Final Environmental Impact Statement

for the Revision of the Resource Management Plans of the Western Oregon Bureau of Land Management

Salem, Eugene, Roseburg, Coos Bay, and Medford Districts, and the Klamath Falls Resource Area of the Lakeview District

Volume III

BLM

Salem, Eugene, Roseburg, Coos Bay, Medford, and Klamath Falls Offices

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WESTERN OREGON PLAN REVISIONS

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

Appendices

Volume III

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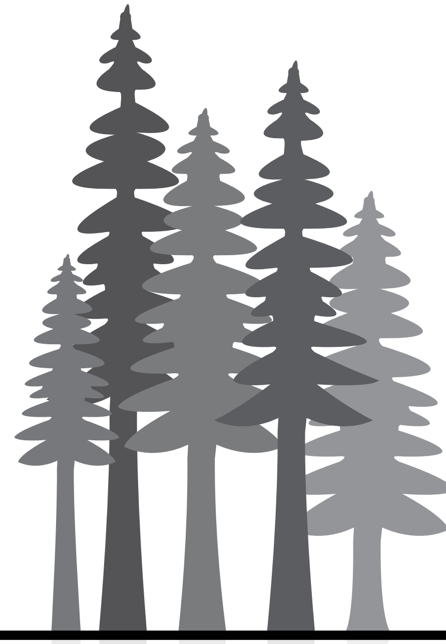
Appendix A
Legal Authorities



This appendix provides the background on the legal authorities and major court rulings that are related to this final environmental impact statement.

In this appendix:

Settlement Agreement

In 1997, timber industry groups, county governments, and others filed a lawsuit (*AFRC v. Clarke*, Civil No. 94-1031-TPJ [D.D.C.]) in the United States District Court for the District of Columbia (D.C. District Court). This lawsuit alleged that the O&C Act had not been appropriately considered in applying the Northwest Forest Plan's management direction to the O&C lands. The allegation was that the Northwest Forest Plan's system of large reserves and its standards and guidelines, which restrict timber harvesting for the purpose of achieving conservation principles, differs from the ruling of the United States Court of Appeals for the Ninth Circuit (Ninth Circuit Court) regarding the statutory direction for managing the O&C lands. The ruling from the Ninth Circuit Court (*Headwaters, Inc. v. BLM*, 914 F.2d 1174, 1183 [9th Cir., 1990]) stated that "exempting certain timber resources from harvesting to serve as wildlife habitat ... is inconsistent with the principles of sustained yield." The *AFRC v. Clarke* lawsuit also alleged that the specific contribution of the BLM-administered lands to the overall conservation strategy of the Northwest Forest Plan was not sufficiently analyzed in the Northwest Forest Plan's supplemental environmental impact statement to determine whether the extensive reservation of the O&C lands from timber harvesting in the Northwest Forest Plan was required to comply with the Endangered Species Act.

To resolve the lawsuit, the Secretary of Interior, the American Forest Resource Council, and the Association of O&C Counties entered into a settlement agreement that was approved by the United States District Court for the District of Columbia (D.C. District Court) on August 28, 2003. At the time of the settlement, the case was pending review in the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) for the D.C. District Court's dismissal of the case as *res judicata*. Under the settlement agreement, the BLM agreed to revise its resource management plans in western Oregon, and in that revision the BLM would consider an alternative that would not create any reserves on the O&C lands, except those reserves required to avoid jeopardy to species listed as threatened or endangered under the Endangered Species Act. The BLM also agreed that all resource management plan revisions shall be consistent with the O&C Act as interpreted by the Ninth Circuit Court.

Res judicata

A rule of civil law that says an issue cannot be relitigated after a final judgment has been rendered.

Major Court Rulings

Following are descriptions of court rulings that are the most relevant to the decisions that must be made in revising the resource management plans for BLM-administered lands in western Oregon.

Headwaters, Inc. v. BLM, 914 F.2d 1174 (9th Cir. 1990)

In a 1990 lawsuit by Headwaters, Inc., the plaintiffs argued that the O&C Act requires the BLM to manage O&C lands for multiple uses, including wildlife conservation, rather than for the dominant use of timber production. There were several issues in this case, including compliance with the National Environmental Policy Act. The issue most relevant to this revision of the resource management plans, however, is interpretation of the O&C Act's reference to forest production.

In ruling on this case, the United States Court of Appeals for the Ninth Circuit (Ninth Circuit Court) stated that "the primary purpose of the O&C Act lands is for timber production in conformity with the provision of sustained yield." Even more explicitly, the Ninth Circuit Court held that "exempting certain timber resources from harvesting to serve as wildlife habitat is inconsistent with the principle of sustained yield." The court also stated that "[i]t is entirely consistent with these goals to conclude that the O&C Act envisions timber production as a dominant use." The court further stated that "[t]he purposes of the O&C Act were twofold. First, the O&C Act was intended to provide the counties ... with [a] stream of revenue. Second, the O&C Act was intended to halt previous practices of clearcutting without reforestation" (*Headwaters, Inc. v. BLM*, 914 F.2d 1174 [9th Cir. 1990]). Citing the legislative history of the O&C Act, the Ninth Circuit Court explained that "[t]his type of [sustained-yield] management will make for a more permanent type of community, contribute to the local dependent industries, protect watersheds, and aid in regulating streamflow." In other words, protecting watersheds, regulating stream flow, and contributing to the economic stability of local communities and industries were expected outcomes of managing these lands under the principles of sustained-yield management. The Ninth Circuit Court found nothing in the legislative history to "suggest that wildlife habitat conservation or conservation of old growth forest is a goal on a par with timber production, or indeed that it is a goal of the O&C Act at all" (*Headwaters, Inc. v. BLM,* 914 F.2d 1183-84 [9th Cir. 1990]).

This opinion was not the first to rule on management of BLM lands under the O&C Act. However, it is the most explicit. It followed previous rulings of the Ninth Circuit Court on the purposes of the O&C Act, specifically: *O'Neal v. United States*, 814 F.2d 1285, 1287 (9th Cir. 1987); and *Skoko v. Andrus*, 638 F.2d 1154, 1156 (9th Cir.), *cert. denied*, 444 U.S. 927, 62 L. Ed. 2d 183, 100 S. Ct. 266 (1979).

Portland Audubon Society v. Babbitt, 998 F.2d 705 (9th Cir. 1993)

In this case, environmental groups challenged a decision made by the BLM to not supplement timber management plans with new information concerning the plan's effect on the northern spotted owl and asked the court to issue an injunction against logging operations in BLM forests that contained northern spotted owl habitat until a supplemental environmental impact statement was prepared. The BLM argued that the holding of the Ninth Circuit Court in *Headwaters, Inc. v. BLM*, 914 F.2d 1174, 1178- 80 (9th Cir. 1990), *reh'g denied*, 940 F.2d 435 (1991), supports the conclusion that the BLM's decision not to supplement the environmental impact statements was reasonable, that the O&C Act requires the BLM to sell 500 million board feet of timber per year, and that relief provided by the court must not conflict with this congressional direction. The court, however, found that the National Environmental Policy Act (passed after the O&C Act) does apply to all government actions having significant environmental impact, even though the actions may be authorized by other legislation. The court also found that the O&C Act did not establish a minimum volume that must be offered every year notwithstanding any other law. Therefore, compliance with the National Environmental Policy Act, or enjoining timber harvests until the BLM complies with the National Environmental Policy Act, is not inconsistent with either the volume requirements of the O&C Act or management of the lands entrusted to its care.

Seattle Audubon Society v. Lyons, 871 F. Supp. 1291, 1314 (W.D. Wash., 1994)

This case was a challenge to the Northwest Forest Plan and was filed soon after the filing of *AFRC v. Clarke* (Civil No. 94-1031-TPJ [D.D.C.]). In the challenge of the Northwest Forest Plan in the United States District Court for the Western District of Washington (Western Washington District Court), the court found that the management decision made about the O&C lands was a lawful exercise of the discretion of the Secretary of the Interior under the O&C Act, because of the broad mandate to manage federal lands to conserve habitat for species listed for protection under the Endangered Species Act. The Western Washington District Court, however, did not identify the Northwest Forest Plan as the *only* decision that would meet the requirements of the Endangered Species Act (*Seattle Audubon Society v. Lyons*, 871 F. Supp. 1291, 1313-1314 [W.D. Wash., 1994]).

Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service, 378 F.3d 1059 (9th Cir. 2004)

In this case (United States Court of Appeals for the Ninth Circuit), the Ninth Circuit Court rejected the regulatory definition of "destruction or adverse modification of critical habitat" and directed consulting agencies to consider the effects of an action on the critical habitat network without reference to other conservation programs, such as the late-successional reserves in the Northwest Forest Plan. The court stated that critical habitat must provide for both the survival and the recovery of a listed species, and that the analysis of whether there is adverse modification always requires consideration of the impacts on the recovery of a species. This case highlighted the issue that resulted from the difference in the Northwest Forest Plan's late-successional reserves and the designated critical habitat for the northern spotted owl.

Major Legal Authorities

The following is a list of the major legal authorities that are relevant to the BLM land use planning process. It is not an inclusive list.

- The Oregon and California Railroad and Coos Bay Wagon Road Grant Lands Act (O&C Act) (43 U.S.C. §1181a, *et seq.*) provides the legal authority for management of O&C lands by the Secretary of the Interior. The O&C Act requires that the O&C lands be managed "for permanent forest production, and the timber thereon shall be sold, cut, and removed in conformity with the principal (sic) of sustained yield for the purpose of providing a permanent source of timber supply, protecting watersheds, regulating stream flow, and contributing to the economic stability of local communities and industries, and providing recreational facilities." (43 U.S.C. §1181a)
- The Federal Land Policy and Management Act of 1976 (FLPMA), as amended, 43 U.S.C. 1701 *et seq.*, provides the authority for BLM land use planning.

— Sec. 102 (a) (7) and (8) sets forth the policy of the United States concerning management of the public lands.

— Sec. 201 requires the Secretary of the Interior to prepare and maintain an inventory of the public lands and their resource and other values, giving priority to areas of critical environmental concern (ACECs), and, as funding and workforce are available, to determine the boundaries of the public lands, provide signs and maps to the public, and provide inventory data to State and local governments.

— Sec. 202 (a) requires the Secretary, with public involvement, to develop, maintain, and when appropriate, revise land use plans that provide by tracts or areas for the use of the public lands.

— Sec. 202(c)(1-9) requires that, in developing land use plans, the BLM shall use and observe the principles of multiple use and sustained yield; use a systematic interdisciplinary approach; give priority to the designation and protection of areas of critical environmental concern; rely, to the extent it is available, on the inventory of the public lands; consider present and potential uses of the public lands; consider the relative scarcity of the values involved and the availability of alternative means and sites for realizing those values; weigh long-term benefits to the public against short term benefits; provide for compliance with applicable pollution control laws, including State and Federal air, water, noise, or other pollution standards or implementation plans; and consider the policies of approved State and tribal land resource management programs, developing land use plans that are consistent with State and local plans to the maximum extent possible consistent with Federal law and the purposes of this Act.

— Sec. 202 (d) provides that all public lands, regardless of classification, are subject to inclusion in land use plans, and that the Secretary may modify or terminate classifications consistent with land use plans.

— Sec. 202 (f) and Sec. 309 (e) provide that Federal, State, and local governments and the public be given adequate notice and an opportunity to comment on the formulation of standards and criteria for, and to participate in, the preparation and execution of plans and programs for management of the public lands.

— Sec. 302 (a) requires the Secretary to manage BLM lands under the principles of multiple use and sustained yield, in accordance with available land use plans developed under Sec. 202 of FLPMA. There is one exception: where a tract of the BLM lands has been dedicated to specific uses according to other provisions of law, it shall be managed in accordance with such laws.

— Sec. 302 (b) recognizes the entry and development rights of mining claimants, while directing the Secretary to prevent unnecessary or undue degradation of the public lands.

— Sec. 701 (b) provides that notwithstanding any provision of FLPMA, in the event of conflict with or inconsistency between FLPMA and the O&C Act, insofar as they relate to management of timber resources and disposition of revenues from lands and resources, the O&C Act shall prevail.

- The National Environmental Policy Act of 1969 (NEPA), as amended, 42 U.S.C. 4321 *et seq*., requires the consideration and public availability of information regarding the environmental impacts of major Federal actions significantly affecting the quality of the human environment. This includes consideration of alternatives and mitigation of impacts.
- The Clean Air Act of 1990, as amended, 42 U.S.C. 7418, requires Federal agencies to comply with all Federal, State and local requirements regarding control and abatement of air pollution. This includes abiding by requirements of State Implementation Plans.
- The Clean Water Act of 1987, as amended, 33 U.S.C. 1251, establishes objectives to restore and maintain the chemical, physical, and biological integrity of the Nation's water.
- The Healthy Forests Restoration Act of 2003, 16 U.S.C. 6501, contains a variety of provisions to expedite hazardous-fuel reduction and forest-restoration projects on specific types of Federal land that are at risk of wildland fire or insect and disease epidemics. It also provides other authorities and direction to help reduce hazardous fuel and restore healthy forest and rangeland conditions on lands of all ownerships.
- The Federal Water Pollution Control Act, 33 U.S.C. 1323, requires Federal land managers to comply with all Federal, State, and local requirements, administrative authorities, process, and sanctions regarding the control and abatement of water pollution in the same manner and to the same extent as any nongovernmental entity.
- The Safe Drinking Water Act, 42 U.S.C. 201, is designed to make the Nation's waters "drinkable" as well as "swimmable." Amendments in 1996 establish a direct connection between safe drinking water and watershed protection and management.
- The Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. 1531 *et seq.*:

— Provides a means whereby the ecosystems upon which endangered and threatened species depend may be conserved and provides a program for the conservation of such endangered and threatened species (Sec. 1531 [b], Purposes).

— Requires all Federal agencies to seek to conserve endangered and threatened species and utilize applicable authorities in furtherance of the purposes of the Endangered Species Act (Sec. 1531 [c] [1], Policy).

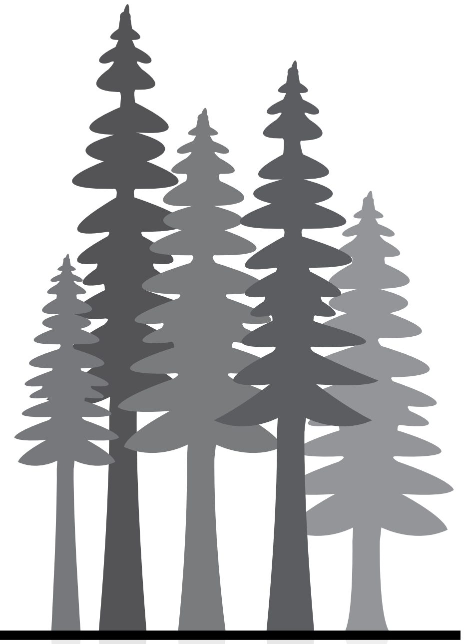
— Requires all Federal agencies to avoid jeopardizing the continued existence of any species that is listed or proposed for listing as threatened or endangered, or destroying or adversely modifying its designated or proposed critical habitat (Sec. 1536 [a], Interagency Cooperation).

— Requires all Federal agencies to consult (or confer) in accordance with Sec. 7 of the ESA with the Secretary of the Interior, through the Fish and Wildlife Service and/or the National Marine Fisheries Service, to ensure that any Federal action (including land use plans) or activity is not likely to jeopardize the continued existence of any species listed or proposed to be listed under the provisions of the ESA, or result in the destruction or adverse modification of designated or proposed critical habitat (Sec. 1536 [a], Interagency Cooperation, and 50 CFR 402).

- The Migratory Bird Treaty Act of 1918 decrees that all migratory birds and their parts (including eggs, nests, and feathers) are fully protected. The Migratory Bird Treaty Act is the domestic law that affirms, or implements, the United States' commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of a shared migratory bird resource.
- The Wild and Scenic Rivers Act, as amended, 16 U.S.C. 1271 *et seq.*, requires Federal land management agencies to identify potential river systems and then study them for potential designation as wild, scenic, or recreational rivers.
- The Wilderness Act, as amended, 16 U.S.C. 1131 *et seq.*, authorizes the President to make recommendations to the Congress for Federal lands to be set aside for preservation as wilderness.
- The Antiquities Act of 1906, 16 U.S.C. 431-433, protects cultural resources on Federal lands and authorizes the President to designate National Monuments on Federal lands.
- The National Historic Preservation Act (NHPA), as amended, 16 U.S.C. 470, expands protection of historic and archaeological properties to include those of national, State, and local significance and directs Federal agencies to consider the effects of proposed actions on properties eligible for or included in the National Register of Historic Places. It also directs the pro-active management of historic resources.
- The American Indian Religious Freedom Act of 1978, 42 U.S.C. 1996, establishes a national policy to protect and preserve the right of American Indians to exercise traditional Indian religious beliefs or practices.
- The Recreation and Public Purposes Act of 1926, as amended, 43 U.S.C. 869 *et seq.*, authorizes the Secretary of the Interior to lease or convey BLM lands for recreational and public purposes under specified conditions.
- The Federal Coal Leasing Amendments Act of 1976, 30 U.S.C. 201 (a) (3) (A) (i), requires that coal leases be issued in conformance with a comprehensive land use plan.
- The Surface Mining Control and Reclamation Act of 1977, 30 U.S.C. 1201 *et seq.*, requires application of unsuitability criteria prior to coal leasing and also to proposed mining operations for minerals or mineral materials other than coal.
- The Mineral Leasing Act of 1920, as amended, 30 U.S.C. 181 *et seq.,* authorizes the development and conservation of oil and gas resources.
- The Onshore Oil and Gas Leasing Reform Act of 1987, 30 U.S.C. 181 *et seq.*, provides that a study be conducted by the National Academy of Sciences and the Comptroller General that results in recommendations for improvements which may be necessary to ensure the following are adequately addressed in Federal land use plans:
  — Potential oil and gas resources are identified.
  — The social, economic, and environmental consequences of exploration for and development of oil and gas resources are determined.
  — Any stipulations to be applied to oil and gas leases are clearly identified.
- The General Mining Law of 1872, as amended, 30 U.S.C. 21 *et seq.*, allows the location, use, and patenting of mining claims on sites on public domain lands of the United States.
- The Mining and Mineral Policy Act of 1970, 30 U.S.C. 21a, establishes a policy of fostering the orderly development of economically stable mining and minerals industries and studying methods for reclamation and the disposal of waste.
- The Taylor Grazing Act of 1934, 43 U.S.C. 315, authorizes the Secretary of the Interior "to establish grazing districts, or additions thereto and/or to modify the boundaries thereof of vacant, inappropriate and unreserved lands from any part of the public domain . . . which in his opinion are chiefly valuable for grazing and raising forage crops[.] . . ." The Act also provides for classification of lands for particular uses.
- Executive Orders 11644 (1972) and 11989 (1997) establish policies and procedures to ensure that off-road vehicle use shall be controlled so as to protect public lands.

- Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), 49 *Fed. Reg.* 7629 (1994), requires that each Federal agency consider the impacts of its programs on minority and low-income populations.
- Executive Order 13007 (Indian Sacred Sites), 61 *Fed. Reg.* 26771 (1996), requires Federal agencies to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions to:
  - — Accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners; and
  - — Avoid adversely affecting the physical integrity of such sacred sites.
- Executive Order 13084 (Consultation and Coordination with Indian Tribal Governments) provides, in part, that each Federal agency shall establish regular and meaningful consultation and collaboration with Indian tribal governments in developing regulatory practices on Federal matters that significantly or uniquely affect their communities.
- Executive Order 13112 (Invasive Species) provides that no Federal agency shall authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk or harm will be taken in conjunction with the actions.
- Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds) directs the Fish and Wildlife Service, in coordination with Federal agencies and Executive departments, to take certain actions to further the implementation of the Migratory Bird Treaty Act in promoting conservation of migratory bird populations.
- Executive Order 13443 (Facilitation of Hunting Heritage and Wildlife Conservation) provides, in part, that Federal agencies shall, consistent with agency missions evaluate the effects of agency actions on game species and their habitats; manage wildlife and wildlife habitats on public lands in a manner that expands and enhances hunting opportunities; work collaboratively with State governments to manage and conserve game species and their habitats; and seek the advice of State fish and wildlife agencies.
- Secretarial Order 3175 (incorporated into the Departmental Manual at 512 DM 2) requires that if Department of the Interior (DOI) agency actions might impact Indian trust resources, the agency must explicitly address those potential impacts in planning and decision documents, as well as consult with the tribal government whose trust resources are potentially affected by the Federal action.
- Secretarial Order 3206 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act) requires DOI agencies to consult with Indian tribes when agency actions to protect a listed species, as a result of compliance with ESA, affect or may affect Indian lands, tribal trust resources, or the exercise of American Indian tribal rights.
- Secretarial Order 3215 (Principles for the Discharge of the Secretary's Trust Responsibility) guides DOI officials by defining the relatively limited nature and extent of Indian trust assets, and by setting out the principles that govern the Trustee's fulfillment of the trust responsibility with respect to Indian trust assets.

Appendix B
Forest Structure and Spatial Pattern



This appendix provides background on the analysis of forest structure and spatial pattern.

In this appendix:

Structural Stage Classification

Conifer forests within the planning area are classified in this analysis by a four-stage structural classification:

- Stand Establishment
- Young
- Mature
- Structurally Complex

These four structural classes are further sub-divided by additional structural divisions and by tree species composition groupings.

Vegetation Series (by plant series)

The vegetation series are groupings that have been made for this analysis based on plant series and do not exactly correspond to mapped plant series or plant association groupings. The data on plant series was modeled at a very fine scale and has been coarsened in scale for this analysis. Adjustments have been made to the geographic boundaries of these vegetation series grouping to provide explicit boundaries without interspersion.

- **Western Hemlock and Tanoak:** Western Hemlock, Sitka Spruce, Pacific Silver Fir, Tanoak
- **Douglas-fir:** Douglas-fir, Grand Fir, White Fir, Shasta Red Fir, Mountain Hemlock, Ponderosa Pine
- **Non-forest**: Jeffrey Pine, Oregon White Oak, Juniper, Sagebrush, Grassland, Water

Classification

Each class appended with Vegetation Series:

- Western Hemlock and Tanoak
- Douglas-fir

1) Stand Establishment

<200 years old in current Forest Operations Inventory Average tree height <50 feet

1a.) Without Structural Legacies

<6 trees per acre ≥20 inches diameter breast height

1b.) With Structural Legacies

≥6 trees per acre ≥20 inches diameter breast height

The Stand Establishment stage extends from stand initiation until stands have reached canopy closure and density-dependent tree mortality begins. Average tree height reflects the influence of site productivity on tree growth. At an average tree height of 50 feet, stands have passed the point at which they are typically pre-commercial thinned. The minimum density of structural legacies is set at 6 trees per acre to maintain consistency with the minimum green tree requirements in the No Action Alternative.

2) Young

<200 years old in current Forest Operations Inventory Average tree height ≥50 feet

Western Hemlock and Tanoak
<24 trees per acre ≥20 inches diameter breast height

Douglas-fir
<12 trees per acre ≥20 inches diameter breast height

2a.) Young High Density
relative density (Curtis RD) ≥ 25

2a1.) Without Structural Legacies
Descended from Stand Establishment without Structural Legacies

2a2.) With Structural Legacies
Descended from Stand Establishment with Structural Legacies

2b.) Young Low Density
relative density (Curtis RD) < 25

2b1.) Without Structural Legacies
Descended from Stand Establishment without Structural Legacies

2b2.) With Structural Legacies
Descended from Stand Establishment with Structural Legacies

The Young stage is characterized by the predominance of density-dependent tree mortality, and, in high density stands, a small range of tree diameters. Young stands have not yet acquired the density of large diameter trees that characterize Mature stands. Young Low Density stands are those with a tree density sufficiently low to largely eliminate the influence of density-dependent tree mortality.

3) Mature

<200 years old in current Forest Operations Inventory

Western Hemlock and Tanoak ≥24 trees per acre ≥20 inches diameter breast height

Douglas-fir
≥12 trees per acre ≥20 inches diameter breast height

3a.) Single Canopy

Western Hemlock and Tanoak
Coefficient of Variation of tree diameters > 10 inches diameter breast height (CVgt[10]) < 0.35

Douglas-fir
CVgt(10) < 0.34

3b.) Multiple Canopy

Western Hemlock and Tanoak
CVgt(10) ≥ 0.35
<4.7 trees per acre ≥40 inches diameter breast height

Douglas-fir
CVgt(10) ≥ 0.34
<2.1 trees per acre ≥40 inches diameter breast height

The Mature stage generally begins as tree growth rates stop increasing (after culmination of mean annual increment), as tree mortality shifts from density-dependent mortality to density- independent mortality. The threshold values for the Mature stage are derived from Poage (*unpublished*), which comprises BLM timber cruise data for timber sales in the late 1980s and early 1990s. This data presents a precise and accurate sample of the population of trees in timber sale areas. Because timber harvest during that period was predominately in Mature and Structurally Complex forest, this data set, described in Poage (2000), provides a characterization of Mature and Structurally Complex forest on BLM-administered lands.

The thresholds presented here for Mature forest are intended to establish a threshold that represents the structural conditions of most Mature forests, but not necessarily absolute minimum conditions found in all Mature forests. Therefore, the density of large trees (greater than 20 inches in diameter) was derived from the 66th percentile of sample values from the Poage dataset, separating the data for the Western Hemlock and Tanoak, and Douglas-fir vegetation series.

The threshold for canopy layering was derived from the coefficient of variation in tree diameters, inferring that variation in tree diameters is reflected by variation in tree heights. The threshold here was derived by the mean coefficient of variation of tree heights minus one standard deviation from the Poage dataset.

This analysis initially examined other measures of canopy layering, included a Canopy Height Diversity index (Spies and Cohen 1992), a Diameter Diversity Index (McComb et al. 2002), and a canopy classification technique in Baker and Wilson (2000).

The Canopy Height Diversity index uses data on tree heights directly, but classified most existing stands over 200 years old in this analysis as "single canopy," and therefore would be too restrictive.

The Diameter Diversity Index infers canopy height diversity from weighted values of tree diameters. The weighting values produce results that may be more effective at classifying existing stands than evaluating modeled stands. The Diameter Diversity Index results do not appear to accurately reflect future changes in canopy layering resulting from thinning or partial disturbance and would classify relatively young, even-aged stands as "multiple canopy."

The technique in Baker and Wilson (2000) uses tree height and canopy measurements, but would classify almost all stands in this analysis as "multiple canopy."

Coefficient of variation in tree diameters provides greater discrimination among the stands in this analysis than the other measures and appears to be sensitive to future changes in stand conditions. Coefficient of variation in tree diameters could provide misleading results in strongly bi-modal stands (i.e., very large trees and very small trees), which would be a concern if this analysis were attempting to provide continuous values of canopy layering. But this analysis is only attempting to classify stands as either single canopy layered or multiple canopies.

4) Structurally Complex

4a.) Existing Old Forest
≥ 200-years old in current Forest Operations Inventory

4a1.) Existing Very Old Forest
≥ 400-years old in current Forest Operations Inventory

4b.) Developed Structurally Complex
< 200-years old in current Forest Operations Inventory

Western Hemlock and Tanoak
- CVgt(10) ≥0.35
- ≥ 24 trees per acre ≥20 inches diameter breast height
- ≥ 4.7 trees per acre ≥40 inches diameter breast height

Douglas-fir
- CVgt(10) ≥0.34
- ≥ 12 trees per acre ≥20 inches diameter breast height
- ≥ 2.1 trees per acre ≥40 inches diameter breast height

This analysis assumes that stands identified as 200 years old or older in the current stand inventory are Structurally Complex forest. In addition, stands that are not 200 years old or older but meet threshold values for Developed Structurally Complex described above are identified as Structurally Complex forest. Threshold values for Developed Structurally Complex include density of very large trees (greater than 40 inches in diameter) derived from the 66th percentile of sample values from the Poage dataset, separating data for the Western Hemlock and Tanoak and Douglas-fir vegetation series.

Structurally Complex stands approximate "old-growth" stands described in many analyses (see, e.g., District RMP/EISs), "Medium/large Conifer Multi-story" stands described in the FEMAT Report, and "Large, Multi-storied Older Forest" stands described in the LSOG Monitoring Report. In this analysis, "late-successional forest" encompasses both Mature and Structurally Complex stands, similar to how the Northwest Forest Plan FSEIS used "late-successional forest" to encompass mature and old-growth forests. The LSOG Monitoring Report (pp. 9-10) summarized the difficulties in describing and classifying older forest conditions.

Table B-1. Comparison Of Different Stand Classification Schemes And The Structural Stage Classification Used In This RMP/EIS[a]

Typical stand age[b] (years)	Oliver (1981) stand development stages	Franklin et al. (2002) structural stage	1994 RMP/EIS Seral stage	Structural stages (This RMP/EIS)
0	Disturbance and legacy creation			
20	Stand Initiation	Cohort establishment	Early seral	Stand Establishment
30	Stem Exclusion	Canopy Closure	Mid seral	Young
50		Biomass accumulation/ competitive exclusion	Late seral	
80	Understory Reinitiation	Maturation		Mature
150	Old Growth	Vertical diversification	Mature seral	Structurally Complex
300		Horizontal diversification	Old-growth	
800-1200		Pioneer cohort loss		

[a]A more extensive comparison of classification schemes can be found in Franklin et al. 2002.
[b]Stand ages are provided as references. However, stands can achieve structural classes at different stand ages, depending on disturbance and site conditions.

Interagency Vegetation Mapping Project Data

Existing vegetation mapping for the planning area was based on the Interagency Vegetation Mapping Project (IVMP), which provides maps of existing vegetation, canopy cover, size, and cover type for the entire range of the Northern Spotted Owl using satellite imagery from Landsat Thematic Mapper (TM). The LSOG Monitoring Report contains detailed descriptions of the IVMP data and evaluations of IVMP map accuracy (Moeur et al. 2005, pp. 18-30, 108-109, 123- 128). Those descriptions and evaluations are incorporated here by reference.

The IVMP was initiated in 1998 under joint program management and funding by the Bureau of Land Management-Oregon and the Forest Service-Region 6. The project's goal was to provide consistent spatial data for monitoring older forests within the portions of the Plan area in Washington and Oregon. The IVMP mapped existing vegetation in the nine physiographic provinces in Washington (Eastern and Western Cascades, Olympic Peninsula, and Western Lowlands) and Oregon (Eastern and Western Cascades, Coast Range, Willamette Valley, and Klamath Mountains).

The IVMP modeling approach combined remotely sensed satellite imagery (25-m Landsat TM), digital elevation models, interpreted aerial photos, and inventory information collected on the ground to classify existing vegetation. Landsat scenes used in the IVMP project ranged from fall 1992 through summer 1996. Of the 17 scenes, 2 were acquired in 1992, 1 each in 1994 and 1995, and 13 in 1996. A regression modeling approach was used to predict vegetation characteristics from this Landsat data.

Inventory plot data were used as reference information for IVMP model building and accuracy assessment. Almost 10,000 plots were used for model building and testing, and another 2,800 plots were held out for an independent accuracy assessment. These data came primarily from Current Vegetation Survey (CVS) plots maintained by Forest Service-Region 6 and Bureau of Land Management-Oregon on Forest Service and Bureau of Land Management lands in Washington and Oregon, and from Forest Inventory and Analysis (FIA) plots administered by Pacific Northwest Research Station on nonfederal lands.

All IVMP map data and supporting documentation are available online at:
http://www.or.blm.gov/gis/projects/ivmp.asp

Average Historical Conditions and the Historic Range of Variability

The description of the Affected Environment and the analysis of effects include a comparison of current and future conditions to the Historic Range of Variability. Characterization of historic landscape conditions can provide a reference point for comparison in the analysis of effects of different land management strategies. Historic landscape conditions were dynamic, which requires characterization of landscape conditions as a range, rather than a discrete point.

There are several challenges in describing the Historic Range of Variability, as dicussed below.

Selecting metrics

Historic Range of Variability is often described by abundance of habitat types and frequency of disturbance, such as mean fire return interval. Some descriptions have included spatial pattern of habitats, such as patch size. Because the Historic Range of Variability is a range, it is not easily quantified, and at many spatial scales, the range is very broad (see, e.g., Wimberly et al. 2000). Simply describing an upper and lower bound of historic conditions may overemphasize the rare, extreme events that defined the bounds (Landres et al. 1999). However, more sophisticated descriptions may be difficult to communicate to decision- makers and the public, and may be difficult to compare to the effects of different land management strategies.

Selecting the portion of history

Historical conditions varied not only in a range of natural disturbance frequencies, but with patterns of pre-European anthropogenic disturbances and with climate changes. The selection of the portion of history to characterize can strongly influence the resulting "range" that is described (Millar and Woolfenden 1999, Long et al. 1998).

Insufficient information

Our knowledge of historical landscape conditions is fragmentary at best. Descriptions of Historic Range of Variability have been built from pollen deposits in lake sediments, tree-ring data, fire-scar data, even animal deposits, such as pack-rat middens. These records are incomplete. Reconstructions from such data sources require inference and modeling to derive a description of Historic Range of Variability.

Change from historical conditions

Some biological and physical characteristics have changed irreversibly from historic conditions and may distort any comparison to Historic Range of Variability. Climate conditions have changed and are continuing to change at a rapid rate. Species introductions and species extirpations have altered biological relationships.

Discussion

These challenges should be considered in interpreting the Historic Range of Variability and caution against using it as an explicit target or management objective.

Several commentors have hypothesized that a landscape that reflects the abundance and arrangement of habitats within the Historic Range of Variability will support the species and processes that were historically present, and that the further the landscape is outside the Historic Range of Variability, the less likely it will support those species and processes (see, e.g., Landres et al. 1999). These hypotheses remain largely untested, but several studies have characterized the historic range of variability in western Oregon and used it as a reference point to compare the effects of management strategies (Nonaka and Spies 2005, Wimberley 2002, Wimberley et al. 2000, Cissel et al. 1999, Rasmussen and Ripple 1998).

This analysis uses the description of habitat abundances and mean fire return intervals from the draft Rapid Assessment Reference Condition Models (USFS and BLM 2005). These models derived historic abundances by modeling disturbance probabilities generated from mean fire return intervals combined with the probabilities of other disturbances such as wind, insect and pathogens. These models described the average amount of the landscape that would be expected in each of the broad vegetation classes, which are roughly equivalent to the structural classes used in this analysis.

This analysis used the description of spatial patterns of habitat types from Nonaka and Spies (2005), which modeled historic spatial pattern in the Coast Range. This modeling of historical conditions was parameterized to the historical fire regimes prior to Euro-American settlement around the mid-1800s

(Nonaka and Spies 2005). Although this research applies to only a portion of the planning area, it presents an available description of historic spatial pattern. The historic spatial pattern in the other provinces in the planning area likely differed from the Coast Range, and therefore the comparative value of this description of Historic Range of Variability is limited and must be used with caution.

FRAGSTATS

The FRAGSTATS is a computer software program designed to compute a wide variety of landscape metrics for categorical map patterns. The original software (version 2) was released in the public domain during 1995 in association with the publication of a USDA Forest Service General Technical Report (McGarigal and Marks 1995).

The following discussion is summarized from the FRAGSTATS website (http://www.umass. edu/ landeco/research/fragstats/fragstats.html), which describes FRAGSTATS in detail Those descriptions are incorporated here by reference.

The FRAGSTATS is a spatial pattern analysis program for categorical maps. The landscape subject to analysis is user-defined and can represent any spatial phenomenon. FRAGSTATS simply quantifies the areal extent and spatial configuration of patches within a landscape; it is incumbent upon the user to establish a sound basis for defining and scaling the landscape (including the extent and grain of the landscape) and the scheme upon which patches are classified and delineated. The output from FRAGSTATS is meaningful only if the landscape mosaic is meaningful relative to the phenomenon under consideration.

The FRAGSTATS computes three groups of metrics. For a given landscape mosaic, it computes several metrics for: (1) each patch in the mosaic; (2) each patch type (class) in the mosaic; and (3) the landscape mosaic as a whole. The FRAGSTATS website contains a detailed description of the metrics.

The FRAGSTATS website includes a discussion on the conceptual background of FRAGSTATS analysis, including advice and caveats about use of the software. Key points from that discussion are summarized here.

A landscape is not necessarily defined by its size; rather, it is defined by an interacting mosaic of patches relevant to the phenomenon under consideration (at any scale). It is incumbent upon the investigator or manager to define landscape in an appropriate manner. The essential first step in any landscape-level research or management endeavor is to define the landscape, and this is of course prerequisite to quantifying landscape patterns.

Classes of Landscape Pattern

Real landscapes, at any scale, contain complex spatial patterns in the distribution of resources that vary over time. Quantifying these patterns and their dynamics is the purview of landscape pattern analysis. Landscape patterns can be quantified in a variety of ways depending on the type of data collected, the manner in which it is collected, and the objectives of the investigation. Broadly considered, landscape pattern analysis involves four basic types of spatial data corresponding to different representations of landscape pattern. These look rather different numerically, but they share a concern with the relative concentration of spatial variability:

(1) Spatial point patterns represent collections of entities where the geographic locations of the entities are of primary interest, rather than any quantitative or qualitative attribute of the entity itself.

(2) Linear network patterns represent collections of linear landscape elements that intersect to form a network.

(3) Surface patterns represent quantitative measurements that vary continuously across the landscape; there are no explicit boundaries (i.e., patches are not delineated). Here, the data can be conceptualized as representing a three-dimensional surface, where the measured value at each geographic location is represented by the height of the surface.

(4) Categorical (or thematic; choropleth) map patterns represent data in which the system property of interest is represented as a mosaic of discrete patches. From an ecological perspective, patches represent relatively discrete areas of relatively homogeneous environmental conditions at a particular scale. The patch boundaries are distinguished from their surroundings by abrupt discontinuities (boundaries) in environmental character states of magnitudes that are relevant to the ecological phenomenon under consideration.

Patch-Corridor-Matrix Model

Patch must be defined relative to the phenomenon under investigation or management; regardless of the phenomenon under consideration (e.g., a species, geomorphological disturbances, etc), patches are dynamic and occur at multiple scales; and patch boundaries are only meaningful when referenced to a particular scale.

It is incumbent upon the investigator or manager to establish the basis for delineating among patches and at a scale appropriate to the phenomenon under consideration.

Corridors are distinguished from patches by their linear nature and can be defined on the basis of either structure or function or both. If a corridor is specified, it is incumbent upon the investigator or manager to define the structure and implied function relative to the phenomena (e.g., species) under consideration.

It is incumbent upon the investigator or manager to determine whether a matrix element exists and should be designated given the scale and phenomenon under consideration.

The Importance of Scale

One of the most important considerations in any landscape ecological investigation or landscape structural analysis is (1) to explicitly define the scale of the investigation or analysis, (2) to describe any observed patterns or relationships relative to the scale of the investigation, and (3) to be especially cautious when attempting to compare landscapes measured at different scales.

Landscape Context

A landscape should be defined relative to both the patch mosaic within the landscape as well as the landscape context. Moreover, consideration should always be given to the landscape context and the openness of the landscape relative to the phenomenon under consideration when choosing and interpreting landscape metrics.

FRAGSTATS Metrics Used in this Analysis

This analysis analyzes the following FRAGSTATS class metrics:

- % BLM cover – the % of BLM cover in each class
- Patch density (PD) – the number of patches per unit area)
- Largest Patch Index (LPI) – the percentage of the landscape comprised by the largest patch in a class

- Edge density – edge length per unit area; edge is defined as abutting patches of different classes
- Mean patch size (ha) – mean average of the distribution of patch sizes
- Median size (ha) – median average of the distribution of patch sizes
- Patch size SD – standard deviation of the distribution of patch sizes
- Patch size CV – coefficient of variation of the distribution of patch sizes
- PAFRAC - perimeter-area fractal dimension; the complexity of patch shapes
- Core % BLM - % of BLM in core patch areas of each class; core areas are defined as the patch that is further than the specified depth-of-edge distance from the patch perimeter
- Disjunct core area density - number of disjunct core areas contained within each patch per unit area
- Core mean patch size (ha) - mean average of the distribution of core area
- Core median patch size (ha) – median average of the distribution of core areas
- Core patch size SD – standard deviation of the distribution of core areas
- Core patch size CV – coefficient of variation of the distribution of core areas
- Clumpiness – the aggregation of patches in each class; the frequency with which different pairs of patch types appear side-by-side on the map
- Connectance - 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 m). 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 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.

Landscape metrics

- Simpson's diversity – the diversity of patch types across the landscape; the probability that any 2 pixels selected at random would be different patch types
- Modified Simpson's diversity – the diversity of patch types (see McGarigal and Marks 1995)
- Simpson's evenness – the distribution of area among patch types
- Modified Simpson's evenness - the distribution of area among patch types (see McGarigal and Marks 1995).

Core patch metrics require definition of a depth of edge distance. 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 physical conditions, such as slope and aspect. Although some aspects of altered microclimate may extend almost 1,000 feet into old-growth forest from a clearcut edge, most effects of edges extend less than 150 feet from an edge (Chan et al. 2004; Brosofske et al. 1997; Chen et al.1995). This analysis defines an edge of 164 feet (which corresponds to 50 meters – the data for spatial analysis is in units of 25 meters). Interior forest habitat is the portion of the patch beyond that distance from an edge with another structural stage.

See tables B-2, B-3, B4 and B-5 on the following pages.

Table B-2. Spatial Pattern Results For BLM-Managed Lands In The Coast Range Province For Current Condition And In 2106 For All Structural Stages

Coast Range	Current			No Harvest 2106			No Action 2106			Alt 1 2106			Alt 2 2106			Alt 3 2106		
Variable	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC
% BLM cover	4.21	42.88	46.77	N/A	0.02	94.92	3.11	4.16	87.67	4.88	6.09	83.97	10.02	13.72	70.13	15.96	8.83	69.08
Patch density (PD)	0.41	1.02	1.04	N/A	0.00	0.23	0.90	1.08	0.64	1.08	1.19	0.81	1.95	3.12	1.71	1.72	1.04	4.57
Largest Patch Index (LPI)	0.04	2.17	1.46	N/A	0.01	21.94	0.04	0.03	16.98	0.09	0.05	16.74	0.11	0.10	6.73	0.09	0.08	8.23
Edge density	7.11	48.34	40.79	N/A	0.01	45.19	8.78	11.87	54.67	11.76	15.08	57.67	22.07	28.74	64.20	36.95	19.25	72.35
Mean patch size (ha)	10.30	42.23	44.83	N/A	10.48	408.11	3.46	3.84	137.65	4.53	5.13	103.25	5.13	4.40	41.09	9.30	8.51	15.12
Median size (ha)	9.06	12.13	7.75	N/A	6.13	31.25	1.00	1.06	3.88	1.25	1.38	1.88	0.38	0.19	0.44	3.63	2.06	0.13
Patch size SD	9.66	201.98	195.60	N/A	10.39	3181.14	6.74	7.61	1560.03	10.31	10.86	1338.81	13.67	14.32	606.58	16.65	18.94	309.13
Patch size CV	93.79	478.25	436.32	N/A	99.19	779.48	194.75	198.15	1133.29	227.75	211.69	1296.68	266.54	325.32	1476.09	178.95	222.59	2044.85
PAFRAC	1.26	1.38	1.32	N/A	N/A	1.44	1.33	1.34	1.36	1.31	1.34	1.38	1.30	1.30	1.36	1.37	1.35	1.35
Core % BLM	1.69	22.67	28.49	N/A	0.01	66.46	0.69	0.88	58.31	1.32	1.57	55.25	3.14	4.84	42.69	4.41	2.71	41.06
Disjunct core area density	0.49	2.68	2.09	N/A	0.00	1.87	0.51	0.72	2.57	0.76	1.00	2.31	1.41	1.69	2.66	2.61	1.29	2.70
Core mean patch size (ha)	4.14	22.33	27.31	N/A	5.32	285.73	0.77	0.82	91.56	1.23	1.32	67.94	1.61	1.55	25.02	2.57	2.61	8.99
Core median patch size (ha)	3.06	4.31	2.06	N/A	1.78	17.44	0.00	0.00	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00
Core patch size SD	5.04	124.22	138.15	N/A	7.57	2270.06	2.65	2.57	1086.68	4.44	4.12	937.13	5.70	6.65	418.63	6.02	7.85	200.07
Core patch size CV	121.76	556.33	505.96	N/A	142.14	794.47	345.32	315.80	1186.90	361.03	312.23	1379.42	354.19	427.66	1673.42	234.24	300.97	2226.51
Clumpiness	0.87	0.85	0.87	N/A	0.95	0.11	0.80	0.80	0.56	0.82	0.82	0.64	0.83	0.83	0.76	0.81	0.83	0.74
Connectance	0.13	0.09	0.09	N/A	6.67	0.22	0.16	0.15	0.17	0.15	0.15	0.15	0.10	0.09	0.11	0.08	0.12	0.07
Landscape metrics																		
Simpson's diversity	0.59			0.10			0.23			0.29			0.48			0.49		
Mod Simpson's diversity	0.90			0.10			0.26			0.34			0.65			0.67		
Simpson's evenness	0.79			0.14			0.30			0.38			0.63			0.65		
Mod Simpson's evenness	0.65			0.09			0.18			0.24			0.47			0.48		

SE - Stand Establishment Y - Young M&SC - Mature and Structurally Complex

Table B-3. Spatial Pattern Results For BLM-Managed Lands In The West Cascades Province For Current Condition And In 2106 For All Structural Stages

West Cascades	Current			No Harvest 2106			No Action 2106			Alt 1 2106			Alt 2 2106			Alt 3 2106		
Variable	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC
% BLM cover	6.97	38.96	44.40	0.02	2.35	88.93	8.58	11.14	71.58	11.05	17.44	62.80	14.56	21.59	54.18	15.27	9.16	65.89
Patch density (PD)	0.59	1.17	1.03	0.00	0.12	0.35	1.77	1.83	1.18	1.85	2.28	1.65	2.55	3.58	2.20	1.60	0.77	3.38
Largest Patch Index (LPI)	0.10	1.05	2.64	0.01	0.28	7.27	0.06	0.26	3.72	0.10	0.28	3.63	0.13	0.28	2.46	0.22	0.28	2.83
Edge density	11.51	44.37	45.12	0.04	3.05	50.67	20.69	23.95	64.46	23.60	34.46	67.96	29.98	40.55	67.53	31.83	16.01	68.85
Mean patch size (ha)	11.83	33.21	43.16	6.92	19.72	253.74	4.84	6.10	60.63	5.97	7.64	38.09	5.72	6.04	24.64	9.57	11.89	19.51
Median size (ha)	8.31	9.50	7.06	7.00	8.50	8.19	1.31	1.38	3.25	1.56	1.75	1.75	0.88	0.25	1.31	3.06	3.19	0.19
Patch size SD	16.64	112.69	233.61	3.78	53.87	1218.07	10.02	17.14	408.11	13.57	20.69	325.32	16.36	20.42	212.55	24.21	30.63	190.48
Patch size CV	140.68	339.32	541.30	54.66	273.17	480.05	206.92	280.93	673.09	227.44	270.92	854.05	286.04	338.34	862.48	252.93	257.61	976.12
PAFRAC	1.30	1.37	1.36	N/A	1.35	1.44	1.31	1.31	1.38	1.30	1.31	1.39	1.29	1.29	1.36	1.35	1.33	1.32
Core % BLM	2.82	20.24	25.32	0.00	1.19	59.61	2.41	3.68	42.53	3.60	6.18	35.71	5.06	8.43	28.86	4.99	3.71	38.14
Disjunct core area density	0.82	2.71	2.46	0.00	0.18	2.28	1.29	1.49	3.65	1.50	2.20	2.99	1.87	2.41	2.93	2.14	1.01	3.00
Core mean patch size (ha)	4.77	17.25	24.61	1.33	10.00	170.08	1.36	2.02	36.02	1.94	2.70	21.66	1.99	2.36	13.13	3.13	4.82	11.30
Core median patch size (ha)	2.50	2.81	1.69	0.69	2.56	10.88	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.19	0.00
Core patch size SD	9.44	71.00	154.26	1.08	36.95	855.84	4.31	9.94	272.60	6.32	11.48	216.73	7.69	11.29	132.20	11.13	18.19	120.37
Core patch size CV	197.67	411.48	626.89	81.48	369.56	503.19	317.16	493.00	756.79	324.96	424.48	1000.57	386.52	479.09	1006.84	356.08	377.12	1065.67
Clumpiness	0.87	0.86	0.86	0.86	0.90	0.54	0.82	0.83	0.75	0.83	0.83	0.78	0.83	0.83	0.80	0.83	0.86	0.76
Connectance	0.13	0.10	0.11	0.00	0.42	0.25	0.10	0.10	0.12	0.11	0.09	0.10	0.09	0.09	0.09	0.10	0.17	0.09
Landscape metrics																		
Simpson's diversity	0.64			0.20			0.46			0.56			0.63			0.52		
Mod Simpson's diversity	1.01			0.22			0.62			0.81			0.99			0.74		
Simpson's evenness	0.85			0.27			0.61			0.74			0.84			0.70		
Mod Simpson's evenness	0.73			0.16			0.44			0.58			0.72			0.54		

SE - Stand Establishment Y - Young M&SC - Mature and Structurally Complex

Table B-4. Spatial Pattern Results For BLM-Managed Lands In The Klamath Province For Current Condition And In 2106 For All Structural Stages

Klamath	Current			No Harvest 2106			No Action 2106			Alt 1 2106			Alt 2 2106			Alt 3 2106		
Variable	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC
% BLM cover	8.18	33.45	51.45	0.04	2.44	90.65	10.08	7.01	76.03	11.51	18.11	63.49	14.77	21.96	56.34	22.27	11.96	58.84
Patch density (PD)	0.67	1.27	0.93	0.00	0.21	0.27	2.17	1.37	0.98	2.09	2.50	1.71	2.12	2.74	1.76	1.78	1.35	5.39
Largest Patch Index (LPI)	0.25	2.94	4.08	0.02	0.08	25.94	0.06	0.08	17.06	0.08	0.09	13.78	0.08	0.15	17.58	0.22	0.10	11.37
Edge density	12.46	40.85	46.69	0.08	3.56	43.57	24.34	15.68	61.06	26.66	35.62	66.17	28.74	36.60	55.48	42.11	25.13	69.03
Mean patch size (ha)	12.23	26.32	55.56	8.53	11.63	341.53	4.65	5.12	77.88	5.52	7.25	37.12	6.98	8.01	31.97	12.53	8.88	10.92
Median size (ha)	7.16	8.19	8.81	4.13	4.25	17.06	1.25	1.25	2.88	1.50	1.53	1.50	0.88	0.44	1.31	3.31	3.06	0.13
Patch size SD	28.81	163.11	372.39	14.71	23.53	3550.25	10.05	12.47	1172.62	12.29	18.08	707.06	16.76	24.70	805.02	30.04	17.68	304.58
Patch size CV	235.48	619.73	670.23	172.45	202.28	1039.53	216.14	243.80	1505.74	222.83	249.46	1904.57	240.04	308.29	2518.16	239.69	199.22	2789.21
PAFRAC	1.28	1.38	1.38	1.49	1.29	1.44	1.30	1.30	1.38	1.31	1.30	1.41	1.29	1.28	1.33	1.35	1.34	1.34
Core % BLM	3.62	17.48	30.91	0.01	1.14	64.15	2.89	2.31	47.74	3.49	6.73	37.97	5.41	9.58	34.00	8.30	3.99	34.03
Disjunct core area density	0.88	2.50	2.52	0.00	0.22	1.84	1.46	0.93	3.37	1.63	2.05	2.70	1.81	2.05	2.54	2.64	1.65	2.76
Core mean patch size (ha)	5.41	13.76	33.38	2.95	5.43	241.68	1.34	1.68	48.90	1.67	2.69	22.20	2.56	3.49	19.29	4.67	2.96	6.32
Core median patch size (ha)	2.00	2.25	2.44	0.69	0.50	9.34	0.00	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.13	0.00
Core patch size SD	19.82	125.60	269.61	7.59	16.12	2635.52	4.49	7.10	854.13	5.40	9.71	536.18	8.41	14.51	598.10	14.82	9.16	208.90
Core patch size CV	366.36	913.12	807.72	257.54	296.89	1090.48	336.52	422.08	1746.64	323.15	360.54	2414.84	329.29	415.30	3099.91	317.09	309.29	3307.90
Clumpiness	0.88	0.86	0.85	0.88	0.89	0.52	0.81	0.83	0.73	0.82	0.83	0.78	0.84	0.85	0.83	0.83	0.83	0.79
Connectance	0.10	0.08	0.10	3.81	0.29	0.23	0.08	0.12	0.12	0.09	0.08	0.09	0.09	0.08	0.09	0.08	0.10	0.07
Landscape metrics																		
Simpson's diversity	0.61			0.17			0.40			0.55			0.61			0.59		
Mod Simpson's diversity	0.95			0.19			0.51			0.79			0.94			0.88		
Simpson's evenness	0.82			0.23			0.54			0.73			0.81			0.78		
Mod Simpson's evenness	0.68			0.14			0.37			0.57			0.68			0.63		

SE - Stand Establishment Y - Young M&SC - Mature and Structurally Complex

Table B-5. Spatial Pattern Results For BLM-Managed Lands In The Eastern Cascades Province For Current Condition And In 2106 For All Structural Stages

East Cascades	Current			No Harvest 2106			No Action 2106			Alt 1 2106			Alt 2 2106			Alt 3 2106		
Variable	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC	SE	Y	M&SC
% BLM cover	9.59	20.83	59.39	0.00	4.54	86.24	7.33	20.77	62.69	26.52	27.18	37.09	26.75	25.48	37.58	55.83	4.33	29.59
Patch density (PD)	0.53	1.04	0.80	0.00	0.21	0.52	0.60	1.41	1.03	0.99	1.30	1.54	0.78	1.38	2.31	61.78	13.12	9.64
Largest Patch Index (LPI)	1.01	4.28	20.46	0.00	0.63	30.62	1.08	0.86	16.86	2.11	2.34	2.75	2.50	1.60	1.91	7.06	2.44	0.19
Edge density	12.21	25.30	52.64	0.00	5.20	51.61	12.46	27.78	54.39	30.38	33.37	45.84	30.37	32.38	46.81	221.60	29.47	69.11
Mean patch size (ha)	17.97	19.94	73.98	1.00	21.65	165.84	12.26	14.69	61.08	26.91	20.84	24.13	34.10	18.50	16.25	61.78	13.12	9.64
Median size (ha)	9.19	6.25	12.56	1.00	9.84	15.81	6.13	5.03	7.38	7.00	5.09	5.50	9.88	2.75	1.00	7.06	2.44	0.19
Patch size SD	29.08	67.83	356.97	0.00	33.25	700.47	23.27	27.98	273.30	56.23	51.76	60.55	71.03	41.90	44.91	221.60	29.47	69.11
Patch size CV	161.86	340.11	482.55	0.00	153.60	422.38	189.78	190.46	447.43	208.92	248.43	250.99	208.31	226.50	276.41	358.68	224.63	716.74
PAFRAC	1.26	1.31	1.40	N/A	1.30	1.39	1.31	1.29	1.36	1.31	1.29	1.33	1.34	1.25	1.28	1.36	1.26	1.32
Core % BLM	5.00	10.49	34.09	0.00	2.37	56.01	2.94	9.75	36.94	13.72	13.83	19.07	13.99	12.73	19.57	32.58	2.21	16.44
Disjunct core area density	0.71	1.57	3.14	0.00	0.33	2.76	0.84	1.79	3.15	1.88	1.98	2.51	1.85	1.93	2.48	2.90	0.30	1.45
Core mean patch size (ha)	9.37	10.04	42.46	0.00	11.32	107.70	4.93	6.89	35.99	13.93	10.60	12.41	17.84	9.24	8.46	36.05	6.68	5.36
Core median patch size (ha)	3.13	1.50	3.72	0.00	5.06	7.28	1.56	0.81	2.38	1.78	0.78	0.81	3.44	3.38	0.00	1.25	0.00	0.00
Core patch size SD	20.59	43.96	222.04	0.00	23.22	480.74	10.88	17.24	173.27	33.52	30.70	36.96	40.76	23.70	27.39	142.23	19.08	43.13
Core patch size CV	219.73	437.77	522.95	0.00	205.21	446.35	220.94	250.06	481.39	240.73	289.53	297.86	228.53	256.50	323.62	394.48	285.86	805.22
Clumpiness	2.42	1.22	1.64	0.83	0.91	0.61	0.88	0.87	0.81	0.88	0.88	0.85	0.88	0.87	0.85	0.84	0.90	0.87
Connectance	1.26	1.31	1.40	0.00	2.80	2.44	2.18	0.94	1.46	1.21	1.40	1.14	1.33	1.37	1.15	1.57	3.29	1.12
Landscape metrics																		
Simpson's diversity	0.58			0.25			0.55			0.71			0.71			0.59		
Mod Simpson's diversity	0.78			0.28			0.73			0.95			1.24			0.78		
Simpson's evenness	0.88			0.33			0.80			1.24			0.95			0.89		
Mod Simpson's evenness	0.63			0.20			0.58			0.89			0.90			0.64		

SE - Stand Establishment Y - Young M&SC - Mature and Structurally Complex

These metrics were generated for the draft EIS even though only three were used in the analysis: mean patch size, connectance, and edge density. The other metrics were generated to evaluate the relative changes is the metrics used in the analysis as a quality control check. Many of the metrics are correlated, and comparison of the results can provide a check for errors in the analysis. The change in these additional metrics over time was generally consistent with the change in the metrics used in the draft EIS analysis and revealed no errors in the analysis. Therefore, FRAGSTATS results for the PRMP in the final EIS were generated only for the metrics used in the analysis: mean patch size, connectance, and edge density.

As noted in *Forest Structure and Spatial Pattern* in *Chapter 3*, all ownerships within a province comprise too large a database for computing most metrics, including connectance. Therefore, only mean patch size was computed for all ownerships at the province scale. Even the computation of mean patch size across all ownerships was lengthy and cumbersome in the draft EIS. Because of limitations in the ability of FRAGSTATS to analyze raster datasets beyond an unknown file size threshold, the final EIS used an alternative approach to calculating mean patch size across all ownerships for the PRMP.

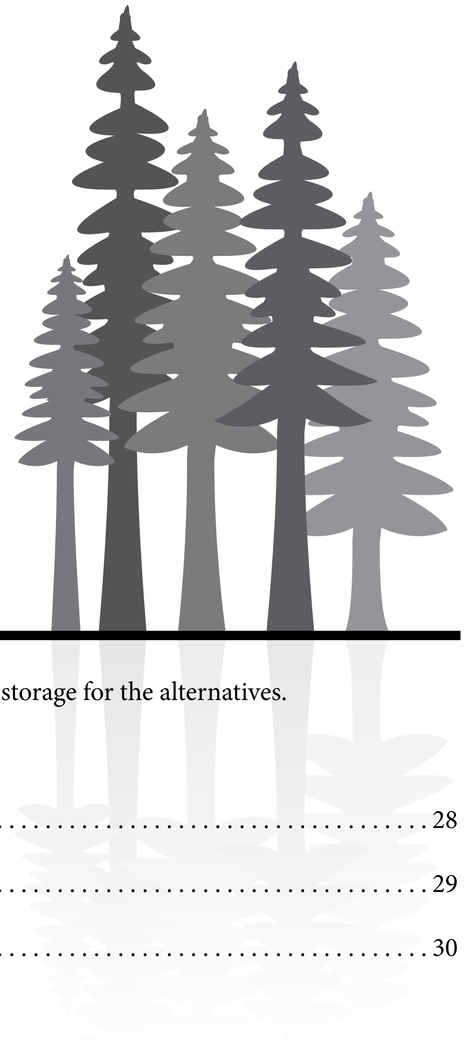
The multi-resolution image segmentation utility available in the commercial software eCognition Professional 4.0 (www.definiens.com) groups pixels into discrete image objects (patches) with numerous spectral, spatial, and contextual attributes that can be used in subsequent analyses. Mean patch area was calculated using eCognition across all ownerships within provinces by dividing the total area of image segments containing pixels with the same forest structural stage classification by the total number of patches for that class. The results were tested by using eCognition to calculate mean patch size for draft EIS alternatives for a sample of years and provinces for which mean patch size results had been calculated in the draft EIS using FRAGSTATS. For example, Table B-6 compares the results from the two methods for Alternative 3 in 2006 (*Comparison of Mean Patch Size Results for Alternative 3 in 2006 by FRAGSTATS and eCognition*).

These results are in very close agreement, and results for other years and alternatives showed similar agreement between eCognition and FRAGSTATS results. Based on this agreement, the eCognition results for the PRMP can be accurately compared to FRAGSTATS results for the other alternatives.

Table B-6. Comparison Of Mean Patch Size Results For Alternative 3 In 2006 By FRAGSTATS And eCognition.

Structural stage	**Mean Patch Size** (acres)	
	FRAGSTATS	**eCognition**
Stand Establishment	41.96	41.98
Young	6.16	6.16
Mature & Structurally Complex	28.81	28.82

Appendix C
Carbon Storage Modeling



This appendix provides background on the calculation of carbon storage for the alternatives.

In this appendix:

Analysis of Carbon Storage

The analysis of carbon storage modeled the amount of carbon stored in the forest and in harvested wood products. The analysis divided carbon storage into three pools:

- live trees
- forest carbon other than live trees
- harvested wood

The carbon in these three pools was summed to calculate the total carbon stored by alternative.

Carbon Storage in Live Trees

1. Live tree carbon was derived in this analysis using the outputs from the OPTIONS model for standing tree volume by species over time for each alternative. This analysis derived live tree volumes from the modeling results based on detailed forest inventory data and site-specific growth and yield curves. See *Appendix R – Vegetation Modeling*.
2. Standing tree volumes measured in board feet were converted to cubic feet using a conversion factor of 6.00 board feet/cubic foot.
3. The cubic foot tree volumes were converted to pounds of biomass according to the conversion factors (Simpson 1993, USDA 1987) shown in *Table C-1*:
4. The pounds of biomass derived from tree volumes were expanded to a total biomass for entire trees (including branches, bark, and roots) by multiplying by 1.85.
5. The total biomass for entire trees was converted to pounds of carbon by multiplying by 0.50 (DOE 2007, Smith et al. 2006*)*.
6. Pounds of carbon were converted to tonnes of carbon by dividing by 2200.

Table C-1. Factors For Converting Tree Volume To Pounds Of Biomass

Species Group	Pounds/Cubic foot
Douglas-fir	35
Northern hardwoods (e.g., red alder, bigleaf maple)	25
True fir	25
Southern hardwoods (e.g., madrone, tanoak, oaks)	44
Ponderosa pine	27
Juniper	25

Carbon Storage in Forests Other than Live Trees

The analysis calculated a total non-live-tree carbon pool for each of the following structural stages: stand establishment, young, mature, and developed structurally complex from values in DOE (2007) for Douglas-fir stands in the Pacific Northwest, West. In additions, the analysis calculated a total non-live-tree carbon pool for existing old forest from values in Smithwick et al. (2002). The values from Smithwick et al. (2002) for stands in the Oregon Coast Range and Oregon West Cascades were averaged to obtain a value for forests classified in this analysis as existing old forest.

The regional averages in DOE (2007) describe tonnes of carbon per acre for stands of various ages. This analysis assigned values to structural stages using stand ages from DOE (2007) as follows:

Stand establishment	age 5
Young	age 35
Mature	age 95
Developed Structurally Complex	age 125

Because the regional averages in DOE (2007) only describe values for stands up to age 125, this analysis used values for existing old forest from Smithwick et al. (2002). The values from Smithwick et al. (2002) for stands in the Oregon Coast Range and Oregon West Cascades were averaged to obtain a value for forests classified in this analysis as existing old forest. Studies of forest ecosystem carbon differ in how they partition the different ecosystem components. As a result, the values for individual ecosystem components cannot be directly compared among different studies as readily as the total carbon values. For example, the values from Smithwick et al. (2002) for soil organic carbon are far higher than the values from DOE (2007), but the values for forest floor and down dead carbon are lower than for values for 125-year-old stands from DOE (2007). These differences most likely reflect a difference in how the pools of carbon were partitioned and measured. Therefore, comparisons among studies are more reliably made for the total forest ecosystem carbon, rather than individual ecosystem components. The Forest Ecosystem carbon (excluding live trees) by structural stage is shown in *Table C-2*.

Table C-2. Forest Ecosystem Carbon (Excluding Live Trees) By Structural Stage

Structural Stage	Tonnes Of Carbon Per Acre					
	Snags	Understory	Down Dead	Forest Floor	Soil Organic	Total
Stand establishment	0.3	1.8	17.8	9.6	38.3	67.8
Young	7.1	1.3	14.2	9.4	38.3	70.3
Mature	12.8	1.2	20.0	15.9	38.3	88.2
Developed structurally complex	14.2	1.1	22.9	18.3	38.3	94.8
Existing old forest	12.3	0.5	22.8	13.5	81.7	130.9

Carbon Storage in Harvested Wood

The calculation of the carbon stored in harvested wood depends on the amount of wood harvested and how much of the carbon in that wood is emitted through harvesting, processing, waste, disposal, and decomposition.

1. The total volume of harvested wood in board feet for each alternative was derived from the outputs from the OPTIONS model. See *Appendix R – Vegetation Modeling*. This volume represents saw log volume only and does not account for pulpwood or chip volume. The total volume of harvest wood in board feet for past harvests was derived from historical records of timber sales by year, from 1962-2005. No pulpwood or chip volume is calculated for past harvests.
2. The board feet of harvested wood was converted to mass of carbon by the conversion factor for softwood lumber from Smith et al. (2006: 35): 1,000 board feet = 0.443 tonnes of carbon.
3. Pulpwood volume is calculated as an additional 5% of the total volume of harvested wood as described above in (1). The volume of pulpwood or chip harvest would be highly variable, in response to many variables, including sale location, topography, stand conditions, yarding systems, and market prices. This calculation was based on the low range of the estimate of past harvests on BLM-administered lands, in which an additional 5% to 10% of the standing merchantable volume of stands harvested was typically harvested as pulpwood or chips. Thinnings would usually have material consisting mainly of tops and sub-merchantable stems, while older stands would include more cull material and broken pieces. Topography, vegetation and yarding systems would affect the availability by reducing the recovery level of material. Areas suitable for ground-based equipment would have a higher recovery level, while areas of steep dense brush would have a lower recovery, because of the difficulty in bringing the material to the landing with cable yarding systems.
4. The amount of carbon emitted from harvested wood over time was subtracted from the total carbon in harvested wood for each decade based on the values for Pacific Northwest softwood saw logs and pulpwood in Smith et al. (2006) and DOE (2007) as shown below in *Tables C-3 and C-4*.

Table C-3. Carbon Emitted From Harvested Saw Logs

Time Since Harvest	Cumulative Percentage of Carbon Emitted Without Energy Capture
10 years after harvest	20.4
20 years after harvest	23.9
50 years after harvest	29.8
100 years after harvest	34.9

Table C-4. Carbon Emitted From Harvested Pulpwood

Time Since Harvest	Cumulative Percentage of Carbon Emitted Without Energy Capture
10 years after harvest	27.0
20 years after harvest	30.9
50 years after harvest	34.5
100 years after harvest	35.5