 (Current structural stage abundance on forested lands)*. The abundance of mature and structurally complex forests within the planning area is well below the average historical condition of 80%.

On BLM-administered lands, mature and structurally complex forests together currently comprise 52% of forest-capable lands. Mature forests comprise 27% and structurally complex forests comprise 25% of forest-capable lands. Mature forests are predominately (82%) mature forests with multi-layered canopies. Structurally complex forests are predominately existing old forest (60%) with a smaller amount of developed structurally complex (37%) (i.e., stands that meet the defining attributes of structurally complex but are identified as less than 200 years old in the current inventory), and only a very small amount of existing very old forest (3%). While establishing accurate stand ages for unmanaged stands is problematic, as described above, structurally complex forests on BLM-administered lands are dominated by stands that are less than 400 years old. This is in contrast to the extensive acreage of structurally complex forest in national forests in the West Cascades Province (most of which is 400 to 500 years old) (Weisberg and Swanson 2003).

Hardwood stands are typically dominated by red alder or big-leaf maple in the Coast Range and West Cascades Provinces, by madrone and oaks in the Klamath Province, and by tanoak in the coastal portion of the Klamath Province. Hardwood stands provide many ecological functions that are distinct from conifer stands and are hotspots for biological diversity (Kennedy and Spies 2005). Red alder stands are particularly noted for nitrogen fixation and high-nitrogen litter (Harrington 2006, Compton et al. 2003). The nitrogen levels in alder stands generally contribute to high growth rates for trees, but nitrogen inputs by alder stands on sites that are already nitrogen rich may lead to nutrient imbalances, which may predispose coastal Douglas fir stands to intensification of Swiss needle cast disease (Perakis et al. 2006, Compton et al. 2003, Maguire et al. 2000). Other hardwood stands (especially dry upland sites dominated by oaks, madrone, or tanoak) are characterized by lower soil fertility and have nitrogen levels that are more limited.

It is not possible to quantify the abundance or to map the location of hardwood stands at this scale of analysis. Hardwood stands are often interspersed with conifer stands throughout the planning area. For example, red alder-dominated riparian stands are typically classified in the forest inventory together with the adjacent upland conifer stand as "northern hardwood mixed." In southwestern Oregon, oak, madrone, or tanoak stands are typically finely interspersed with conifer stands without discrete boundaries. Both cases generally result in classifying the hardwood stand together with mixed or conifer-dominated stands in the forest inventory. Therefore, the acres identified in the forest inventory as "northern hardwood mixed" or "southern hardwood" over-estimate the abundance of hardwood stands. The current abundance of "northern hardwood mixed" or "southern hardwood" acres on BLM-administered lands is 8% of forest-capable acres across the planning area: 14% of forest-capable acres in the Coast Range; 8% in the West Cascades; 4% in the Klamath; and 1% in the Eastern Cascades. In the Coast Range Province, Ohmann et al. (2007) modeled hardwood stand abundance as approximately 7% of the landscape across all ownerships. Hardwood abundance across all ownerships is likely lower in the West Cascades and Eastern Cascades Provinces, and higher in the Klamath Province.

## Spatial Patterns of Structural Stages

The spatial arrangement of forest structural stages influences fundamental ecosystem processes, such as the flows of energy, materials, and organisms (Nonaka and Spies 2005, Forman 1995). In addition to the abundance of structural stages, this analysis describes the spatial patterns of structural stages to evaluate forest fragmentation and connectivity.

Fragmentation is the breaking up of large habitat areas into smaller patches. Fragmentation is often coupled with habitat loss. The two processes together have a cumulative effect that can result in an overall reduction in biological diversity. The populations of species that are associated with mature & structurally complex forests are more likely to decline in a fragmented landscape because of the smaller patches of suitable habitat and the greater isolation from neighboring populations (Jules 1998; Forman 1995; USDA USFS and USDI BLM 1994b, pp. 3&4-29 to 3&4-31). As habitat is fragmented, the connectivity of the habitat decreases. Beyond some threshold, fragmentation disrupts connectivity of the habitat and contributes to population declines. Such thresholds are poorly understood for most species and depend on the scale at which a species interacts with its habitat (With and Crist 1995).

Larger habitat patches can support greater species diversity. For many species that are associated with mature & structurally complex forests, patches below a certain size are no longer suitable habitat. However, these minimum patch sizes are highly species-specific (to the limited extent they have been quantified). For example, Carey et al. (1992) suggest that a breeding pair of northern spotted owls requires a mature & structurally complex forest patch of about 2,000 acres in mixed conifer forests, whereas marbled murrelets use much smaller patches for nesting (ranging from 7 to 368 acres) (Ralph et al. 1995). Smaller patch size leads to increased amounts of edge habitat and decreased amounts of interior forest habitat. Edge habitats are created where contrasting habitat types abut. Edges between mature & structurally complex forests and stand establishment or young forests are characterized by altered microclimate and altered biological interactions (Forman 1995, pp. 412-415). The depth of edge habitat varies for specific biophysical characteristics and ecological processes, and is strongly influenced by the degree of contrast between habitat types and such physical conditions as slope and aspect. This analysis examines spatial patterns of the forested landscape using FRAGSTATS, a spatial patterns analysis program for categorical maps. See *Appendix B - Forest Structure and Spatial Pattern*. FRAGSTATS quantifies the aerial extent and spatial configuration of patches within a landscape. The user defines and scales the landscape (including the extent and grain of the landscape) and the scheme upon which patches are classified and delineated.

For a given landscape mosaic, FRAGSTATS computes several metrics for:

- each patch in the mosaic
- each patch type (class) in the mosaic
- the landscape mosaic as a whole

For this analysis, patches are delineated as stand establishment, young, or mature & structurally complex forest. As noted above, the IVMP data used to classify non-BLM-administered lands cannot reliably distinguish between mature and structurally complex forest, and therefore these structural stages are combined for this portion of the analysis. Additionally, the contrast between mature and structurally complex forest patches is too low to constitute an edge for many important ecological processes (such as the habitat for the northern spotted owls). Nonforest is not included in the spatial analysis.

The FRAGSTATS produces a wealth of metrics, many of which are highly correlated. For any given analysis of spatial patterns, many of the metrics do not reveal clear patterns. This analysis uses the following metrics:

- mean patch size (mean average of the distribution of patch sizes); and
- connectance index (number of functional joinings between patches of the same structural stage; this analysis defines patches as functionally joined if they are within 1,969 feet [600 meters]). This threshold distance represents the approximate distance within which northern spotted owls are expected to be able to move freely between stands of suitable habitat (Lint 2007 *personal communication*). This threshold distance does not provide an analysis of how well-connected habitat patches are for all species, because the effects of habitat fragmentation are highly species-specific. However, this threshold distance provides analysis directly applicable to northern spotted owls and generally relevant for highly mobile species associated with mature and structurally complex forests.

Results for additional metrics are included in the *Appendix B -Forest Structure and Spatial Pattern*.

Spatial patterns are analyzed by province for BLM-administered lands, because the entire planning area comprises too large a database for computing many of the metrics. For all ownerships, even the province comprises too large a database for computing most metrics, including connectance. Therefore, only mean patch size is computed for all ownerships at the province scale. See *Table 3-4 (Current mean patch size by structural stage by province)*.

The changes in spatial patterns over time from this analysis can be compared to the measures of spatial patterns from other studies or estimates of average historic conditions of spatial patterns to provide a qualitative evaluation of overall trends. However, a direct comparison of the absolute values of the spatial pattern measures should be made with caution. Measures of spatial patterns are highly dependent on the spatial extent of the analysis, the resolution of the data (i.e., the grain size), and the classification scheme (in this analysis, the structural stage classification). As these factors differ, the absolute values in the results will differ. For example, connectance is higher in the Eastern Cascades Province than in other provinces for all structural stages partly because the spatial extent of this province is much smaller than the other provinces. See *Table 3-5 (Current connectance on BLM-administered lands by structural stage by province)*. The spatial extent, grain size, and classification scheme in this analysis differ from studies of historic spatial patterns within the planning area (Nonaka and Spies 2005, Wimberly 2002). Therefore, the results from this analysis should be compared to the results from those studies only to evaluate relative trends in spatial patterns, not to make a direct comparison of the absolute values of the specific spatial pattern measures.

# Forest Structure and Spatial Pattern at the Province Scale

The FEMAT report and the Northwest Forest Plan FSEIS provided general descriptions of the existing conditions at the province scale (FEMAT, pp. IV-6 to IV-11; USDA USFS and USDI BLM 1994b, pp. 3&4-16 to 3&4-28), but did not explicitly analyze the effects of the alternatives at the province scale. The six resource management plans and environmental impact statements (RMPs/ EISs) for the six districts within the planning area described the vegetation communities, the characteristics of the stages of forest development, and the biological diversity and ecological health of the forest ecosystems within each BLM district. Each district analysis concluded, consistent with the FEMAT report and Northwest Forest Plan FSEIS, that late-successional forests have been reduced in abundance and highly fragmented by past timber harvesting and other land management activities (USDI BLM 1994a, pp. 3-23 to 3-39; USDI BLM 1994b, pp. 3-34 to 3-46; USDI BLM 1994c, pp. 3-18 to 3-45; USDI BLM 1994d, pp. 3-30 to 3-57; USDI BLM 1994e, pp. 3-17 to 3-42; USDI BLM 1994f, pp. 3-21 to 3-41, 3-63 to 3-66, 3-79 to 3-82). Those analyses are incorporated by reference. Current conditions across the Coast Range, West Cascades, and Klamath Provinces generally reflect the structural stage abundance and spatial patterns described for the planning area as a whole. The Eastern Cascades Province differs from the other provinces in many measures of structural stage abundance and spatial patterns partly because of its differing ecological conditions and management history. However, these different patterns have little effect on the overall pattern for the planning area, because the Eastern Cascades Province comprises only 2% of the BLM-administered forest lands modeled within the planning area.

## Coast Range

The natural disturbance regime in much of the Coast Range Province is characterized by infrequent, high-intensity fires and windstorms. Average historic forest conditions were 79% mature & structurally complex forests, 16% young forests, and 5% stand establishment forests (USDA USFS and USDI BLM 2005a). Currently, the Coast Range Province has more stand establishment forests and less mature & structurally complex forests than it did historically. The Coast Range Province has little remaining mature & structurally

**Table 3-4. Current Mean Patch Size By Structural Stage By Province**

| Structural Stages | Current Mean Patch Size (acres) | Physiographic Provinces | | | |
|---|---|---|---|---|---|
| | | Coast Range | West Cascades | Klamath | Eastern Cascades |
| Stand Establishment | BLM only | 25.5 | 29.2 | 30.2 | 44.4 |
| | All ownerships | 44.3 | 21.5 | 41.9 | 14.5 |
| Young | BLM only | 104.4 | 82.1 | 65.0 | 49.3 |
| | All ownerships | 5.8 | 8.0 | 6.2 | 11.1 |
| Mature & Structurally Complex | BLM only | 110.8 | 106.6 | 137.3 | 182.8 |
| | All ownerships | 15.3 | 28.4 | 28.8 | 28.2 |

**Note:** Because the 2006 data differs slightly for the alternatives (as explained in the text), the spatial configuration differs among the alternatives. As with the abundance data above, the spatial pattern results for 2006 use the data from Alternative 3.

**Table 3-5. Current Connectance On BLM-Administered Lands By Structural Stage And Province**

| Structural Stages | Physiographic Provinces | | | |
|---|---|---|---|---|
| | Coast Range | West Cascades | Klamath | Eastern Cascades |
| Stand Establishment | 0.13 | 0.13 | 0.10 | 2.42 |
| Young | 0.09 | 0.10 | 0.08 | 1.22 |
| Mature & Structurally Complex | 0.09 | 0.11 | 0.10 | 1.64 |

complex forests, most of which are mature forests with highly fragmented patches of structurally complex forests, primarily on BLM-administered lands (USDA USFS and USDI BLM 1994b, pp. 3&4-21, 3&4-25, 3&4-27). The mature & structurally complex forests together currently comprise 26% of all forest lands in the province (50% of BLM-administered lands). Stand establishment forests currently comprise 60% of all forest lands in the province (5% of BLM-administered lands). See *Table 3-3 (Current structural stage abundance on forested lands)*.

The spatial pattern of structural stages in the Coast Range Province has been strongly altered from historic conditions (Nonaka and Spies 2005, Wimberly 2002). Current spatial patterns in the Coast Range are characterized by small, scattered patches of mature & structurally complex forest set in a matrix of young and stand establishment forests. Mean patch size and connectance of mature & structurally complex forest are lower than average historic conditions (Nonaka and Spies 2005).

On BLM-administered lands, stand establishment forests are in fewer and smaller patches than young or mature & structurally complex forest, which is consistent with the overall abundance of structural stages.

Red alder stands in the Coast Range have increased in abundance since the 1930s (Wimberly and Ohmann 2004), but it is unknown how current hardwood abundance compares with the historical range of variability (Ohmann et al. 2007, Long et al.1998). The current distribution and abundance of red alder stands in the Coast Range have been considered by some to be an unnatural artifact of past timber harvesting practices (FEMAT, p. V-25). The increase in red alder stands is not continuing throughout the Coast Range. The abundance of red alder stands in the central Coast Range has been declining in recent decades, in contrast to the southern Coast Range (Kennedy and Spies 2005, Wimberly and Ohmann 2004). Forest management practices will likely reduce the abundance of red alder stands within the planning area (Spies 2006, Alig et al. 2000).

Swiss needle cast, caused by the native fungus *Phaeocryptopus gaeumannii,* has recently caused substantial growth loss of Douglas fir, primarily in young plantations within 30 miles of the coast (Kanaskie et al. 2005; Maguire et al. 2000; USDI BLM 1994a, p. 3-27). Possible reasons for the increased effects of Swiss needle cast include shifting plantation composition to pure Douglas fir on sites that previously supported Sitka spruce, western red-cedar, and western hemlock; past planting of off-site Douglas fir; climate changes; and soil nutrition changes (Perakis et al. 2006, Campbell and Liegel 1996).

In the southern part of the Coast Range, Port-Orford cedar root disease (caused by the introduced pathogen, *Phytophthora lateralis*) has been killing Port-Orford cedar (*Chamaecyparis lawsoniana*). Port-Orford root disease is discussed further under the Klamath Province below.

## West Cascades

The natural disturbance regime in the West Cascades is complex with moderate or highly variable fire frequencies and intensities. Average historical conditions are similar to the Coast Range (USDA USFS and USDI BLM 2005a). Like the Coast Range and Klamath Provinces, the West Cascades Province currently has more stand establishment forest and less mature & structurally complex forest than average historical conditions. Nevertheless, the West Cascades Province currently has greater amounts of mature

& structurally complex forests than other provinces, especially on Forest Service lands (USDA USFS and USDI BLM 1994b, pp. 3&4-19, 3&4-20, 3&4-25, 3&4-27). Mature & structurally complex forests currently comprise 43% of all forest lands in the province (49% of BLM-administered lands). Stand establishment forests currently comprise 37% of all forest lands in the province (8% of BLM-administered lands). See *Table 3-3 (Current structural stage abundance on forested lands)*.

There are no studies modeling the historic spatial patterns in the West Cascades comparable to those done in the Coast Range, which approximated a range of historic patch sizes (Cissel et al. 1999). The overall comparison to current conditions is likely similar to the Coast Range with a current mean patch size and connectance of mature & structurally complex forest that is lower than average historic conditions.

As in the Coast Range, stand establishment forests on BLM-administered lands are in fewer and smaller patches than young or mature & structurally complex forest, which is consistent with the overall abundance of structural stages.

## Klamath

The natural disturbance regime in much of the Klamath Province is characterized by frequent, low-intensity fires. Forests in the Klamath Province are highly fragmented by natural factors, and past cutting has resulted in many mixed-age stands (USDA USFS and USDI BLM 1994b, pp. 3&4-22, 3&4-25, 3&4-27). Average historic forest conditions in most of the province were 70% mature & structurally complex forests, 15% young forests, and 15% stand establishment forests (mixed conifer southwest Oregon reference condition model; USDA USFS and USDI BLM 2005a). Other reference condition models are applicable in smaller portions of the province. For example, the Oregon coastal tanoak model, applicable to the coastal portions of the province, describes average historical forest conditions as 30% mature & structurally complex forests, 60% young forests, and 10% stand establishment forests (USDA USFS and USDI BLM 2005a). The dry ponderosa pine-mesic model (applicable to dry sites in the eastern portion of the province) describes average historical forest conditions as 45% mature & structurally complex forests, 45% young forests, and 10% stand establishment forests (USDA USFS and USDI BLM 2005a).

Like the Coast Range and West Cascades, the Klamath Province currently has more stand establishment forests and less mature & structurally complex forests than it did historically. Mature & structurally complex forests currently comprise 35% of all forest lands in the province (55% of BLM-administered lands). Stand establishment forests currently comprise 52% of all forest lands in the Klamath Province (9% of BLM-administered lands). See *Table 3-3 (Current structural stage abundance on forested lands)*.

There are no studies modeling the historic spatial patterns in the Klamath Province comparable to those done in the Coast Range. Historic spatial patterns were likely more variable and difficult to characterize, because of the complex interaction of highly variable geology and climate with the highly variable disturbance regimes. Therefore, comparisons to the historic spatial patterns for the province would be speculative.

As in the Coast Range and West Cascades Provinces, stand establishment forests on BLM-administered lands in the Klamath Province are in fewer and smaller patches than young or mature & structurally complex forests. The disparity in the patch size between stand establishment forests and young forests is less. The patch size of mature & structurally complex forests is larger in the Klamath province than in the Coast Range or West Cascades, which is consistent with the overall abundance of structural stages.

In the western part of the Klamath Province, Port-Orford cedar root disease caused by the introduced pathogen *Phytophthora lateralis*, has been killing Port-Orford cedar (*Chamaecyparis lawsoniana*). The supplemental environmental impact statement for management of Port-Orford cedar in southwest Oregon (USDA USFS and USDI BLM 2004b) described the ecological role of Port-Orford cedar, the spread of the disease, and the effects of different management actions to control the disease. That analysis concluded that the rate of the spread of the disease is decreasing, and that Port-Orford cedar is not in danger of extirpation (USDA USFS and USDI BLM 2004b, pp. 3&4-19 to 3&4-52). That analysis is incorporated by reference.

In the Klamath Province, fire exclusion has shifted fuel loads and tree species composition, which has made these stands more susceptible to drought-induced mortality, insect and disease mortality, and high-intensity, stand-replacing fires (Taylor and Skinner 2003; Frost and Sweeney 2000; USDA USFS and USDI BLM 1994b, pp. 3&4-22; and USDI BLM 1994f, pp. 3-24 to 3-26).

## Eastern Cascades

Forests in the Eastern Cascades are highly fragmented by natural factors. The natural disturbance regime in much of the region is characterized by frequent, low-intensity fires (USDA USFS and USDI BLM 1994b, pp. 3&4-20, 3&4-21, 3&4-25, 3&4-27). The average historic forest conditions in the province were 45% mature & structurally complex forests, 45% young forests, and 10% stand establishment forests (USDA USFS and USDI BLM 2005a).

The Eastern Cascades Province currently has slightly less mature & structurally complex forests, less young forests, and more stand establishment forests than it did historically. The mature & structurally complex forests currently comprise 36% of all forest lands in the province (66% of BLM-administered lands). Young forests currently comprise 27% of all forest lands in the province (23% of BLM-administered lands). Stand establishment forests currently comprise 37% of all forest lands in the province (11% of BLM-administered lands). See *Table 3-3 (Current structural stage abundance on forested lands)*.

The classification of structural stages in the Eastern Cascades Province and the characterization of average historic conditions are more challenging than in any other province. The prevailing frequent, low-intensity fire regime produced stands that are difficult to classify. Most descriptions of the average historic abundance, including the estimates used above, would estimate greater abundance of stand establishment forest if all stands that were partially disturbed (such as by moderate- or low-severity fires) were classified as stand establishment forest.

There are no studies modeling the historic spatial patterns in the Eastern Cascades Province comparable to those done in the Coast Range. The historic spatial patterns were likely very different from the Coast Range, because the frequent, low-intensity fire regime in the Eastern Cascades Province would have produced a more fine-grained mosaic of structural stages.

The total acreage of the Eastern Cascades Province within the planning area is far less than in the other provinces, which complicates the direct comparison of the measures of spatial patterns with other provinces. The extent of the landscape analyzed alters the absolute values of spatial pattern metrics, as explained above. As in the other provinces, stand establishment forests on BLM-administered lands in the Eastern Cascades Province are in fewer and smaller patches than mature & structurally complex forests. However, unlike other provinces, the spatial patterns of young forests are similar to stand establishment forests, which is consistent with overall abundance. The Eastern Cascades has the lowest percentage of young forest on BLM-administered lands of all the provinces within the planning area.

In the Eastern Cascades Province, as in the Klamath Province, fire exclusion has shifted fuel loads and tree species composition, which has made these stands more susceptible to drought-induced mortality; insect and disease mortality; and high-intensity, stand-replacing fires (USDA USFS and USDI BLM 1994b, pp. 3&4-20 and 3&4-21; USDI BLM 1994f, pp. 3-24, 3-63 to 3-66, 3-79 to 3-82).