Appendix D

Modeling

This page intentionally left blank.

Table of Contents

List of Tables

List of Figures

List of Charts

Introduction

This appendix describes the use of a computer model (known as a ***forest estate model***) in the development of a forest land plan for the OESF.

What Is a Forest Estate Model?

A forest estate model is a mathematical, computer model that can aid the decision making process by finding an optimized solution to the problem to how to efficiently and effectively manage forest resources. It is a sophisticated analysis tool, integral to the forest land planning processes. It can tell us where and when to conduct silvicultural activities (timber harvests) in order to meet DNR's many objectives.

How Are Forest Estate Models Used in the Forest Land Planning Process?

In broad terms, forest land planning within the OESF involves the following steps:

1. The definition of specific goals and measurable objectives for the OESF, based on existing policies, rules, and laws.
2. The development of management alternatives, consisting of a set of strategies for achieving the stated goals and objectives.
3. The use of a forest estate model to determine if each management alternative can meet the stated goals and objectives, and if so, a determination of the most efficient or optimal means of doing so.
4. The use of quantitative analysis techniques to evaluate the output of the forest estate model to determine if there are potential environmental impacts associated with the alternatives (refer to RDEIS Chapter 3).

DNR uses a forest estate model to evaluate each of the management alternatives (step 3, above) and to determine the optimal methods, timing, and location of forest management activities necessary to meet the stated objectives.

DNR uses the *Remsoft Spatial Planning System*, a commercially available forest estate modeling software package developed by Remsoft Inc., in the development of the OESF Forest Land Plan.

How Does the Model Work?

In broad terms, a forest estate model is a simplified representation of the real world. It attempts to capture the most significant features of the decision under consideration (in this case, how to manage the forest) by means of mathematical abstraction. That is, it relies on formulas to represent the myriad factors that influence management decisions.

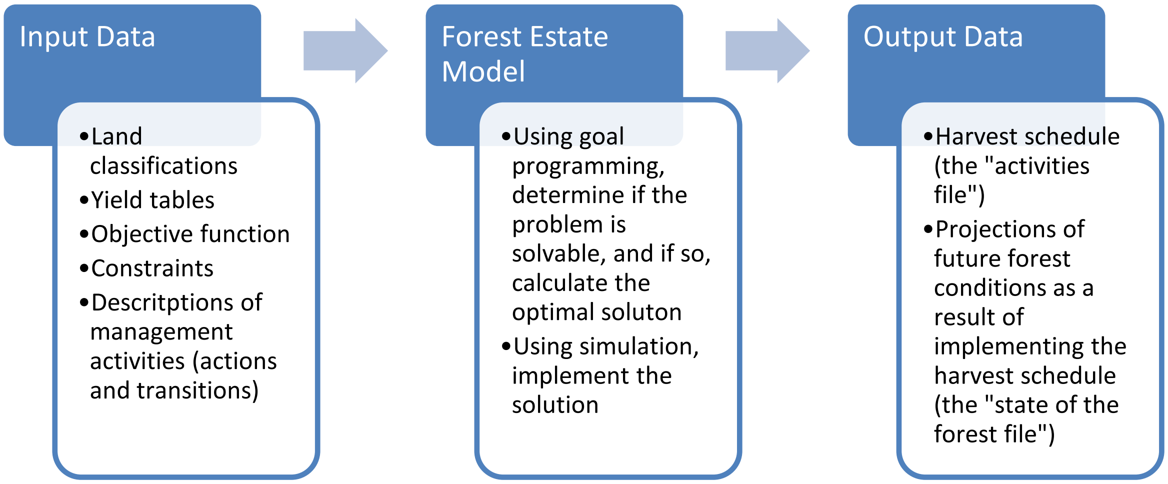
Forest estate models use an analysis technique known as *mathematical programming*. Mathematical programming can help answer questions about how to allocate limited resources among competing activities in an optimal way. In mathematical programming, the problem (how to manage the forest) is represented completely in mathematical terms, normally by means of a criterion which the model seeks to maximize or minimize. In mathematical programming terminology, the criterion is known as the *objective function*. The objective function for both No Action and the Landscape alternatives is to maximize the financial return to the trust beneficiaries, as represented by *net present value*. For additional information, refer to *Objective Function,* p. D-70. The objective function is subject to a set of mathematical *constraints* which describe the requirements to which the decisions made by the model must adhere. These constraints may reflect ecological, financial, operational, or policy considerations. For additional information, refer to *Constraints,* p. D-76.

Collectively, the mathematical equations describing the problem are represented as a multi-dimensional matrix, for which the model seeks a solution. Mathematical programming models that solve problems (i.e., the matrix) using linear functions are known as *linear programming models*. Similar to linear programming is a modeling technique known as *goal programming*, which allows for somewhat greater flexibility in finding a solution. In goal programming, the constraints are not absolutely binding. That is, deviations from the constraints are allowed and individual constraints may be under- or over-achieved. Any deviations that do take place, however, incur a penalty which helps to minimize deviations. Using goal programming, it is sometimes possible to solve otherwise unsolvable problems. DNR used a goal programming forest estate model for the development of the OESF Forest Land Plan.

Forest estate models accept as input detailed data on current conditions (such as detailed forest inventory data, administrative designations, the location of the stream network and riparian areas, northern spotted owl habitat designations); projections of future forest conditions, known as *yield tables*, (either in the presence or absence of a variety of harvest activities); and descriptions of harvest activities, including the circumstances under which certain silvicultural actions are appropriate (known as *actions*) and the results of conducting those actions (known as *transitions*). Given the objective function, and the constraints under which it is to be achieved, the forest estate model determines if a solution exists (in modeling terminology, if the solution is *feasible*), and if so, what activities must take place to achieve the solution in an efficient and optimal manner.

In the context of forest land planning, the solution provided by the forest estate model is a list of management activities known as a harvest schedule. It is a report of the recommended locations, timing, and types of harvest activities that are necessary to optimize the objective function and, to the greatest extent possible, meet the constraints. Using a modeling technique known as *simulation*, the forest estate model also provides a detailed report of site-specific future forest conditions across the entire OESF as a result of implementing the harvest schedule. These data are output in two databases. The harvest schedule is known as the “activities file”; future forest conditions are reported in the “state of the forest” file.

Figure D-1. Generalized Representation of the Forest Estate Model



Since the forest estate model is an abstraction of real word conditions, it is subject to inherent uncertainties. These uncertainties are described Chapter 4 “Cumulative Effects and Mitigation” of the Revised Draft Environmental Impact Statement (RDEIS).

What Data Is Input to the Forest Estate Model?

The forest estate model requires the following data as input:

1. Land classifications
2. Stand-level projections of future forest conditions (known as yield tables)
3. Objective function
4. Constraints
5. Descriptions of management activities (known as actions and transitions)

Land Classifications

Land classifications are attributes that describe a given location on the ground. For example, a given location may be described by the watershed (e.g. Type 3 watershed #405), hydrologic zone (e.g. “rain dominated”), or forest inventory unit (e.g. #4087) in which it is located; or its distance from the stream channel (e.g. within 75 feet). These classifications are derived from a suite of spatial and tabular Geographical Information System (GIS) data which are combined together to form a DNR data set known as the Large Data Overlay (LDO) (Snyder 2010). A subset of the attributes from the Large Data Overlay is represented in tabular form inside the forest estate model using attributes known as *themes*. Table D-1 describes the five themes used in the forest estate model.

Table D-1. Themes Used in the Forest Estate Model

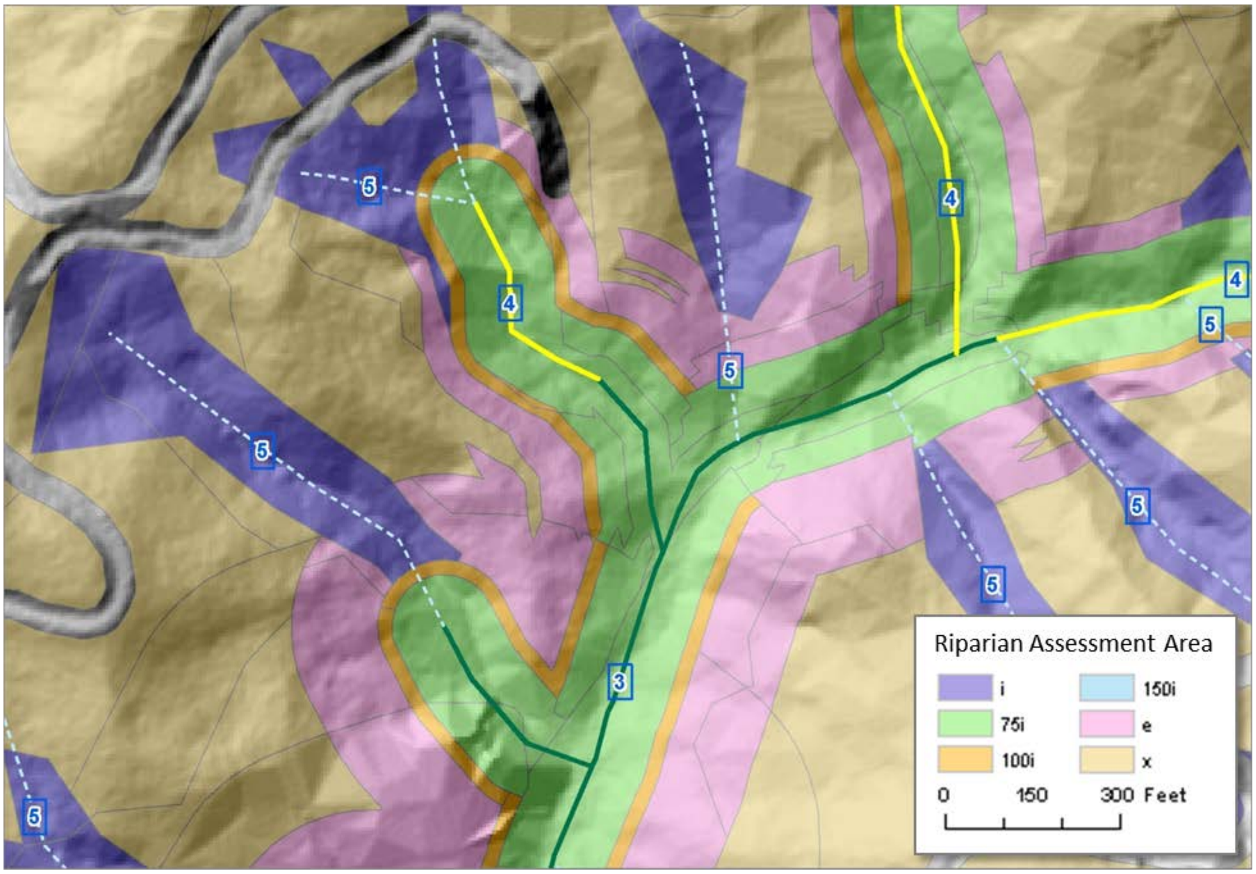
Theme number	Description
TH1	**Forest Inventory Unit (FIU):** DNR has an extensive forest inventory, which covers the majority of its forested lands. The inventory is divided into separate units (on average, approximately 70 acres in size) representing areas with relatively contiguous or homogenous forest conditions (known as stands). The inventory contains detailed data on forest stand characteristics, such as tree species composition, average tree diameter, height, volume, basal area, and density. DNR's forest inventory consists of actual field-measured data, collected from many thousands of field plots (at a density of one plot per five acres). Each forest inventory unit is given a unique numerical identifier. The forest estate model uses the "as sampled" data, which are the original, field-collected measurements. Since the field-collected measurements describe the conditions that were present at the time of sampling, they are "grown" to the current date using the Pacific Northwest Coast variant of the USDA Forest Service Forest Vegetation Simulator (FVS-PN). Areas lacking forest inventory data were assigned to one of twelve forest strata, which are generalized classifications of forest conditions (see description under *Forest Strata*, p. D-21). To provide a greater level of detail of forest conditions within the riparian area, an additional riparian forest inventory was conducted for the development of the OESF Forest Land Plan. This riparian forest inventory was based on a classification of the riparian area using aerial photographs. For this classification, 24 Forest Inventory Units within the riparian area were selected as reference stands. These stands were considered representative of the range of riparian forest conditions found in the OESF. The riparian area was divided into two distance intervals (0-75 feet, and 75-150 feet) along each side of the stream (left bank and right bank). The accuracy of the existing forest inventory was examined using aerial photographs, and in those cases where it could be refined, the existing inventory data for the given location was replaced with the data from the reference stand that it most closely resembled. The entire riparian area was examined, but only in some cases was it necessary to replace the existing inventory.

Theme number	Description
TH2	The **Silvicultural Regime** describes the sequence of harvest activities (the timing and type of harvest) currently assigned to a given area. A multitude of regimes is possible. Some stands are managed with a series of commercial thinnings; some receive a final regeneration harvest; and some stands receive no management at all. The selection of the appropriate regime for a given area is a primary function of the forest estate model. The decision is based on site-specific conditions, as well as considerations that take place at larger scales, such as those at the watershed- or landscape-level. One regime was modeled that included no management whatsoever. Areas assigned this regime received no harvests. Ten thinning regimes were modeled. Each was comprised of commercial thinnings at 30-year intervals. The ten thinning regimes differed only in the decade in which the first thinning is conducted. Thinnings were modeled by generally following the recommendations of Holmberg and Aulds (2007) and Carey (2003, 2007). In addition to assigning either a no management or thinning regime, at each decade, the forest estate model also determines whether or not to regenerate a forest stand. That is, if and when to harvest the majority of trees in an area. Regeneration harvests were not modeled as silvicultural regimes, per se, but instead were considered harvest “actions”. Such “action-based” harvests served to transition the forest from one regime to another, with a corresponding change in forest conditions. For example, the original stand may have been assigned a commercial thinning regime. It receives an action-based regeneration harvests that transitions the stand to a new state (in some cases, to the Ecosystem Initiation Stage of stand development). The stand is replanted and its growth begins anew. At that point it is set along a new trajectory, assigned to either the no management or to one of the thinning regimes, subject to action-based harvests as the model deems appropriate. By default, at the beginning of the forest estate model run, TH2 is assigned either a value of “LMP08” for stands that have been recently thinned, or a value of “NA99” otherwise. TH2 is subsequently updated at each decade as the forest estate model schedules harvest actions. For additional information, refer to *Silvicultural Regimes*, p. D-22
TH3	**Management Deferral Status** describes the level of harvest activities permitted within a given area. These deferral designations were assigned in accordance with the 2006 Policy for Sustainable Forests, the 1997 Habitat Conservation Plan, and the 2006 Settlement Agreement. Deferrals may be short-term (1 or more decades) or long-term (all 10 decades of the model simulation), or they may restrict some harvests but not others (thinning might be allowed, but not regeneration harvests). For additional information, refer to *Deferrals*, p. D-14.

Theme number	Description
TH4	**Forest Management Units (FMUs)** are areas of contiguous forest designated for management activities. Silvicultural activities are tailored to the site specific conditions within each Forest Management Unit. Forest Management Units average approximately 65 acres in size. A Forest Management Unit may consist of all or part of a Forest Inventory Unit, or it may contain parts of multiple inventory units. For those areas in which a Forest Management Unit had not yet been created, the underlying Forest Inventory Unit was used instead. All theme 4 values used a prefix to identify the source data, either "FMU-" (Forest Management Unit) or "RIU-" (Resource Inventory Unit, synonymous with Forest Inventory Unit.)
TH5	The **Watershed and Riparian Assessment Area** consists of a combination of three values: the Type 3 watershed identifier (a unique identifier assigned to each Type 3 watershed in the OESF), the hydrologic zone (a classification of each area according to its dominant precipitation type, either rain-dominated [RD] or rain-on-snow-dominated [RS]), and the riparian assessment area (a classification of each location based on its distance from the stream channel). The riparian assessment area is patterned after the expected average width interior-core and exterior buffers as described in the 1997 Habitat Conservation Plan. These areas vary in width based on stream type. They are not meant as buffer recommendations; instead, they are used to designate areas in which riparian function is assessed. In the forest estate model, these areas are represented by the following designations (refer to Figure D-1): • i = This area includes potentially unstable slopes, channel migration zones, and wetlands. Features with an "i" suffix (75i, 100i, 150i) correspond to the expected average width interior core buffer for Type 1 through 4 waters, following DNR 1997 (Table IV.5, p. IV.58) • 75i = This area includes the 100-year floodplain and all areas within 75 feet of the 100-year floodplain for Type 1 through 4 waters. • 100i = This includes all areas in the 25 foot wide area between 75 and 100 feet from the outer edge of the 100-year floodplain for Type 1 through 4 waters. • 150i = This includes all areas in the 50 foot wide area between 100 and 150 feet from the outer edge of the 100 year floodplain of Type 1 and 2 waters. "e" features correspond to the expected average width exterior buffer (DNR 1997, Table IV.8, p. IV.117) • e = "e" features are measured from the outer edge of the interior-core buffer. For Type 1 through 3 waters, "e" features are 150 wide. For Type 4 waters, they are 50 feet wide. • x = Uplands. These areas are not considered part of the riparian area.

Figure D-2. Riparian Assessment Area

"i" features (purple) include potentially unstable slopes, channel migration zones, and wetlands. "75i" features (green) include the 100-year floodplain and all areas within 75 feet of the 100-year floodplain of Type 1-4 waters. "100i" features (orange) include the 25-foot wide area between 75 and 100 feet from the outer edge of the 100-year floodplain for Type 1-4 waters. "150i" features (light blue, not pictured) include the 50-foot wide area between 100 and 150 feet from the 1000-year floodplain of Type 1 and 2 waters. "e" features (pink) are measured outward from the edge of the interior-core buffer. For Type 1-3 waters, they are 150 feet wide; for Type 4 waters, they are 50 feet wide. "x" features (tan) are uplands, and are not considered part of the riparian area. Note: roads are considered non-forest and are excluded from the spatial representation of the forest estate model. Where unstable slopes are overlapped by "75i", "100i", or "150i" features, the latter is assigned. In these instances, the unstable slope may be identified using the deferral status (THEME 3).



As a means of reducing the complexity of the input data to the forest estate model, the spatial representation of the five themes described above was simplified using an iterative GIS process. The input data was processed using a three-pass "eliminate", which combined adjacent polygons based on shared attribute values and length of shared boundaries. The localized effects of the eliminate process are visible in Figure D-2 as apparent incongruities or spatial anomalies in the data. Some buffers may appear jagged, discontinuous, or asymmetrically applied. However, when summarized at larger scales such as the Type 3 watershed level or at the scale of the OESF, the net change in acreage in any single riparian buffer category was negligible. On average, at the Type 3 watershed-level, the eliminate process resulted in a 2.7 percent reduction in interior core buffers (n = 594, standard deviation 16.6 percent) and 1.7 percent reduction in exterior buffers (n = 594, standard deviation 12.5 percent). At the OESF-level, the eliminate process increased interior core buffers by 0.2 percent and decreased exterior buffers by 0.3 percent.

Collectively, the five themes shown in table D-1 serve to describe any given location on the OESF. The unique combination of values taken on by the five themes, with the addition of an age index, is known as a *development type*. A development type is the basic unit upon which actions are conducted and predictions about the outcome of those actions are made in the forest estate model. For the OESF forest estate model, the age index is measured in decades.

For example, if themes 1 through 5 were assigned the values shown in table D-2, and the stand had an age index of 9 , its development type would be:

"90574 Lmp9 Na Fmu-68902 102-rd-100 9"

Table D-2. The Use of Themes to Construct a Development Type

Theme	Example value	Description
TH1	90574	Stand conditions are specified by forest inventory unit # 90574
TH2	Lmp9	Currently assigned to a commercial thinning regime which has its first scheduled harvest during the ninth decade
TH3	Na	Not subject to a deferral
TH4	Fmu-68902	Located within forest management unit # 68902
TH5	102-rd-100	Located within Type 3 watershed #102, in the rain-dominated (rd) hydrologic zone, within the 25 foot wide band located between 75 and 100 feet of the 100 year floodplain of a Type 1 through 4 stream

All stands with this unique combination of attributes (i.e. development type) are expected to grow and respond to silvicultural activities in the same manner. Approximately 462,000 development types were used in the forest estate model, one for each unique combination of values for themes 1 through 5 with the addition of an age index.

Additional land classifications were derived using groupings (in modeling terminology, known as *aggregations*) of various themes. Aggregations are defined on a theme-by-theme basis. That is, aggregations may be constructed from any of the five themes, but each aggregation may only include values from a single theme. For example, the collection of all areas in which thinning is permitted was represented by an aggregate of THEME 3 values "NA" and "PARTIAL". The boundaries of each of the eleven Landscape Planning Units in the OESF were represented using aggregations of Forest Management Units (THEME 4). Aggregations are also used extensively in describing the *operability criteria* - the circumstances under which management actions may occur (refer to *Actions*, p. D-24).DNR manages a total of 270,381 acres within the OESF[1]. Since the forest estate model is used primarily to analyze and project changes in forest conditions over time, non-forested areas such as water bodies and roads were not included in the forest estate model[2]. As a result, the total area included in the forest estate model is smaller (approximately 257,566 acres). Non-forested areas were identified by their land use classification in the Large Data Overlay. The width of the road right-of-way was modeled as either 30 feet or 50 feet, according to the road use classification. For a description of the database query used to identify these areas, refer to the Large Data Overlay documentation (Snyder 2010).

DEFERRALS

Table D-3 describes which areas in the OESF are deferred from harvest, the duration of the deferral, the permitted activities, and the data source and queries used to identify the area in question. A stand may be subject to one or more deferrals. In such cases, the most restrictive deferral takes precedence. Most deferrals are based on assessments of current conditions. However, deferrals of northern spotted owl habitat also incorporate and assessment of projected future conditions. Stands that currently do not meet procedural definitions for Young Forest or Old Forest habitat, yet do so within the first three decades, are subject to the same deferrals as described in table D-3. That is, once a stand becomes Young Forest or Old Forest habitat, action-based harvests are no longer permitted during the first three decades. As with the northern spotted owl deferrals based on current conditions, these stands are "released" at decade four. Other deferrals, however, may still be in effect which would preclude harvests. In addition, modeling rules known as constraints, may also serve to exclude harvests from some areas (refer to *Constraints*, p. D-76)

Table D-3 Deferral Status

Classification	Duration	Activities	Data source and query
Marbled murrelet occupied sites and their associated 100 meter buffer, and reclassified sites	Long-term (decades 1-10)	None permitted.	Data source: TBD MMGMT_DESC <> "-1" Manually edited to include reclassified sites.
Gene pool reserves	Long-term (decades 1-10)	None permitted.	Data source: ROPA.GENEPOOL
Natural Area Preserves	Long-term (decades 1-10)	None permitted.	Data source: LDO SUR_OWN_CD = 74
Natural Resources Conservation Area	Long-term (decades 1-10)	None permitted.	Data source: LDO SUR_OWN_CD = 75
Administrative Sites	Long-term (decades 1-10)	None permitted.	Data source: LDO SUR_OWN_CD = 13
"Problem" stands	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 440
"Inoperable" stands	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 450
Low sites stands with no commercial value.	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 460
Research or permanent plots	Short-term (decades 1-3)	No "action-based" harvests during the first 3 decades. "Inventory-based" thinning harvests are permitted. These areas are "released" at decade 4, upon which time the harvest restriction is lifted. Other constraints may still apply which would preclude harvest.	Data source: LDO DEFER_YR in (2014, 2019)

Classification	Duration	Activities	Data source and query
	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 481 or DEFER_YR in (2025, 2030, 2039, 2049, 2059, 2069, 2070)
Seral stage blocks (old growth research areas?)	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 482
Upland Wildlife Management Areas	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 483 or LANDUSE_CD = 494
Recreation sites	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 610
Protected from harvest (general category)	Long-term (decades 1-10)	None permitted.	Data source: LDO LANDUSE_CD = 640
Old growth forests	Long-term (decades 1-10)	None permitted.	Data source:LDO WOGHI_INDX ≥ 38
Mapped Old Forest spotted owl habitat	Long-term (decades 1-10)	None permitted.	Data source: LDO NSO_MGMT_CD = 'OF'
Type A spotted owl nesting habitat	Long-term (decades 1-10)	None permitted.	Data source: LDO NSO_MGMT_CD = 'A'
Type B spotted owl nesting habitat	Long-term (decades 1-10)	None permitted.	Data source: LDO NSO_MGMT_CD = 'B'
High quality spotted owl nesting habitat	Long-term (decades 1-10)	None permitted.	Data source: LDO NSO_MGMT_CD = 'HQ'
Sub-mature spotted owl habitat	Short-term (decades 1-3)	No "action-based" harvests during the first 3 decades. "Inventory-based" thinning harvests are permitted. These areas are "released" at decade 4, upon which time the harvest restriction is lifted. Other constraints may still apply which would preclude harvest.	Data source: LDO NSO_MGMT_CD = 'S'
Young Forest Marginal spotted owl habitat	Short-term (decades 1-3)	No "action-based" harvests during the first 3 decades. "Inventory-based" thinning harvests are permitted. These areas are "released" at decade 4, upon which time the harvest restriction is lifted. Other constraints may still apply which would preclude harvest.	Data source: LDO NSO_MGMT_CD = 'Y'

Classification	Duration	Activities	Data source and query
'Unknown" spotted owl habitat at least 50 years old	Short-term (decades 1-3)	No "action-based" harvests during the first 3 decades. "Inventory-based" thinning harvests are permitted. These areas are "released" at decade 4, upon which time the harvest restriction is lifted. Other constraints may still apply which would preclude harvest.	Data source: LDO NSO_MGMT_CD = 'U' and Ager >= 50
Wetland and their associated buffers	Long-term (decades 1-10)	No "action-based" harvests. Inventory-based thinning harvests permitted.	Data source: LDO O_WET_TY in ('i', 'e')
Potentially unstable slopes and landforms; floodplain and all areas within 25 feet of the floodplain for Type 1 through 4 waters	Long-term (decades 1-10)	None permitted.	Data source: LDO O_UNST_TY = 'i' or (O_RB_DIST > 0 and O_RB_DIST <= 25)

Yield Tables

Yield tables provide stand-level projections of forest conditions and how they change over time. These changes may result from natural growth or harvest activities. Eleven separate yield tables (one for each of the eleven silvicultural regimes; see discussion under *Silvicultural Regimes*) were produced for each of the approximately 4,000 Forest Inventory Units and 12 forest strata in the OESF.

The yield tables were developed using the Pacific Northwest Coast variant of the USDA Forest Service Forest Vegetation Simulator (FVS-PN) (USDA 20008). FVS uses the stand-level forest conditions from DNR's forest inventory (where available, or from forest strata if inventory data is not available) as starting conditions, and then projects the future condition of a suite of stand-level parameters at 10-year (decadal) intervals. Table D-4 lists the parameters included within the yield tables. The calculated parameters include the size, density, and volume of trees within a forest stand; and whether the stand meets the definition of various habitat classes.

Table D-4. Stand-Level Forest Parameters Included in the Yield Tables.

Parameter name	Description
RIU_ID	See description under Table D-1
TH1	See description under Table D-1
TH2	See description under Table D-1

Parameter name	Description
TH3	See description under Table D-1
TH4	See description under Table D-1
TH5	See description under Table D-1
YAGE	A forest may be composed of multiple groups (or cohorts) of age classes. YAGE is a statistical estimate of the main tree cohort in the stand.
YTOPHTI	Average height (feet) of the 40 largest diameter live trees in the stand.
YBA8I	Basal area (square feet per acre) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YRD8I	Curtis' relative density (unitless) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YBA3D5I	The total basal area (square feet per acre) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 3.5 inches.
YTPA8I	A count of the number of live trees per acre with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YTPA3D5I	A count of the number of live trees per acre with a diameter at breast height (dbh) greater than or equal to 3.5 inches.
YTPA20I	A count of the number of live trees per acre with a diameter at breast height (dbh) greater than or equal to 19.5 inches.
YTPA30I	A count of the number of live trees per acre with a diameter at breast height (dbh) greater than or equal to 29.5 inches.
YTPA39I	A count of the number of live trees per acre with a diameter at breast height (dbh) greater than or equal to 38.5 inches.
YRD3D5I	Curtis' relative density (unitless) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 3.5 inches.
YQMD8I	Quadratic mean diameter (inches) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YQMD3D5I	Quadratic mean diameter (inches) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 3.5 inches.
YCFTI	Volume (cubic feet per acre) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YBFTI	Volume (Scribner board feet per acre) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YSDII	Reineke's Stand Density Index, a unitless measure of stocking of trees within the stand.
YSDIMXI	Theoretical maximum Reineke's Stand Density Index achievable within the stand.
YLAYERSI	The number of canopy layers in the stand (calculated using default settings for the Pacific Northwest Coast variant of the USDA Forest Service Forest Vegetation Simulator).
YSTCLSI	The number of structure classes in the stand (calculated using default settings for the Pacific Northwest Coast variant of the USDA Forest Service Forest Vegetation Simulator).
ySNAG20I	A count of the number of dead, standing trees per acre with diameter at breast height (dbh) greater than or equal to 19.5 inches.

Parameter name	Description
yCWDI	Estimated coarse woody debris, in cubic feet per acre. Includes both an estimate of the coarse woody debris from the forest inventory (subject to decay over time) and an FVS-derived estimate of the additional input of coarse woody debris from tree mortality, as trees dies, become snags, and fall down.
YSNAG30I	A count of the number of dead, standing trees per acre with diameter at breast height (dbh) greater than or equal to 29.5 inches.
YPCNTBA8R	Volume removal due to harvest, reported as a percent of the basal area of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
YCFTR	Volume removal due to harvest, reported as cubic volume per acre of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
YBFTR	Volume removal due to harvest, reported as Scribner board feet per acre of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
PPAALL	An estimate of the number of marbled murrelet nesting platforms (reported as platforms per acre) derived by applying the inventory model method, as described in section 15 of the Forest Practices Board Manual (WFPB 2004)

Additional yields for northern spotted owl habitat were calculated in a separate step by processing the standard output of the USDA Forest Service Forest Vegetation Simulator. A summary of the queries used to derive these yields is presented in table D-5. Northern spotted owl yields were based on Procedure 14-004-120 *Northern Spotted Owl Management (Westside)*.

Table D-5. Derived Stand-Level Forest Parameters (Yields)

Parameter name	Description	Query
YYFMHABI	Binary value (0 or 1) indicating whether the stand qualifies as Northern Spotted Owl young forest marginal habitat.	• Dominants/co-dominants at least 85 feet tall AND • (At least 2 snags per acre ≥ 20 inches dbh OR at least 4800 cubic feet per acre down wood) AND • Curtis' relative density ≥ 48 for trees ≥ 3.5 inches dbh • 115 to 280 trees per acre ≥ 3.5 inches dbh AND • Dominants/co-dominants at least 30 percent conifer, by trees per acre
YSMHABI	Binary value (0 or 1) indicating whether the stand qualifies as Northern Spotted Owl sub-mature habitat.	• Dominants/co-dominants at least 85 feet tall AND • At least 3 snags per acre ≥ 20 inches dbh AND • At least 2400 cubic feet per acre down wood AND • Curtis' relative density ≥ 48 for trees ≥ 3.5 inches dbh • 115 to 280 trees per acre ≥ 3.5 inches dbh AND • Dominants/co-dominants at least 30 percent conifer, by trees per acre
YYFHABI	Binary value (0 or 1) indicating whether the stand qualifies as Northern Spotted Owl young forest habitat.	Qualifies as either young forest marginal or sub-mature habitat using above queries

Parameter name	Description	Query
YOFHABI	Binary value (0 or 1) indicating whether the stand qualifies as Northern Spotted Owl old forest habitat.	• Mapped as "Old Forest" per the Settlement Agreement (WEC v. Sutherland, 2006) OR • Not a single species stand AND • Canopy typically dominated by 75 to 100 trees per acre with a dbh ≥ 20 inches AND • Curtis' relative density ≥ 48 for trees ≥ 3.5 inches dbh AND • More than 1.3 canopy layers AND • At least 1 snag per acre ≥ 20 inches dbh AND • At least 2400 cubic feet per acre down wood OR • Not a single species stand AND • Canopy typically dominated by 15 to 75 trees per acres with a dbh ≥ 30 inches AND • Curtis' relative density ≥ 48 for trees ≥ 3.5 inches dbh AND • More than 1.3 canopy layers AND • At least 2 snags per acre ≥ 30 inches dbh AND • At least 2400 cubic feet per acre down wood OR • At least 31 trees per acre ≥ 21 inches dbh AND • At least 15 trees per acre ≥ 31 inches dbh AND • Curtis' relative density ≥ 48 for trees ≥ 3.5 inches dbh AND • At least 12 snags per acre ≥ 20 inches dbh AND • At least 2400 cubic feet per acre down wood
YMURRPOCC	Probability (measured on a continuous scale from 0 to 1) of marbled murrelet occupancy within the stand.	Adapted from a logistic regression equation developed by Raphael and others (2008) relating the marbled murrelet probability of occupancy to an estimate of the number of canopy layers and the number of platforms. FVS provides an initial estimate of the number of canopy layers and platforms. These initial estimates are augmented in a post-process, described on p. D-90 through D-93. $\frac{e^{-0.44-0.94*layers+0.19*platforms}}{1+e^{-0.44-0.94*layers+0.19*platforms}}$

FOREST STRATA

Approximately 38,397 acres (or 15%) of the OESF has either not yet been inventoried, or the inventory data for these areas is incomplete. In order for these areas to be incorporated into the forest estate model, generalized classifications of forest conditions known as *forest strata* were developed. Like the forest inventory, forest strata can be used to describe current conditions. Yield tables built from forest strata can describe future conditions, such as how these forests are expected to grow naturally or respond to harvest activities. The forest strata used in the forest estate model were based on three key factors that determine how a forest grows and changes over time: site class, shade tolerance, and stand density.

Site class is a measure of how rapidly trees grow and is typically based on how tall the trees get after a set period of time (usually 50 or 100 years). It is reported on an ordinal scale from one (low productivity) to five (high productivity).

Shade tolerance is a classification of the tree species found within a forest, based on how well they grow under a shaded condition. Species such as Douglas-fir (*Pseudotsuga menziesii*) grow poorly when shaded; they are considered shade intolerant. Species such as western hemlock (*Tsuga heterophylla*) grow well when shaded; they are considered shade tolerant. Forests consisting of both shade tolerant and shade intolerant species were classified as mixed.

Stand density is a measure of tree stocking, that is, the number of trees in a given area. It was reported as a percent of the maximum Reineke's Stand Density Index, in three classes: less than 30 percent of maximum stand density, between 30 and 70 percent of maximum stand density, and greater than 70 percent of maximum stand density.

A total of 45 strata can be constructed from the possible combinations of site class (I, II, III, IV, V), shade tolerance (tolerant, intolerant, mixed), and stand density (< 30%, 30-70%, > 70%). A review of the existing forest inventory revealed that only 39 of the possible 45 strata were documented to occur on the OESF. DNR constructed yield tables for each of these 39 strata using a subset of the forest inventory data. This process utilized the actual data that was collected during the forest inventory (i.e., the "as sampled" data), and only from stands that were in the 30-year age class (between 26 and 34 years of age) at the time they were inventoried. This age class was selected since it provided a broad range of data and was considered representative of conditions across the entire OESF.

Within each stratum, the yield table parameters for the 30-year age class were calculated as an area-weighted average of its constituent stands. That is, all stands in the 30-year age class (aged 26-34) that met the definition of the given stratum were examined, and their stand-level parameters were combined. For example, one of the 39 strata is defined as site class III, shade tolerant, with a stand density greater than 70 percent. All stands in the 30-year age class with this combination of site class (III), shade tolerance (tolerant), and stand density (> 70%) were selected, and an average value for each stand level parameter (such as basal area or volume) was calculated. The average value was area-weighted, so that larger stands carried more weight than smaller stands in the calculation.

Yield tables span multiple decades, with each row in the table representing the condition of the stand at a given decade. The area-weighted averages described above were used to populate a single row in the yield table, that corresponding to the 30-year age class (decade 3). Yield table parameters for the remaining decades were generated by modeling these data forward and backward in time using the Pacific

Northwest Coast variant of the USDA Forest Vegetation Simulator (FVS-PN). The resulting yield tables were then examined, and the 39 strata were further grouped into the 12 strata shown in table D-6, based on similarities in stand development trajectories, predictions of future board foot volume, and spotted owl habitat.

Table D-6. Forest Strata

Strata	Site class	Shade tolerance	Stand density (as a percent of the maximum Reineke's Stand Density Index)	Area assigned to each stratum at the start of the forest estate model run (acres, % of OESF)	
I_ALL	I	All (tolerant, intolerant, and mixed)	All	685	< 1%
II_ALL	II	All (tolerant, intolerant, and mixed)	All	2,675	1%
III_I_ALL	III	Intolerant	All	1,914	1%
III_M_37	III	Mixed	30 to 70 percent	8,725	3%
III_M_7	III	Mixed	> 70 percent	1,574	1%
III_TM_3	III	Tolerant and mixed	< 30 percent	26	< 1%
IIIIV_T_37	III and IV	Tolerant	30 to 70 percent	19,610	8%
IIIIV_TM_7	III and IV	Tolerant and mixed	> 70 percent	1,891	1%
IV_I_ALL	IV	Intolerant	All	60	< 1%
IV_M_37	IV	Mixed	30 to 70 percent	1,067	< 1%
IV_TM_3	IV	Tolerant and mixed	< 30 percent	13	< 1%
V_ALL	V	All (tolerant, intolerant, and mixed)	All	155	< 1%

To assign a stand that lacks inventory data to a strata-based yield table requires some knowledge of its site class, shade tolerance, and stand density. The age of the stand must also be known in order to determine which row of the yield table should be used to describe the stand's current condition. Age data was available for all DNR-managed lands within the OESF. Where available, site class data was taken from completed soil surveys, and shade tolerance and stand density were taken from completed stocking surveys. Where data were unavailable, a landscape-level average was used. The default stratum for the OESF was IIIIV_T_37, which refers to shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density between 30 and 70 percent of the maximum.

Growth and yield tables built from the 12 forest strata were used for two purposes: 1) to represent forest conditions within areas with incomplete or lacking forest inventory data; and 2) to represent future forest conditions for stands selected by the forest estate model to receive an "action-based" harvest. All stands selected for action-based harvest were transitioned from an inventory-based yield table (if available) to a strata-based growth and yield table.

SILVICULTURAL REGIMES

A *silvicultural regime* describes the sequence of harvest activities (the timing and type of harvest) currently assigned to a given area. Eleven silvicultural regimes were included in the forest estate model: one in which no-management occurs (labeled "NA99"), and ten regimes consisting of variable density thinnings at 30 year intervals beginning in each of the ten decades of the model simulation (labeled "LMPx"[3], where x refers the decade in which the first variable density thinning occurs) . The eleven regimes are listed in Table D-7.

Table D-7. Silvicultural Regimes

Regime	Description	Decade									
		1	2	3	4	5	6	7	8	9	10
NA99	No management										
LMP1	Variable density thinning harvests at 30-year intervals, beginning in decade 1.	VDT			VDT			VDT			VDT
LMP2	Variable density thinning harvests at 30-year intervals, beginning in decade 2.		VDT			VDT			VDT		
LMP3	Variable density thinning harvests at 30-year intervals, beginning in decade 3.			VDT			VDT			VDT	
LMP4	Variable density thinning harvests at 30-year intervals, beginning in decade 4.				VDT			VDT			VDT
LMP5	Variable density thinning harvests at 30-year intervals, beginning in decade 5.					VDT			VDT		
LMP6	Variable density thinning harvests at 30-year intervals, beginning in decade 6.						VDT			VDT	
LMP7	Variable density thinning harvests at 30-year intervals, beginning in decade 7.							VDT			VDT
LMP8	Variable density thinning harvests at 30-year intervals, beginning in decade 8.								VDT		
LMP9	Variable density thinning harvests at 30-year intervals, beginning in decade 9.									VDT	
LMP10	Variable density thinning harvests at 30-year intervals, beginning in decade 10.										VDT

By design, the timing of the variable density thinning harvest within each silvicultural regime is pre-determined. Scheduling the thinning harvests within each regime in advance greatly reduces the complexity of the problem the forest estate model must solve. The forest estate model must still determine the timing the first thinning entry, but decisions about the timing of subsequent thinning entries are passive. Unless the stand is re-assigned to another regime (for a description of how or why this would occur, refer to *Actions*, p. D-24 and *Transitions*, p. D-52.), thinning harvests automatically occur at 30-year intervals.

For any given stand, the effects of the variable density thinnings shown in Table D-7 are represented in a corresponding yield table for that stand and regime. A separate yield table was generated for each forest inventory unit (or forest strata, for areas lacking forest inventory data) for each of the eleven silvicultural regimes. Since the timing and effects of these variable density thinning harvests are represented in the yield tables, they are known as "inventory-based" harvests. For a description of how variable density thinning harvest prescriptions were represented in the forest estate model, refer to *Descriptions of Management Activities*, p. D-24.

In addition to the variable density thinning harvests shown in Table D-7, at each decade the forest estate model also determines whether or not to intervene in the development trajectory of the stand by conducting additional management activities. These activities were represented using modeling constructs known as "actions". Most, but not all, actions involve harvest. Harvests conducted as part of an action are known as "action-based" harvests.

Actions were not modeled as silvicultural regimes, per se, but instead serve to change the stand from one regime to another. In cases where the action includes a harvest, there is a corresponding change in forest conditions within the stand. The process of changing regimes due to action-based harvests creates additional "composite" silvicultural regimes, as illustrated in Figure D-3.

DESCRIPTIONS OF MANAGEMENT ACTIVITIES (ACTIONS AND TRANSITIONS)

At a basic level, the forest estate model conducts two general classes of harvest activities: thinnings and regeneration harvests. Each of which may be further categorized based upon differences in the silvicultural activities themselves, or the modeling techniques used to represent them.

As described in *Silvicultural Regimes*, variable density thinning harvests conducted as part of the silvicultural regimes are classified as "inventory-based". All inventory-based harvests were modeled as variable density thinnings. Harvest prescriptions followed the recommendations of Holmberg and Aulds (2007) and Carey (2003 and 2007). The residual (post-harvest) stand density varied with shade tolerance. The target residual Curtis' relative density for trees greater than or equal to 7.5 inches dbh (yield parameter YRD8I) was 35 for shade intolerant stands, 38 for stands with mixed shade tolerance, and 42 for shade tolerant stands. Forest growth and yields under each of the silvicultural regimes listed in Table D-7 were modeled using the Pacific Northwest Coast variant of the USDA Forest Service Forest Vegetation Simulator (FVS-PN) (USDA 2008). Modeling of the thinning regime within FVS included the insertion of 134 established understory trees per acre 30 years after each thinning entry.

Actions

All management decisions within the forest estate model are represented using modeling constructs known as "actions". Each action represents some type of active intervention by the model on the development trajectory of the stand. Most, but not all, actions involve harvests.

One of the first decisions (i.e., actions) the forest estate model must make is to determine what silvicultural regime to assign to each stand. For a stand to be considered eligible of a given regime, it had to satisfy its *operability criteria* - a set of conditions that must be met in order for the action (in this case, the assignment of a regime) to take place.

For inventory-based thinning harvests, the operability criteria dictate that the stand must be one in which thinning is permitted (that is, it is not located in a land classification that would preclude thinning harvests); and the stand conditions must warrant thinning at each decade in which the given regime has scheduled a thinning harvest. For example, the LMP1 regime schedules thinning harvests in decades 1, 4, 7, and 10 (Table D-7). For a stand to be assigned to the LMP1 regime, the stand must be eligible for thinning in each of those decades. For a stand to be eligible for thinning, at the beginning of the decade the average top height of the 40 largest trees in the stand must be least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The operability criteria also specify minimum requirements for stand top height during the first decade (Table D-8).

This assignment of the initial silvicultural regime is an example of an action that does not involve harvest, per se. The action merely assigns a silvicultural regime; unless the forest estate model schedules another action, the inventory-based harvests that make up that regime occur automatically over time as the regime is implemented.

Other actions do include harvests. These action-based harvests are all conducted in a similar manner. The harvest prescriptions for all action-based harvests are identical, akin to a regeneration harvest; the majority of trees are removed. However, based on a classification of the spatial configuration of the Forest Management Unit being harvested, a given action-based harvest may be classified as either a thinning or a regeneration harvest. Using a spatial characteristic known as *edge density*, action-based thinning harvests can be further categorized as either uniform or variable density thinnings; action-based regeneration harvests can be classified as variable retention harvests with high, medium, or low edge density (Table D-10). For a description of how edge density is calculated and used to classify action-based harvests, refer to *Edge Density*, p. D-64.

At each decade, the forest estate model evaluates each stand and decides whether an action-based harvest should occur. The operability criteria for action-based harvests consider whether the activity is permitted in the area in question, and whether stand conditions warrant the activity. In addition to determining whether the harvest should occur, the forest estate model must also decide what the development trajectory should be for the stand following harvest. That is, on what silvicultural regime should the stand be placed following the harvest. In general, action-based harvests may occur at any decade. However, the decision to conduct an action-based harvest in one decade affects the eligibility and timing of future action-based harvests in the stand in question. A modeling feature known as a "lock"[4] allows each action-based harvest to exclude future action-based harvests in the same stand until a specified number of decades have elapsed.

All actions within the forest estate model are conducted upon "development types". A development type is a means of identifying an area by its unique combination of thematic values (Table D-1).

Table D-8 summarizes each of the actions included in the OESF forest estate model. As described above, actions serve two primary functions in the forest estate model. They are used to represent the decisions about the appropriate silvicultural regime for a given stand, and whether the stand should receive an action-based harvest.

Table D-8. Actions

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP1	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP1 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 1)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP1 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 85 feet	The THEME1 aggregate agLMP1 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 1, 4, 7, and 10. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. Since this action is assessed only in period 1, THEME2 holds one of two default values. A default value of NA99 indicates the stand has not been recently managed. The THEME3 aggregate agOK2THIN specifies that the deferral status is either NA (not deferred) or PARTIAL (no VRH allowed, but thinning is permitted). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2THIN specifies that the riparian assessment area is either “i”, “75i”, “100i”, “150i”, “e”, or “x”. Since this aggregate includes all riparian assessment areas, no areas are excluded by this aggregate. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP2	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP2 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 2)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP2 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 75 feet	The THEME1 aggregate agLMP2 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 2, 5, and 8. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 75 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP3	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP3 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 3)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP3 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER**: • yTophti_1 ≥ 55 feet	The THEME1 aggregate agLMP3 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 3, 6, and 9. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 55 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP4	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP4 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 4)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP4 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 35 feet	The THEME1 aggregate agLMP4 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 4, 7, and 10. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 35 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP5	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP5 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 5)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP5 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 25 feet	The THEME1 aggregate agLMP5 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 5 and 8. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 25 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP6	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP6 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 6)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP6 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 15 feet	The THEME1 aggregate agLMP6 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 6 and 9. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 15 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP7	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP7 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 7)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP7 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 10 feet	The THEME1 aggregate agLMP7 includes all Forest Inventory Units whose stand conditions warrant thinning in decades 7 and 10. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 10 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP8	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP8 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 8)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP8 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 5 feet	The THEME1 aggregate agLMP8 includes all Forest Inventory Units whose stand conditions warrant thinning in decade 8. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 5 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP9	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP9 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 9)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP8 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 0 feet	The THEME1 aggregate agLMP9 includes all Forest Inventory Units whose stand conditions warrant thinning in decade 9. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 0 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP10	No harvest is conducted as part of this action. Instead, this action determines whether to place the development type on the LMP9 regime (an inventory-based thinning regime composed of variable density thinnings at 30 year intervals with the first entry scheduled for decade 9)	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP8 • THEME2 equals NA99 • THEME3 is a member of aggregate agOK2THIN • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2THIN **YIELD PARAMETER:** • yTophti_1 ≥ 0 feet	The THEME1 aggregate agLMP10 includes all Forest Inventory Units whose stand conditions warrant thinning in decade 10. At the beginning of each of these decades, the top height of the 40 largest trees in the stand must be at least 80 feet, and the stand must contains at least 4,800 net Scribner board feet per acre of harvestable volume. The THEME2, THEME3, THEME4, and THEME5 components of the mask are the same as described for action aLMP1. An additional criterion specifies that the top height of the 40 largest trees in the stand is at least 0 feet at the end of the first decade.	No

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aNA99r	Action-based harvest, followed by assignment to the NA99 (no management) regime	1-3	**THEMATIC MASK:** • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
		4-10	**THEMATIC MASK:** • THEME3 is a member of aggregate agANYHARVP2 • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • yTophti_1 ≥ 85 feet	The THEME3 aggregate agANYHARVP2 specifies that the deferral status is either NA (not deferred) or PARTIAL (no VRH allowed, but thinning is permitted). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (yTophti) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP1r	Action-based harvest, followed by assignment to the LMP1 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the first decade following the action-based harvest.	1-3	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP1r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP1r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 1. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP1r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_M_37”, “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
		4-6	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP1r • THEME3 is a member of aggregate agANYHARVP2 • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** yTophti_1 ≥ 85 feet	The THEME1 aggregate agLMP1r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 1. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP1r: "I_ALL", "II_ALL", "III_I_ALL", "III_M_37", "III_M_7", "IIIIV_T_37", "IIIIV_TM_7", "IV_M_37", and "V_ALL". The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARVP2 specifies that the deferral status is either NA (not deferred) or PARTIAL (no VRH allowed, but thinning is permitted). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either "75i", "100i", "150i", "e", or "x". This aggregate excludes "i" features. An additional criterion (yTophti) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP2r	Action-based harvest, followed by assignment to the LMP2 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the second decade following the action-based harvest.	1-3	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP2r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP2r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 2. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP2r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
		4-5	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP2r • THEME3 is a member of aggregate agANYHARVP2 • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • yTophti_1 ≥ 85 feet	The THEME1 aggregate agLMP2r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 2. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP2r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARVP2 specifies that the deferral status is either NA (not deferred) or PARTIAL (no VRH allowed, but thinning is permitted). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (yTophti) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP3r	Action-based harvest, followed by assignment to the LMP3 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the third decade following the action-based harvest.	1-3	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP3r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP3r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 3. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP2r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, “IV_TM_3”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
		4	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP3r • THEME3 is a member of aggregate agANYHARVP2 • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • yTophti_1 ≥ 85 feet	The THEME1 aggregate agLMP3r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 3. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP3r: "I_ALL", "II_ALL", "III_I_ALL", "III_M_37", "III_M_7", "III_TM_3", "IIIIV_T_37", "IIIIV_TM_7", "IV_I_ALL", "IV_M_37", "IV_TM_3", and "V_ALL". The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARVP2 specifies that the deferral status is either NA (not deferred) or PARTIAL (no VRH allowed, but thinning is permitted). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either "75i", "100i", "150i", "e", or "x". This aggregate excludes "i" features. An additional criterion (yTophti) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP4r	Action-based harvest, followed by assignment to the LMP4 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the fourth decade following the action-based harvest.	1-3	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP4r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP4r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 4. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP4r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, “IV_TM_3”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP5r	Action-based harvest, followed by assignment to the LMP5 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the fifth decade following the action-based harvest.	1, 2	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP5r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP5r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 5. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP5r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, “IV_TM_3”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP6r	Action-based harvest, followed by assignment to the LMP6 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the sixth decade following the action-based harvest.	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP6r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP6r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 6. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP6r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, “IV_TM_3”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP7r	Action-based harvest, followed by assignment to the LMP7 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the seventh decade following the action-based harvest.	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP7r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP7r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 7. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP7r: "I_ALL", "II_ALL", "III_I_ALL", "III_M_37", "III_M_7", "III_TM_3", "IIIIV_T_37", "IIIIV_TM_7", "IV_I_ALL", "IV_M_37", "IV_TM_3", and "V_ALL". The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either "75i", "100i", "150i", "e", or "x". This aggregate excludes "i" features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP8r	Action-based harvest, followed by assignment to the LMP8 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the eighth decade following the action-based harvest.	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP8r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP8r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 8. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP8r: "I_ALL", "II_ALL", "III_I_ALL", "III_M_37", "III_M_7", "III_TM_3", "IIIIV_T_37", "IIIIV_TM_7", "IV_I_ALL", "IV_M_37", "IV_TM_3", and "V_ALL". The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either "75i", "100i", "150i", "e", or "x". This aggregate excludes "i" features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP9r	Action-based harvest, followed by assignment to the LMP9 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the ninth decade following the action-based harvest.	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP9r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP9r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 9. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP9r: “I_ALL”, “II_ALL”, “III_I_ALL”, “III_M_37”, “III_M_7”, “III_TM_3”, “IIIIV_T_37”, “IIIIV_TM_7”, “IV_I_ALL”, “IV_M_37”, “IV_TM_3”, and “V_ALL”. The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either “75i”, “100i”, “150i”, “e”, or “x”. This aggregate excludes “i” features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Name	Description of action	Decades in which the action may occur	Operability criteria (the circumstances under which the action may occur)	Description of operability criteria	Does conducting the action reset the age of the development type?
aLMP10r	Action-based harvest, followed by assignment to the LMP10 regime (an inventory-based thinning regime comprised of variable density thinnings at 30 year intervals). The first thinning entry is scheduled for the tenth decade following the action-based harvest.	1	**THEMATIC MASK:** • THEME1 is a member of aggregate agLMP10r • THEME3 is a member of aggregate agANYHARV • THEME4 is a member of aggregate agOK2VRH • THEME5 is a member of aggregate agOK2VRH **YIELD PARAMETER:** • Yp1op = 1	The THEME1 aggregate agLMP10r includes all Forest Inventory units whose stand conditions warrant regeneration in decade 10. Eligibility for regeneration is based on classifications of site class, shade tolerance, and stand density; following the same methodology used to define the forest strata (refer to Table D-6). All forest inventory units that satisfy the classifications for the following strata are included in aggregate agLMP10r: "I_ALL", "II_ALL", "III_I_ALL", "III_M_37", "III_M_7", "III_TM_3", "IIIIV_T_37", "IIIIV_TM_7", "IV_I_ALL", "IV_M_37", "IV_TM_3", and "V_ALL". The strata themselves are also included in the aggregate. The THEME3 aggregate agANYHARV specifies that the deferral status is NA (not deferred). The THEME4 aggregate agOK2VRH is grouping of Forest Management Units based on their edge density. This aggregate includes all edge densities; therefore no FMUs are excluded by this aggregate. The THEME5 aggregate agOK2VRH specifies that the riparian assessment area is either "75i", "100i", "150i", "e", or "x". This aggregate excludes "i" features. An additional criterion (Yp1op) specifies that the top height of the 40 largest trees in the stand is at least 85 feet at the end of the first decade, and the stand is not classified as either Young Forest or Old Forest spotted owl habitat.	Yes

Transitions

Each action performed by the model has a corresponding "transition". The transition is a modeling rule describing how the conducted action is expected to change the stand in question. Transitions specify the pre-harvest development type (in modeling terminology, the "source") and the post-harvest development type (the "target"). The source receives an action, and as a result, all or part of the source transitions to the target. The software used to develop the forest estate model allows some flexibility in defining the transitions. Transitions arising from an action can be described on either an area or proportional basis. That is, a transition may specify the number of acres (e.g. 15 acres) or the proportion (e.g. 80 percent) of a development type that is affected by the action. Transitions may also be single or multiple outcome. That is, an action may transition a source development type to one or more target development types. To reduce complexity, all transitions in the OESF forest estate model were treated as single outcome and were applied to 100 percent of the development type.

Table D-9. Transitions

Name (which action does the transition correspond to)	Description	Target development type	Percent of development type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP1	Assign the development type to the LMP1 regime	Same as source, except that the regime (TH2) is now set to LMP1	100	4
aLMP2	Assign the development type to the LMP2 regime	Same as source, except that the regime (TH2) is now set to LMP2	100	4
aLMP3	Assign the development type to the LMP3 regime	Same as source, except that the regime (TH2) is now set to LMP3	100	4
aLMP4	Assign the development type to the LMP4 regime	Same as source, except that the regime (TH2) is now set to LMP4	100	5
aLMP5	Assign the development type to the LMP5 regime	Same as source, except that the regime (TH2) is now set to LMP5	100	6
aLMP6	Assign the development type to the LMP6 regime	Same as source, except that the regime (TH2) is now set to LMP6	100	7
aLMP7	Assign the development type to the LMP7 regime	Same as source, except that the regime (TH2) is now set to LMP7	100	8
aLMP8	Assign the development type to the LMP8 regime	Same as source, except that the regime (TH2) is now set to LMP8	100	9

Name (which action does the transition correspond to)	Description	Target development type	Percent of development type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP9	Assign the development type to the LMP9 regime	Same as source, except that the regime (TH2) is now set to LMP9	100	10
aLMP10	Assign the development type to the LMP10 regime	Same as source, except that the regime (TH2) is now set to LMP10	100	10
aNA99r	Regeneration harvest, followed by a no-management regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of, and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a no management trajectory by setting the regime (TH2) to NA99.	100	4

Name (which action does the transition correspond to)	Description	Target development type	Percent of developmen t type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP1r	Action-based harvest, followed by the LMP2 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as “aggregates”, were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum “F_IIIIVTM7” = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP1.	100	4

Name (which action does the transition correspond to)	Description	Target development type	Percent of developmen t type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP2r	Action-based harvest, followed by the LMP2 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP2.	100	4

Name (which action does the transition correspond to)	Description	Target development type	Percent of development type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP3r	Action-based harvest, followed by the LMP3 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP3.	100	5

Name (which action does the transition correspond to)	Description	Target development type	Percent of development type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP4r	Action-based harvest, followed by the LMP4 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP4.	100	6

Name (which action does the transition correspond to)	Description	Target development type	Percent of developmen t type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP5r	Action-based harvest, followed by the LMP5 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP5.	100	7

Name (which action does the transition correspond to)	Description	Target development type	Percent of developmen t type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP6r	Action-based harvest, followed by the LMP6 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP6.	100	8

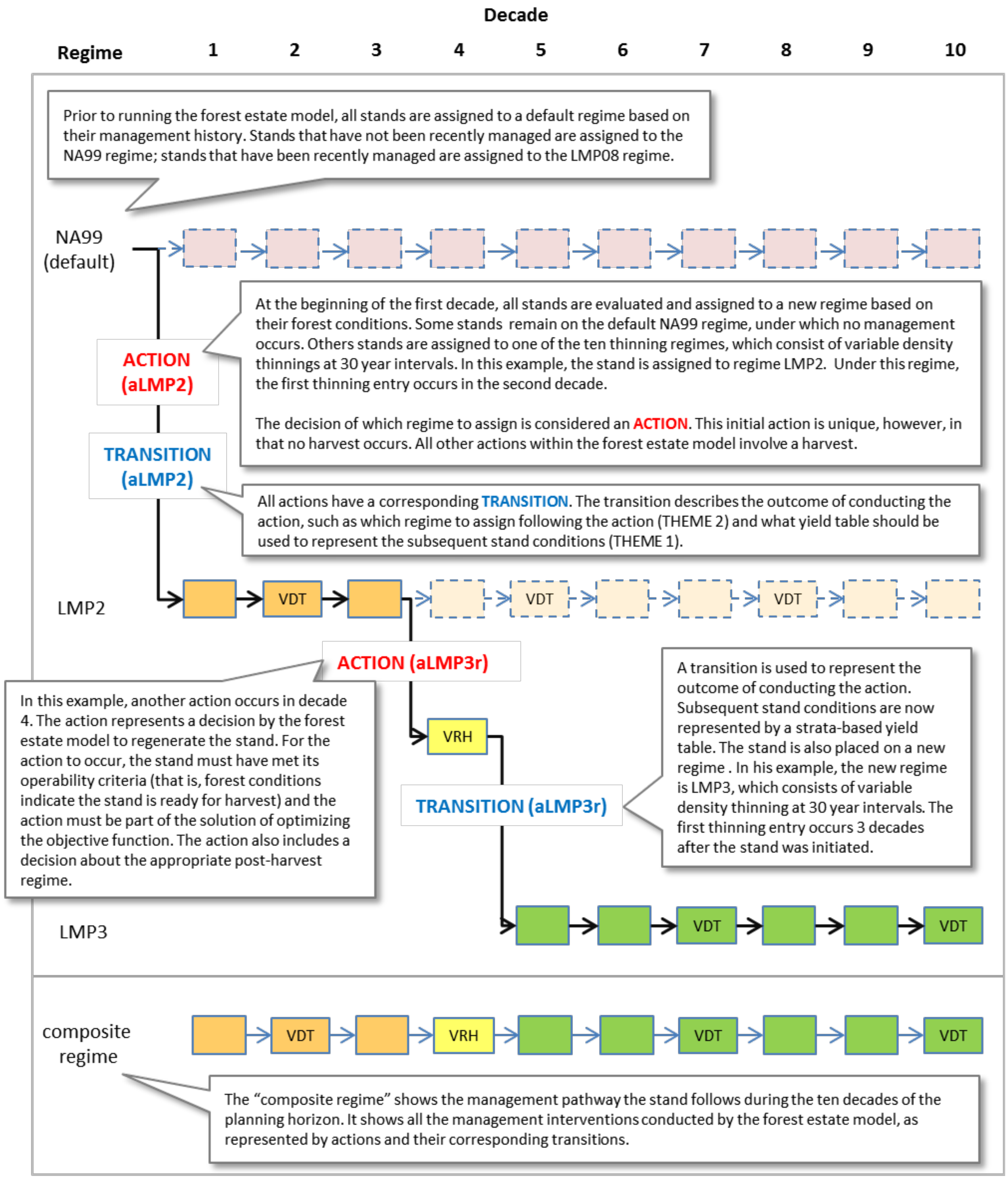
Name (which action does the transition correspond to)	Description	Target development type	Percent of development type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP7r	Action-based harvest, followed by the LMP7 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP7.	100	9

Name (which action does the transition correspond to)	Description	Target development type	Percent of development type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP8r	Action-based harvest, followed by the LMP8 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as "aggregates", were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum "F_IIIIVTM7" = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP8.	100	10

Name (which action does the transition correspond to)	Description	Target development type	Percent of developmen t type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP9r	Action-based harvest, followed by the LMP9 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as “aggregates”, were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum “F_IIIIVTM7” = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP9.	100	10

Name (which action does the transition correspond to)	Description	Target development type	Percent of developmen t type affected	Lock (number of sub-sequent decades during which additional actions are prohibited)
aLMP10r	Action-based harvest, followed by the LMP10 thinning regime.	Same as source, except for forest inventory unit (TH1) and regime (TH2). • Change the TH1 value to show that all subsequent yields are derived from a strata-based yield. The resulting stratum varies according to the TH1 value of the development type being acted upon. Groupings of TH1 values, known as “aggregates”, were constructed in a manner similar to that used to construct the strata themselves. That is, aggregates were constructed based on similarities in site class, shade tolerance, and stocking level. A thematic mask was used to check which aggregate the development type was a member of and transition accordingly. Any development types with a TH1 value not assigned to an aggregate were transitioned to the default stratum “F_IIIIVTM7” = shade tolerant western hemlock / Douglas-fir forest, located on either site class III or IV ground, with a stand density > 70% of the maximum. • Place the development type on a thinning regime by setting the regime (TH2) to LMP10.	100	10

Figure D-3. Composite Silvicultural Regimes and the Effects of Actions and Transitions



EDGE DENSITY

Action-based harvests were classified into one of five harvest types, according to a measure known as the edge-to-area ratio (also known as edge density) of the forest management unit[5] (Table D-10). The edge-to-area ratio describes the spatial configuration of the unit, and is a comparison of the perimeter of a unit to the area it encloses. Simple shapes such as a circle or a square have a low edge-to-area ratio. That is, the perimeter is relatively small compared to the area. More complex shapes (such as units with extensive riparian buffers or units with high levels of retention) have high edge-to-area ratios; the perimeter is relatively large compared to the area.

The edge-to-area ratio was calculated for each forest management unit (FMU), following the methods of Di Lucca and others (2003, 2004) and in accordance with growth and yield models developed by the British Columbia Ministry of Forests and Range (TIPSY 2007). Since operability can vary within a forest management unit, the calculation of edge-to-area ratio considers the expected retention of forest cover within the FMU and any edge associated with that retention. In addition, areas identified as part of the recommended riparian buffers under the No Action Alternative were treated as if they retained forest cover and contributed to the amount of edge within the forest management unit. The resulting edge-to-area ratio (incorporating the recommended buffers for the No Action Alternative) was used in the forest estate model for both alternatives.

Figure D-4a. Edge density is calculated for each Forest Management Unit (FMU). The FMU (shown outlined in black) is comprised of mulitple polygons (shown in grey) representing the various land classifications, known in the forest estate model as *themes.* The themes are derived from the Large Data Overlay. These polygons represent features such as unstable slopes, riparian analysis areas, hydrologic zones, and roads.

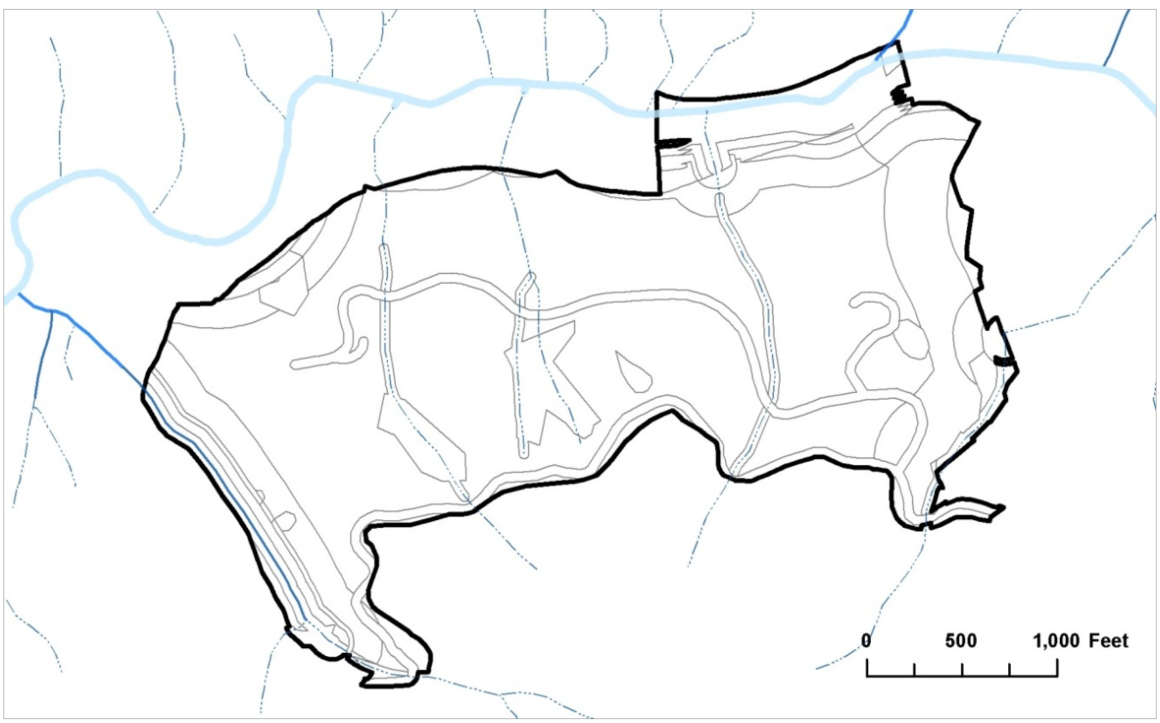


Figure D-4b. Forest retention within each FMU is identified in part by the deferral status of the individual polygons (THEME 3). For the calculation of edge density, areas with a long-term harvest deferral (THEME3 = 9999) or a restriction on harvest activities (THEME 3 = Partial) are treated as forested.

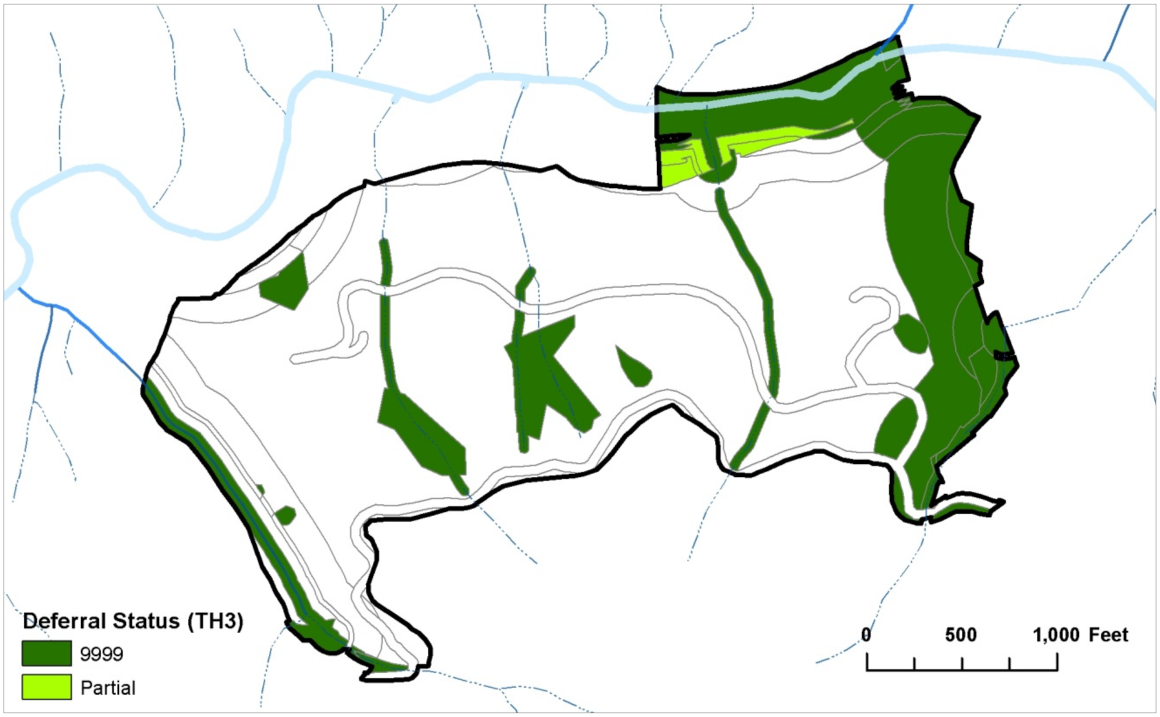
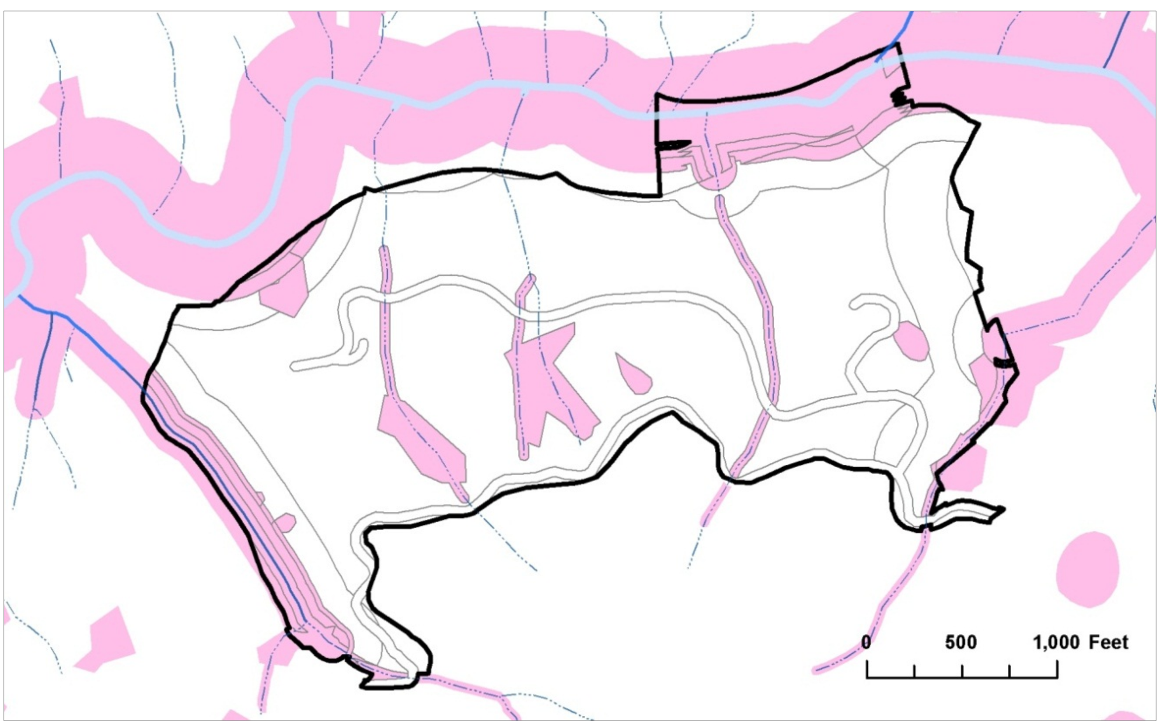


Figure D-4c. Forest retention. In addition to the deferral status, the recommended riparian buffers from a simulation of the 12-step watershed assessment process for the No Action Alternative are also treated as forested. These recommended buffers are used in the calculation of edge density for both alternatives.



Figure

D-4d. Forest Retention. Individual polygons are consolidated, based on their requirements for the retention of forest cover. Roads are treated as non-forest. The boundaries between individual polygons are dissolved, each *gap* (a contiguous area in which retention of forest cover is not required) is numbered, and processed separately.

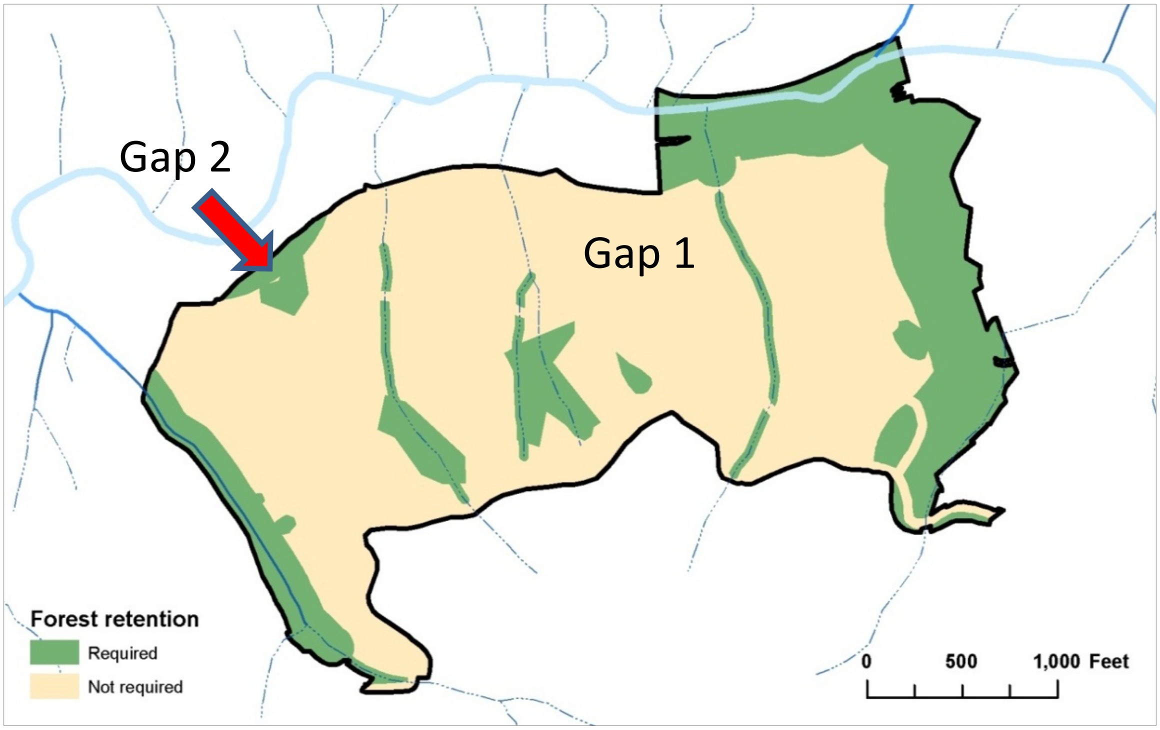
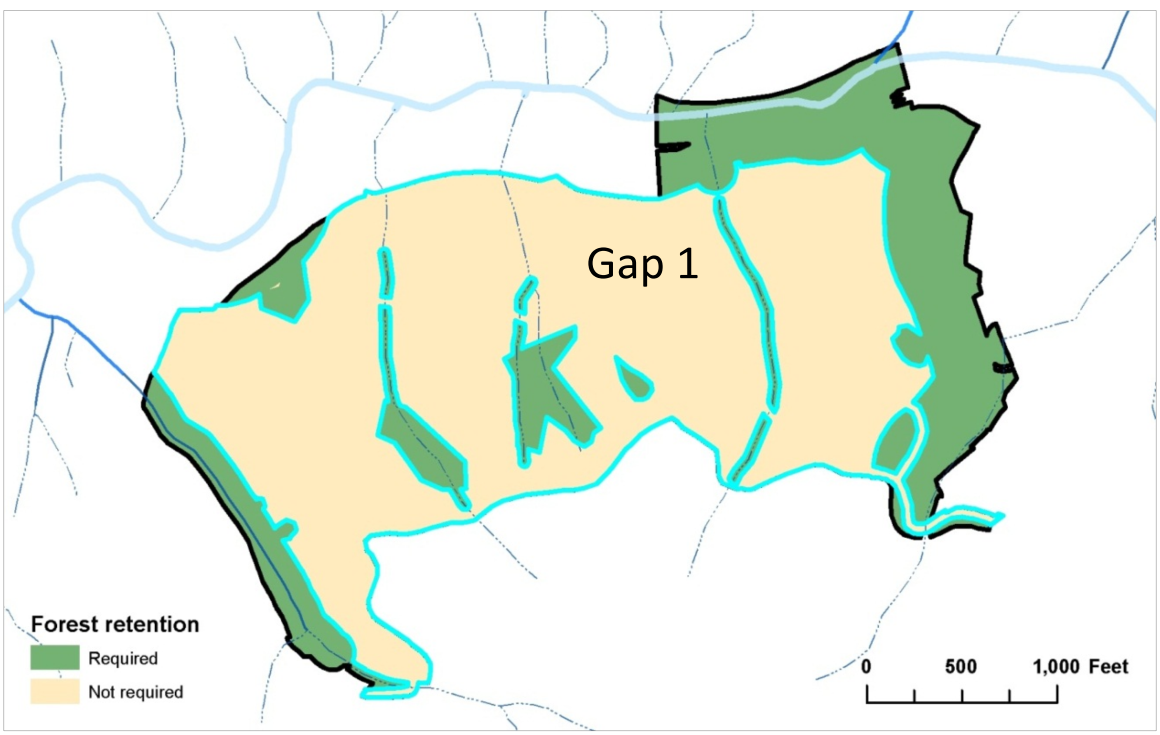


Figure D-4e. Calculation of Edge Density. For each identified gap, the edge density is based in part on the edge-to-area ratio, calculated as the perimeter (in feet) divided by the area (in acres). In this example, the perimeter of gap 1 is shown highlighted in blue.



For each gap, the initial calculation of edge density is based on the ratio of the perimeter of the gap (in feet) divided by the area of the gap (in acres). Since the GIS data is a simplified representation of real-world conditions, an adjustment factor is applied to increase the edge-to-area ratio by 15 percent (that is, it is multiplied by 1.15). The adjustment factor is meant to compensate for the loss of detail that occurs when the each polygon is digitized (Equation D-1).

Equation D-1.

$$edge\ density\ of\ each\ gap = 1.15 * \frac{perimeter\ of\ each\ gap\ in\ feet}{area\ of\ each\ gap\ in\ acres}$$

An adjustment is also made to account for additional forest edge associated with required leave tree retention, per *PR 14-006-090, Management of Forest Stand Cohorts (Westside)*. The adjustment takes into consideration an estimate of the width of each gap. For gaps greater than 400 feet across, an additional 23 feet/acre of edge density was included to the initial value calculated using equation D-1, above. A minimum bound of 166.67 feet/acre was used for each gap. That is, if the edge density of the gap were less than 166.67 feet/acre, it was assigned a value of 166.67.

The edge densities for all of the gaps within the FMU are then combined as an area-weighted sum to report a single edge density for the entire FMU (Equation D-2, where *i* is used as an index to the *n* gaps within the FMU). A maximum bound of 2,932 feet/acre was used for each FMU. That is, if the edge density of the FMU were greater than or equal to 2,932 feet/acre, it was assigned a value of 2,932.

Equation D-2.

$$edge\ density\ of\ FMU = \frac{\sum_{i=1}^{n} edge\ density\ of\ gap_i * area\ of\ gap_i}{\sum_{i=1}^{n} area\ of\ gap_i}$$

Table D-10. Timber Harvest Classifications

Harvest type	Harvest code	Edge to area ratio (feet per acre)	Size of harvest opening[6]		Retention[7]	
			Acres	Width in feet	Trees per acres	Percent
Variable retention harvest (low edge density)	VRH-L	< 331	> 5	> 526.5	< 5	< 5
Variable retention harvest (medium edge density)	VRH-M	331 - 523	2 - 5	333 - 526.5	5 – 8	5 – 7
Variable retention harvest (high edge density)	VRH-H	523 - 1103	0.5 - 2	166 - 333	8 – 17	7 – 15
Variable density thinning	VDT	1103 - 2340	0.1 - 0.5	74.5 - 166	17 – 35	15 – 40
Uniform thinning	UT	> 2340	< 0.1	< 74.5	> 35	> 40

Forest Growth Following Harvest

Forest growth following harvest was modeled using the Pacific Northwest Coast variant of the USDA Forest Vegetation Simulator (FVS-PN). For some harvest types, FVS projections of standing volume were adjusted based on the configuration of the forest management unit.

Forest growth is influenced primarily by availability of resources (such as nutrients, water, light, or space). Trees can grow rapidly in areas where resources are readily available; trees grow more slowly in areas where resources are limited or competition for resources is high. The shapes and sizes of forest management units or the patterns of unharvested areas within these units (known as retention) can affect the rate of growth of the replanted forest by influencing the availability of these resources. For example, regrowth in long, narrow units or in units with complex shapes may be slower than in the open-grown conditions found in larger, simpler, or wider units due to a lesser availability of light. The edge-to-area ratio (also known as edge density) was used to represent this phenomenon. Refer to Figure D-4 for an illustration of how the edge-to-area ratio is calculated.

Each forest management unit is assigned an adjustment factor based on its edge-to area ratio. The adjustment factor is used to account for the effects of competition for resources (namely light availability) and the resulting reduction in the rate of forest growth. The adjustment factor is directly proportional to the edge-to-area ratio. That is, it has the greatest effect in stands with a high edge density (complex shapes with high shading) and the least effect in stands with a low edge density (simple shapes with more open-grown conditions). Since forest regrowth following harvest is modeled using FVS, which assumes open-grown conditions for some harvest types, the adjustment factor accounts for those situations where the assumption of open-grown conditions does not apply.

The adjustment factor is only applied to stands that have received an action-based harvest; it is not applied to stands that receive an "inventory-based" variable density thinning (i.e., one of the silvicultural regimes shown in Table D-7). Once an FMU has received an action-based harvest, the adjustment factor is applied to any subsequent action-based harvests. For any subsequent harvests, the estimated harvest volume is multiplied by the adjustment factor. In this manner, the harvest volume for a stand that has regrown in an FMU with a high edge density will be less for than an otherwise identical stand that has regrown in an FMU with a low edge density. Note that the adjustment factor is only applied to the projected harvest volume removals; it is not applied to any other stand parameters included in the yield tables (table D-2).

Table D-11. Timber Harvest Classifications and Adjustment Factors

Harvest type	Harvest code	Adjustment factor
Variable retention harvest (low edge density)	VRH-L	0.83 – 0.91
Variable retention harvest (medium edge density)	VRH-M	0.73 – 0.83
Variable retention harvest (high edge density)	VRH-H	0.43 – 0.73
Variable density thinning	VDT	< 0.43
Uniform thinning	UT	< 0.43

Objective Function and Constraints

Within the forest estate model, the goals, objectives, and strategies used by both alternatives are represented by two types of modeling constructs: an *objective function* (a mathematical criterion the model seeks to optimize), and a set of *constraints* (mathematical rules that describe the requirements to which the decisions made by the model must adhere). Each is described in the following sections.

OBJECTIVE FUNCTION

The objective function for both alternatives is to maximize or optimize the financial return to the trust beneficiaries, as represented by *net present value.* Net present value is a financial term referring to the sum of both current and future cash flow. It is the cash inflow (revenue from timber sales) minus cash outflow (costs of forest management). Future revenues and expenses are expressed in terms of their equivalent in today's dollars through a method known as discounted cash flow analysis. All future revenues and expenses are discounted five percent per year back to the present date. Discounted cash flow analysis is a quantitative means of representing that money in the future is not as valuable as money in the present. The discounted values (known as present values) for each decade are summed, and the forest estate seeks to maximize this sum, known as the net present value. Since the forest estate model is structured as a decadal model, the discount is performed as if all cash flow occurred at the midpoint of the given decade.

Since DNR used a goal programming forest estate model, the objective function also incorporates a term to account for the penalty incurred when deviating from a goal. The penalty serves as a financial incentive for the model to meet each goal to the best of its abilities. Under goal programming, deviations are allowed and individual goals may be under- or over-achieved. Any deviations that do take place, however, incur a financial penalty (for additional information, refer to *Constraints*, p. D-76). DNR elected to use goal programming since it allows for greater flexibility in meeting multiple objectives. Note that unlike revenues and costs, any incurred penalties are not discounted. By not discounting the penalty, in effect, it becomes stronger over time relative to revenue and costs. With each passing decade, the incentive to meet each goal increases.

Equation D-3. Generalized Form of the Objective Function

$$\boldsymbol{Maximize} \sum_{\boldsymbol{decade}=1}^{\mathbf{10}} (\boldsymbol{revenue} - \boldsymbol{costs} - \boldsymbol{penalty})$$

A multitude of revenues and costs are included in the objective function for the OESF forest estate model. The complete objective function is given by Equation D-4. Each revenue and cost is summarized in Table D-12, and described in following sections.

Equation D-4. Objective Function

$$Maximize \sum_{decade=1}^{10} (\underbrace{R_{act} + R_{inv}}_{\text{Revenue}} - \underbrace{C_{fee(AARF)} - C_{mgmt(actVRH)} - C_{mgmt(actVDT)} - C_{mgmt(inv)} - C_{rd(act)} - C_{rd(inv)}}_{\text{Costs}} - \underbrace{penalty}_{\text{Penalty}})$$

Table D-12. Description of Terms Used in the Objective Function

Term	Type	Description	Units	Calculation
Ract	Revenue	Discounted revenue from action-based harvests	$	Harvest volume (mbf) x revenue ($/mbf) [Table D-13]
Rinv		Discounted revenue from inventory-based harvests	$	Harvest volume (mbf) x revenue ($/mbf) [Table D-13]
Cfee(AARF)	Cost (fee)	Discounted cost from Access Road Revolving Fund	$	Harvest volume (mbf) x $22.25/mbf
Cmgmt(actVRH)	Cost (management)	Discounted management costs (direct and indirect) from action-based variable retention harvests (VRH)	$	Harvest extent (ac) x cost ($/ac) [Table D-14]
Cmgmt(actVDT)		Discounted management costs (direct and indirect) from action-based variable density thinnings (VDT)	$	Harvest extent (ac) x cost ($/ac) [Table D-14]
Cmgmt(inv)		Discounted management costs (direct and indirect) from inventory-based variable density thinnings (VDT)	$	Harvest extent (ac) x cost ($/ac) [Table D-14]
Crd(act)	Cost (road)	Discounted road costs from action-based harvests	$	Harvest extent (ac) x cost ($/ac). Road costs ($) area calculated for each road segment. The cost is then converted to a per acre value ($/ac) by amortizing the cost across the road segment's "roadshed" - the total area the road segment provides access to. Costs are incurred at the time of harvest by summing the per acre road costs for all road segments traversed by the harvest in question and multiplying by the size of the harvest (in acres). [Table D-15, Figure D-5]
Crd(inv)		Discounted road costs from inventory-based harvests	$	
penalty	Penalty	Goal programming	$	Extent of area deviating from goal

		penalty. Not discounted.		(ac) x penalty ($9999/ac)

REVENUE

On the OESF, DNR generates revenue primarily from the sale of timber on the lands that it manages. At a basic level, the gross revenue for any given timber sale is determined by two factors[8]: 1) the price that a purchaser pays DNR for the right to harvest the timber (usually reported as a dollar value per unit of wood volume, such as dollars per thousand board feet), and 2) the volume of timber sold.

The price that a purchaser pays DNR for the right to harvest the timber, known as *stumpage*, is influenced by a number of factors. The timber has a certain value once it is delivered to the mill. This value, known as the *delivered value*, is based on factors such as trees species and the quality (known as the *grade*) of the timber. When bidding on a timber sale, the purchaser considers the delivered value and must take into account the expenses they expect to incur in order to deliver the timber to the mill (such as logging, road construction, and transportation costs), any fees they are required to pay, and their profit margin. Additional factors that influence stumpage include regional supply and demand, the number of bidders at auction, and inflation.

Timber prices used in the forest estate model vary by forest type and harvest type (Table D-13). These values were estimated from a review of 2003-2011 Washington Department of Revenue (DOR) Stumpage Value Determination Tables for western Clallam and Jefferson counties.[9] The DOR stumpage estimates cover timber sales across a variety of ownerships, include all major marketable species, and are drawn from actual mill reports. Timber sale prices were adjusted for inflation using the Producer Price Index (PPI)[10] for all commodities.

Table D-13. Timber Sale Prices (Stumpage) by Forest Type

Forest type	Price per thousand board feet		
	Action-based harvests	Inventory-based harvests	
		Top height < 110 feet	Top height ≥ 110 feet
Douglas-fir with red alder	$251	$111	$136
Douglas-fir with red cedar	$297	$157	$182
Douglas-fir with western hemlock	$250	$110	$135
Red alder with Douglas-fir	$242	$102	$127
Western hemlock with Douglas-fir	$249	$99	$134
Western hemlock with red alder	$242	$92	$127
Western hemlock with red cedar	$287	$137	$172
Western hemlock or Pacific silver fir	$244	$94	$129

The prices shown in Table D-13 have been adjusted to compensate for the purchaser's estimated logging and transportation costs, based on a combination of harvest operations using both cable and ground-based systems and the customary timber hauling distances on the western Olympic Peninsula. Typically, stumpage also incorporates an estimate of the purchaser's expected road costs, such as any maintenance and construction required as part of the timber sale. However, timber sale revenue and road costs were treated separately in the objective function. For a discussion of how road costs are tabulated, refer to *Road Costs*, p. D-73.

COSTS

Fees

Fees associated with the Access Road Revolving Fund (AARF) were incorporated into the objective function as a separate cost variable. AARF is an account maintained and administered by DNR to fund the ongoing maintenance, repair, and (re)construction of the roads used to provide access to public lands. The fee, assessed for all timber harvests in the forest estate model, was estimated as $22.25 per thousand board feet.

Management Costs

DNR incurs various expenses in the course of managing its land base. These expenditures are represented in the forest estate model as a combination of direct and indirect costs. Direct costs account for expenditures associated with planning and conducting timber sales, such as sale preparation, appraisal, and contract compliance. Indirect costs account for expenditures such as staffing, consultation with specialists, and silvicultural activities including site preparation, planting, management of competing vegetation, and pre-commercial thinning. Indirect costs vary by harvest type, and were less for variable retention harvests with high levels of retention (those classified as having a high edge density) and thinning harvests since these stands will rely on natural regeneration (versus planting) and are not expected to require as much silvicultural activities.

Table D-14. Management Costs Used in the Forest Estate Model.

Totals may not add, due to rounding.

Harvest type	Harvest type	Cost per acre		
		Direct	Indirect	Total
Action-based	VRH (Low edge density)	$811	$550	$1,362
	VRH (Medium edge density)	$811	$550	$1,362
	VRH (High edge density)	$811	$281	$1,093
	Variable density thinning	$811	$281	$1,093
	Uniform thinning	$811	$281	$1,093
Inventory-based	Variable density thinning	$811	$281	$1,093

Road Costs

Each timber sale offered by DNR includes provisions for optional and required road improvements and construction to be completed prior to active haul. These provisions are the responsibility of the purchaser, who recoups their cost by adjusting their bid at auction. Typically, the purchaser's road costs are reflected in the stumpage value. However, timber sale revenue and road costs were treated separately in the forest estate model and are calculated using separate terms in the objective function (refer to Equation D-4 and Table D-12).

The purchaser's road-related expenditures were estimated using a GIS analysis that considered which road segments were utilized to harvest a given location and the type and size of harvest. The existing road network was divided into segments by placing stations every 100 feet. In consultation with DNR Olympic Region staff, each road segment was assigned an estimated 30-year life cycle cost. This cost was varied by Landscape Planning Unit, based on factors such as the distance to rock sources and the quality of available rock. A GIS analysis was then used to identify the shortest route from each Forest Management Unit to Highway 101. From the routing analysis, the total acreage served by each road segment was determined, and a cost value (in dollars per acre) was assigned to each road segment.

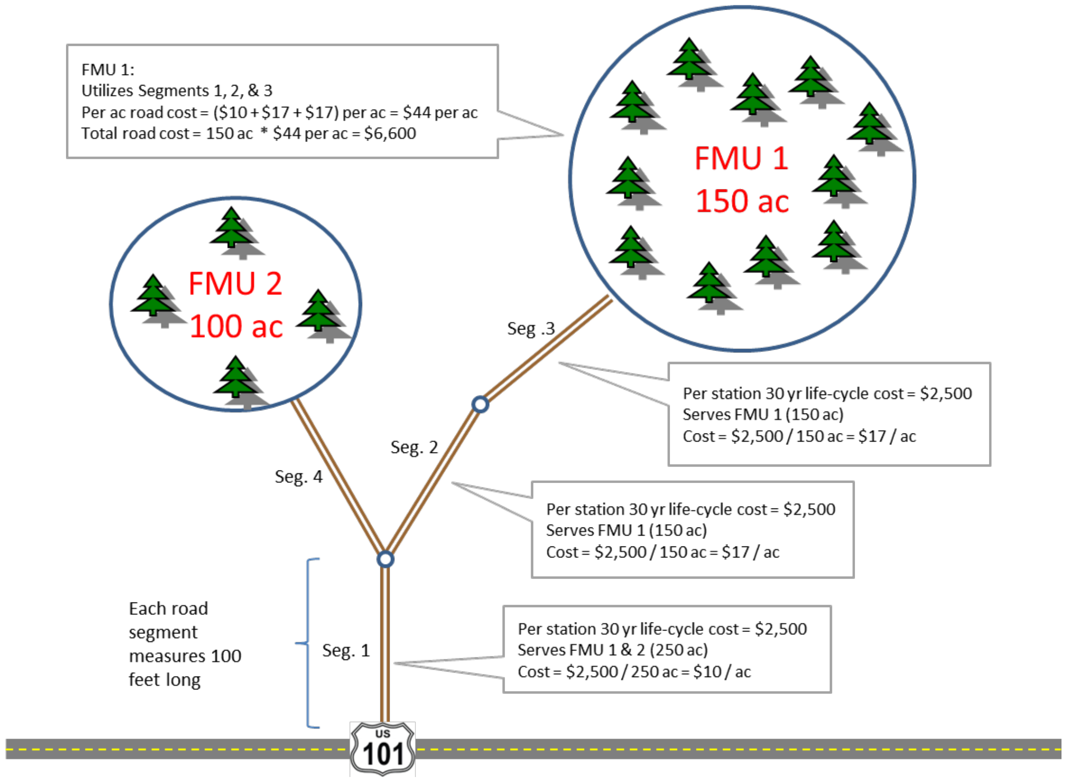
The road expense incurred during the harvest of any given FMU is tallied by multiplying the total acres of harvest for that FMU by the sum of the per-station road costs for each segment traversed en route to Highway 101 (Figure D-5). Road costs were incurred at the time of harvest. Costs varied by forest management unit and were approximately $800 per acre harvested.

Table D-15. Estimated Road Costs

Landscape	Rank	Road costs (per road station)
Clallam	3	$4,900
Copper Mine	2	$3,500
Dickodochtedar	2	$3,500
Goodman Creek	2	$3,500
Kalaloch	3	$4,900
Queets	1	$2,500
Reade Hill	3	$4,900
Sekiu	3	$4,900
Clearwater	2	$3,500
Sol Duc	1	$2,500
Willy Huel	2	$3,500

Figure D-5. Methodology for Estimating Road Costs for Each Forest Management Unit

Hypothetical values for illustration only. Costs varied by forest management unit and were approximately $800 per acre harvested, as incorporated in the forest estate model.


FMU 1:
Utilizes Segments 1, 2, & 3
Per ac road cost = ($10 + $17 + $17) per ac = $44 per ac
Total road cost = 150 ac * $44 per ac = $6,600
FMU 1
150 ac
FMU 2
100 ac
Seg .3
Per station 30 yr life-cycle cost = $2,500
Serves FMU 1 (150 ac)
Cost = $2,500 / 150 ac = $17 / ac
Seg. 2
Seg. 4
Per station 30 yr life-cycle cost = $2,500
Serves FMU 1 (150 ac)
Cost = $2,500 / 150 ac = $17 / ac
Each road segment measures 100 feet long
Seg. 1
Per station 30 yr life-cycle cost = $2,500
Serves FMU 1 & 2 (250 ac)
Cost = $2,500 / 250 ac = $10 / ac
US
101

CONSTRAINTS

Table D-16 provides a summary of the constraints incorporated into the forest estate model. Each constraint describes a modeling rule for the forest estate model to follow in achieving its stated objective of maximizing net present value. Some constraints are inviolate. That is, the forest estate model is bound by the constraint; if the constraint cannot be met, the model solution is considered infeasible. Other constraints are treated as goals. The forest estate model may violate the goal, but any deviations incur a financial penalty of $9,999 per acre for each goal that is not met.

Table D-16. Summary of Constraints and Goals Incorporated Into the Forest Estate Model

Constraint	Type	Alternative	
		No Action	Landscape
Perpetual timber harvest constraint	Inviolate. Must be met.	✓	✓
Even flow of harvest volume, not to deviate by more than 25 percent from one decade to the next	Inviolate. Must be met.	✓	✓
No variable retention harvests in stands < 30 years old or > 80 years old during the first decade.	Inviolate. Must be met.	✓	✓
Maintenance and restoration at least 40 percent of DNR-managed lands in each landscape planning unit as Young Forest Habitat (or better)	Varies by Landscape Planning Unit. Inviolate for some; goal for others.	✓	✓
Maintenance and restoration at least 20 percent of DNR-managed lands in each landscape planning unit as Old Forest Habitat	Varies by Landscape Planning Unit. Inviolate for some; goal for others.	✓	✓
No variable retention harvest of Old Forest Habitat during the restoration phase	Inviolate. Must be met.	✓	✓
Limits on the level of variable retention harvests in stands more than 50 years old that are not classified as either structural habitat or Old Forest	Inviolate. Must be met.	✓	
Restoration of large woody debris recruitment potential for each Type 3 watershed	Goal. Deviations permitted, but incur a penalty.		✓
Restoration of stream shade for each Type 3 watershed	Goal. Deviations permitted, but incur a penalty.		✓
Avoidance of detectable increases in peak flow for each Type 3 watershed	Goal. Deviations permitted, but incur a penalty.	✓	✓

CONSTRAINT: Perpetual Timber Harvest Constraint

The OESF forest estate model covers a finite time period. For this planning process, the time period (known as the *planning horizon*) was modeled as 10 decades. Linear programming, forest estate models with a finite planning horizon are subject to a modeling anomaly known as the *end-of-horizon-effect*. This effect causes fluctuations in harvest levels in the ending decade, as the model attempts to maximize revenue by liquidating its assets. The model will also defer necessary but otherwise less-profitable expenditures such as stand-tending silviculture that won't pay an ecological or financial return within the planning horizon.

To prevent these effects, the forest estate model utilizes a common technique known as a perpetual timber harvest constraint. This constraint requires that the ending standing inventory for all operable acres is at least equal to the average operable inventory over the planning horizon. The use of such a constraint ensures that the level of harvest proposed by the harvest schedule is sustainable over the long-term, beyond the planning horizon.

The perpetual timber harvest constraint applies to both alternatives. The constraint is binding and must be followed. Otherwise, the model solution is considered infeasible.

Equation D-5. Perpetual Timber Harvest Constraint

$$ending\ operable\ inventory \geq average(operable\ inventory_{decades\ 1..10})$$

CONSTRAINT: Even Flow

DNR's *Policy for Sustainable Forests* (DNR 2006) directs the agency to ensure inter-generational equity among beneficiaries. In accordance with this policy, the OESF forest estate model utilizes an *even flow* constraint to restrict variation in the timber harvest volume over time. Using the constraint, the total harvest volume for any decade shall not vary up or down more than 25 percent from the level of the preceding decade.

The even flow constraint applies to both alternatives. The constraint is binding and must be followed. Otherwise, the model solution is considered infeasible.

CONSTRAINT: Harvest in Stands Less than 30 or Greater Than 80 Years of Age During the First Decade

During the first decade, no variable retention harvests are allowed in stands less than 30 years of age or greater than 80 years of age. This constraint is used to prevent the forest estate model from scheduling harvest actions that meet their operability criteria but are considered inappropriate management choices.

The constraint applies to both alternatives. The constraint is binding and must be followed. Otherwise, the model solution is considered infeasible.

CONSTRAINT or GOAL: Maintenance and Restoration of at Least 40 Percent of DNR-Managed Lands in Each Landscape Planning Meeting or Exceeding the Definition for Young Forest Habitat

An objective for spotted owl conservation on DNR-managed lands in the OESF is to develop and implement land management plans that do not appreciably reduce the chances for the survival and recovery of the northern spotted owl sub-population on the Olympic Peninsula (DNR 1997, p.IV.86). The strategy for achieving this objective includes the restoration and maintenance of threshold levels of potential spotted owl habitat within each landscape planning unit, including at least 40 percent of DNR-managed lands meeting or exceeding the definition for "Young Forest" spotted owl habitat. This strategy was represented within the forest estate model as a modeling rule.

As a means of determining how quickly each alternative should be required to meet the habitat threshold, a separate forest estate model run examined the development of spotted owl habitat in the absence of forest management. That is, the model measured the time required to meet the 40 percent Young Forest habitat threshold when no timber harvests were allowed to take place. Habitat thresholds were tallied separately for each landscape planning units; the results are presented in Table D-17.[11]

Table D-17. Young Forest Habitat Thresholds

Landscape planning unit	Total acres (based on an aggregation of Theme 4)	Young Forest habitat threshold (40 % of DNR-managed acres, based on aggregation of Theme 4)	Decades to achieve habitat threshold under a no-management scenario	Constraint (inviolate) or Goal (deviations allowed, but incur penalty)
Clallam	17,276	6,910	1	Goal
Clearwater	55,203	22,081	>5	Goal
Coppermine	19,246	7,698	>5	Goal
Dickodochtedar	28,047	11,219	2	Constraint
Goodman	23,799	9,520	3	Constraint
Kalaloch	18,122	7,249	4	Constraint
Queets	20,807	8,323	>5	Goal
Reade Hill	8,479	3,392	1	Constraint
Sekiu	10,014	4,006	5	Constraint
Sol Duc	19,134	7,654	2	Constraint
Willy Huel	37,428	14,971	>5	Goal

The time required to achieve the Young Forest habitat threshold under no-management was used as a benchmark in formulating a set of modeling rules for the No Action and Landscape alternatives. A separate rule was formulated for each landscape planning unit. Most were designed as constraints, applied at the beginning of the decade in which a no-management scenario achieves the Young Forest habitat threshold. The constraint is binding and may not be violated. In this manner, these landscapes will achieve their habitat thresholds no slower than they would under no management.

For other landscape planning units, Young Forest habitat thresholds were designed as goals. The decision to formulate a modeling rule as a goal instead of a constraint for a given landscape was based on its trajectory for habitat development. The Clearwater, Coppermine, Queets, and Willy Huel landscapes required more than five decades to achieve the desired level of habitat under no management. For these areas, Young Forest habitat thresholds were formulated as goals that came into effect in the fifth decade. Under no management, the Clallam landscape was projected to achieve its habitat threshold in the first decade, but due to patterns of natural stand development, fell below the threshold level in subsequent decades. Its habitat threshold was formulated as a goal, beginning in the first decade.

For those landscapes whose habitat thresholds were formulated as goals, the modeling rule is non-binding. Deviations are permitted, but a penalty of $9,999 is incurred for each acre the landscape planning unit in question falls short of its habitat threshold. For all other landscapes, the constraint is binding and must be followed. Otherwise, the model solution is considered infeasible.

CONSTRAINT or GOAL: Maintenance and Restoration of at Least 20 Percent of DNR-Managed Lands in Each Landscape Planning Unit as Old Forest Habitat

A similar process was used to formulate the modeling rules for the restoration and maintenance of Old Forest habitat. The strategy for achieving the conservation objective includes the restoration and maintenance of at least 20 percent of DNR-managed lands as "Old-Forest" spotted owl habitat. The time required to achieve the Old Forest habitat thresholds under no-management was used as a benchmark in formulating a set of modeling rules for the No Action and Landscape alternatives (Table D-18). A separate rule was formulated for each landscape planning unit. Most rules were designed as constraints, which were applied at the beginning of the decade in which a no-management scenario achieves the Old Forest habitat threshold. The constraint is binding and may not be violated. Otherwise, the model solution is considered infeasible.

Modeling rules for landscape planning units that required more than five decades to achieve the desired level of habitat under no management were designed as goals. For these landscapes, the modeling rule is non-binding. Deviations are permitted, but a penalty of $9,999 is incurred for each acre the landscape planning unit in question falls short of its habitat threshold. The goal is applied at the beginning of the fifth decade.

Table D-18. Old-Forest Habitat Thresholds

Landscape planning unit	Total acres (based on an aggregation of Theme 4)	Old Forest habitat threshold (20 % of DNR-managed acres, based on aggregation of Theme 4)	Decades to achieve habitat threshold under a no-management scenario	Constraint (inviolate) or Goal (deviations allowed, but incur penalty)
Clallam	17,276	3,455	5	Constraint
Clearwater	55,203	11,041	1	Constraint
Coppermine	19,246	3,849	>5	Goal
Dickodochtedar	28,047	5,609	4	Constraint
Goodman	23,799	4,760	1	Constraint
Kalaloch	18,122	3,624	5	Constraint
Queets	20,807	4,161	1	Constraint
Reade Hill	8,479	1,696	1	Constraint
Sekiu	10,014	2,003	>5	Goal
Sol Duc	19,134	3,827	5	Constraint
Willy Huel	37,428	7,486	1	Constraint

CONSTRAINT: Harvest of Old Forest Habitat During the Restoration Phase

The term "restoration phase" refers to the period of time it takes for each landscape planning unit to meet its target level of northern spotted owl habitat. By the end of the restoration phase, 40 percent of each landscape planning unit shall consist of habitat that meets or exceeds the definition of Young Forest habitat; half of which (that is, 20 percent of each landscape) shall meet the definition of Old Forest habitat. During the restoration phase, existing young stands are developing the structural characteristics that would allow them to be classified as spotted owl habitat. DNR's 1997 Habitat Conservation Plan anticipated the restoration phase would last approximately 40 to 60 years (DNR 1997, p.IV.91)

The OESF forest estate model uses a constraint to restrict harvest activities during the restoration phase. For the purposes of the constraint, the restoration phase was defined as including decades one through five. During this time, no action-based harvests[12] are allowed in Old Forest northern spotted owl habitat. Inventory-based harvests within Old Forest are not limited by this constraint.

The constraint applies to both alternatives all landscape planning units. The constraint is binding and must be followed. Otherwise, the model solution is considered infeasible.

CONSTRAINT: Level of Variable Retention Harvests in Stands More Than 50 Years Old Are Not Classified as Either Structural Habitat or Old Forest

In 2006, DNR settled a legal challenge to its 10-year sustainable harvest calculation brought by the Washington Environmental Council (*WEC v. Sutherland*, 2006). Among the terms of the settlement agreement was a provision for additional short-term protection for northern spotted owls through harvest restrictions in certain areas which were considered to contribute to spotted owl conservation. The settlement agreement set limits on the amount of regeneration harvests in stands 50 years or older that are not classified as either "structural habitat"[13] or Old Forest.

A separate harvest limit is specified for each landscape planning unit. The harvest limits, shown in Table D-19, were based on earlier guidance provided by OESF's interim HCP implementation procedure for northern spotted owls (PR-HCP-021(e), June 1997). DNR's Olympic Region tracks the cumulative regeneration harvests conducted since implementation of the HCP for the type of stands in question. Regeneration harvests are permitted as long as the harvest limit has not yet been reached for the given landscape.

Under the terms of the settlement agreement, the harvest limits for the OESF remain in effect until the completion of landscape planning. Since the Landscape Alternative is considered a completion of landscape planning, this constraint is only applied to the No Action Alternative. Cumulative total regeneration harvest to date since implementation of the HCP for stands 50 years or older not classified as either structural habitat or Old Forest is reported as a sum from fiscal years 1998 through 2011, as of November 2010. The harvest limit, harvest to date, and remaining available harvest for each landscape are shown in Table D-19.

Table D-19. Harvest Limits in Stands 50 Years or Older that are Not Classified as Either Structural Habitat or Old Forest.

Landscape planning unit	Maximum acres of regeneration harvest in stands 50 years or older, not classified as either structural habitat or Old Forest.	Cumulative regeneration harvests to date (as of month year) since implementation of the HCP (acres)	Remaining available acres of regeneration harvests
Clallam	2,940	888	2,052
Clearwater	0	0	0
Coppermine	100	43	57
Dickodochtedar	947	440	507
Goodman	246	55	191
Kalaloch	123	8	115
Queets	260	190	70

Reade Hill	245	15	230
Sekiu	191	191	0
Sol Duc	3,139	2,202	937
Willy Huel	390	91	299

The constraint is applied by requiring that the total regeneration harvests during the first four decades for the landscapes in question do not exceed the available acres shown in Table D-19. The constraint is lifted beginning in the fifth decade.

The constraint only applies to the No Action alternative. The constraint is binding and must be followed. Otherwise, the model solution is considered infeasible.

GOAL: Large Woody Debris

The ability of the riparian area to supply functional large woody debris to the stream channel is known as its large woody debris (LWD) recruitment potential. Within each Type 3 watershed, LWD recruitment potential was assessed through an examination of the projected riparian forest composition and structure, following the methodology outlined in DNR's Watershed Analysis Manual (WFPB 1997). At decadal intervals, all riparian forests[14] were assigned a "riparian condition code", which is a characterization of the tree species (hardwood, conifer, mixed), size (quadratic mean diameter), and stand density (Curtis' relative density). Riparian condition codes were then given a qualitative rating of high, medium, or low, based on their expected ability to provide large woody debris. The qualitative ratings were adjusted based on the distance of the given forest stand from the stream channel. Scores were summed within each watershed, and the forest estate model seeks to avoid decreases in the watershed-level LWD score over time.

The dominant vegetation type was classified as either conifer (C), hardwood (H), or mixed (M), based on generalized groupings (aggregations) of Forest Inventory Units (THEME 1) based on their primary and secondary tree species. Stands lacking forest inventory data (i.e., those which rely on strata-based yield tables) were assigned a default forest type of western hemlock/Douglas-fir (WHDF).

Table D-20. Dominant Vegetation Types

Forest type	Riparian condition code 1 (vegetation type)
DFRC, DFWH, WHDF, WHRC, WHSF	C
RADF	H
DFRA, WHRA	M

DF = Douglas-fir, RC = red cedar, WH = western hemlock, SF = silver fir, RA = red alder, MA = big-leaf maple

Table D-21. Average Tree Size Classes

Quadratic mean diameter (QMD) of stand using trees 8" dbh and larger (YQMD8I)	Riparian condition code 2 (Size)
YQMD8I < 12	S
12 ≤ YQMD8I < 20	M
YQMD8I ≥ 20	L

Table D-22. Stand Density Classes

Curtis' relative density of stand using trees 4" dbh and larger (YRD3D5I)	Riparian condition code 3 (density)
YRD3D5I < 42	S
YRD3D5I ≥ 42	D

The riparian condition code is constructed from a concatenation of the three vegetative characteristics listed in Tables D-20, D-21, and D-22. For example, a stand classified as hardwood, small, sparse receives a riparian condition code of HSS. Each riparian condition code is assigned a qualitative ranking ("low", "medium", "high") which reflects its potential to contribute functional large woody debris to the stream channel (Table D-23).

Table D-23. Large Woody Debris Recruitment Potential Rating (DNR 1997a)

Riparian condition code	LWD recruitment potential rating
HSS, HSD, MSS, MSD, CSS, CSD, HMS, HLS	Low
HMD, MMS, CMS, CLS, HLD, MLS	Medium
CMD, MMD, MLD, CLD	High

These qualitative rankings were then adjusted to account for the expected likelihood of delivery of large woody debris, which generally declines with increasing distance from the stream channel (McDade and others 1990, Welty and others 2002). That is, trees close to the stream channel are more likely to intercept the stream when they fall; whereas trees further from the stream channel are less likely to do so. The adjusted ratings, summarized in Table D-24, were applied to all riparian forests located beyond 75 feet of the outer edge of the 100-year floodplain of Type 1 through 4 waters. The preliminary ratings were not adjusted for areas within 75 feet of and including the 100-year floodplain.

Table D-24. Preliminary and Adjusted Qualitative Ratings of LWD Recruitment Potential

Location	Theme 5	Preliminary Rating	Adjusted Rating
Within 75 feet of and including the 100-year floodplain of Type 1 through 4 streams	75i	Low	(same)
		Medium	(same)
		High	(same)
Between 75 and 100 feet of the 100-year floodplain of Type 1 through 4 streams	100i	Low	Low
		Medium	Low
		High	Medium
Between 100 and 150 feet of the 100-year floodplain of Type 1 and 2 streams	150i	Low	Low
		Medium	Low
		High	Medium
Potentially unstable slopes, channel migration zones, and wetlands; along Type 5 streams regardless of distance, or located further than 150 feet from the 100-year floodplain of Type 1 and 2 streams or further than 100 feet from the 100-year floodplain of Type 3 and 4 streams.	i	Low	Low
		Medium	Low
		High	Low

Within each Type 3 watershed, the acreages of riparian forests in the low, medium, and high LWD recruitment potential classes were tallied at decadal intervals. A weighting factor was applied to the acre sum for each class, and a weighted sum of all classes was calculated using Equation D-6. The weighting factors were 0.1, 0.2, and 0.8 for the low, medium, and high classes respectively.

Equation D-6.

$$LWD\ score = \left(0.1\sum acres\ LOW\right) + \left(0.2\sum acres\ MEDIUM\right) + \left(0.8\sum acres\ HIGH\right)$$

The LWD score was then formulated as a goal for each Type 3 watershed, and treated as a non-declining yield[15]. As a non-declining yield, the forest estate model strives to avoid decreases in large woody debris recruitment potential in successive decades. That is, from one decade to the next, the forest estate model attempts to ensure that the LWD score for a given Type 3 watershed either remains the same or increases. Since the modeling rule is formulated as a goal, the score may decrease but a penalty of $9,999 is subtracted from the calculation of net present value for each acre in which a decrease is observed.

The constraint only applies to the Landscape alternative. LWD recruitment potential for the No Action alternative is addressed through a different process. The No Action Alternative relies on a simulation of the 12-step watershed assessment procedure to determine the buffer width is necessary to provide for riparian function. The No Action alternative provides for LWD by applying the recommended buffer width. For a description of how the No Action alternative was modeled, refer to *Modeling the No Action Alternative*, p. D-96.

GOAL: Shade

The amount of shade provided to the stream channel was assessed by examining riparian forests conditions. All forests located within 75 feet of and including the 100-year floodplain of Type 1 through 4 waters were assessed. Two stand characteristics were considered: the height of trees within the stand (using average height [feet] of the 40 largest diameter live trees in the stand); and stand density (using Reineke's Stand Density Index). The yield variables YTOPHI and YSDII were used to represent tree height and stand density, respectively (refer to Table D-4 for a summary of yield variables). An acre-weighted sum of the product of these variables was calculated for each Type 3 watershed using equation D-7.

Equation D-7.

$$shade\ score = \sum (acres * YTOPHTI * YSDII)$$

The shade score was then formulated as a goal for each Type 3 watershed, and treated as a non-declining yield. From one decade to the next, the forest estate model attempts to ensure that the shade score for a given Type 3 watershed either remains the same or increases. Since the modeling rule is formulated as a goal, the score may decrease but a penalty of $9,999 is subtracted from the calculation of net present value for each acre in which a decrease is observed.

The constraint only applies to the Landscape alternative. Stream shade for the No Action alternative is addressed through a different process. The No Action Alternative relies on a simulation of the 12-step watershed assessment procedure to determine the buffer width is necessary to provide for riparian function. The No Action alternative provides for shade by applying the recommended buffer width. For a description of how the No Action alternative was modeled, refer to *Modeling the No Action Alternative*, p. D-96.

GOAL: Peak Flow

The term *peak flow* refers to periods of high stream flow or maximum discharge, usually associated with storm events. In the Pacific Northwest, peak flows often coincide with humid, winter storms where rain falls on top of an existing snowpack (commonly known as "rain-on-snow" events) (Pentec Environmental, Inc. 1997).

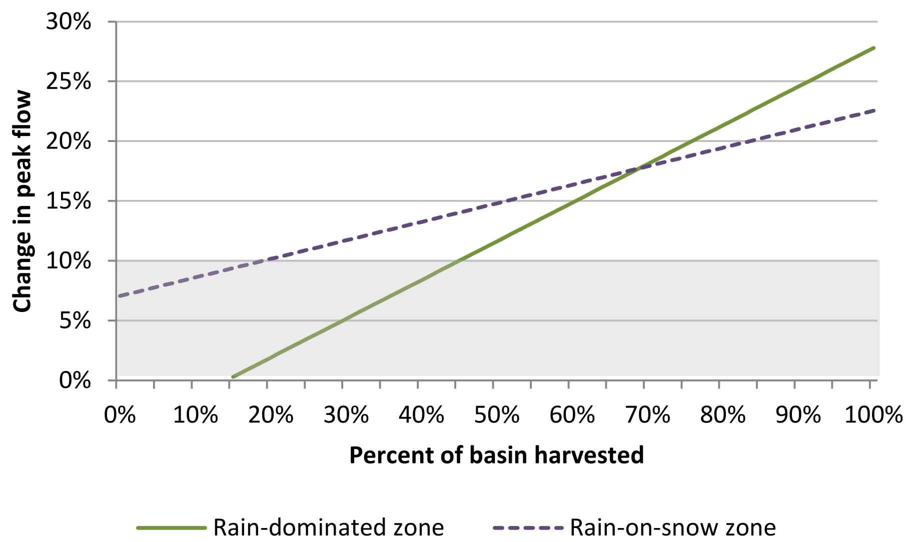
The expected peak flow response is based on an assessment of forest conditions within each Type 3 watershed at each decade. Forests that are young (less than 24.5 years of age) and sparse (with a Curtis' relative density less than 24.5) are considered "hydrologically immature". These forests contribute more to peak flow because their lack of a dense canopy allows greater snow accumulation and subsequent rapid melting (DNR 2004). The yield variables YAGE and YRD3D5I were used to represent age and density, respectively.

The assessment of hydrologic conditions within each watershed was based on a method developed by Grant and others (2008) to predict the change in peak flow resulting from harvest. Hydrologic effects were evaluated at the Type 3 watershed level. Grant uses the percent of harvest within a watershed to calculate a percent change in peak flow for a given hydrologic zone. A hydrologic zone is a spatial classification that groups the portions of the landscape that share common hydrologic processes such as precipitation type and seasonality, hydraulic conductivity and residence times, and partitioning of surface and subsurface flow (Winter 2001 as cited in Grant and others 2008). Following Grant and others (2008), a ten percent change in peak flow above an un-managed condition was considered the detection limit.

Three hydrologic zones were examined: lowland, rain-dominated, and rain-on-snow (transient snow) zone. The lowland and rain-dominated zones were grouped. The transient snow zone is of particular interest because it represents the geographic region where rain-on-snow events are particularly common during winter months, and such events are potentially affected by timber harvest (Berris and Harr 1987; Christner and Harr 1982; Harr 1986; Jones and Grant 1996; as cited in Grant and others 2008). Hydrologic change as a result of precipitation in the snow-dominated zone was ignored, as precipitation falls primarily as snow and is unlikely to be affected by rain-on-snow events.

Grant and others (2008) found the relationship between percent harvest and percent change in peak flow varies by hydrologic zone (Chart D-1). In general, the rain-dominated hydrologic zone is less sensitive to changes in hydrologic maturity. That is, a greater percentage of the watershed must be harvested before changes in peak flow can be detected. For the rain-dominated zone, changes in peak flow become detectable when approximately 45 percent of the watershed has been harvested; for the rain-on-snow zone, the threshold is approximately 20 percent.

Chart D-1. Peak Flow Response to Harvest in the Rain-Dominated and Rain-on-Snow Hydrologic Zones
Adapted from Grant and others (2008). Grey shading indicates limit of detection.



The forest estate model seeks to avoid detectable increases in peak flow by limiting the number of hydrologically immature acres. For each Type 3 watershed, a threshold level of hydrologic immaturity was calculated as 0.45 times the total acres in the rain-dominated zone plus 0.20 times the total acres in the rain-on-snow zone. Only DNR-managed lands were included in the calculation. Hydrologic immaturity above this threshold was assumed to result in detectable increases in peak flow.

The threshold for each Type 3 watershed was formulated as a goal. The total number of hydrologically immature acres may exceed the threshold, but a penalty of $9,999 is subtracted from the calculation of net present value for each acre above the detectable threshold. The goal is applied to both alternatives.

What Data is Output from the Forest Estate Model?

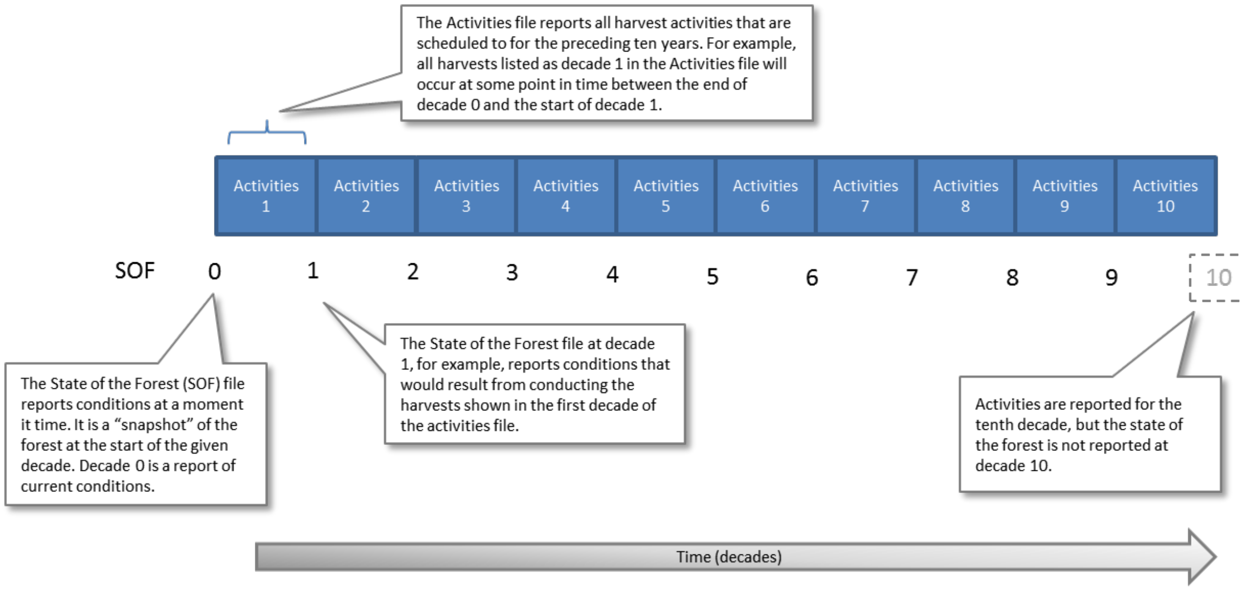
In the context of forest land planning, the solution provided by the forest estate model is a list of management activities known as a harvest schedule. It is a report of the recommended locations, timing, and types of harvest activities that are necessary to optimize the objective function and, to the greatest extent possible, meet the constraints. The harvest schedule is output in a Microsoft Access database known as the "Activities File". Tables D-25 and D-26 describe each field contained in the activities file.

Using a modeling technique known as simulation, the forest estate model also provides a detailed report of site-specific future forest conditions across the entire OESF as a result of implementing the harvest schedule. These data are output in a Microsoft Access database known as the "*State of the Forest File*". Tables D-27 and D-28 describe each field contained in the state of the forest file. These data are output in two databases.

Both the Activities File and the State of the Forest File report data in decadal increments. The State of the Forest File reports conditions at a moment in time. It is a "snapshot" of the forest at the start of the given decade. Decade 0 of the State of the Forest File is a report of current conditions; decade 1 is a report of projected conditions 10 years later; decade 2, 20 years later; etc. It is a report of instantaneous conditions.

The Activities File, in contrast, reports harvests in ten-year intervals. Each decade in the Activities File is a report of harvests scheduled for the preceding ten years. For example, decade 1 harvests will occur at some point in time between the end of decade 0 and the start of decade 1 (Figure D-6).

Figure D-6. Sequencing of Data Reporting in the State of the Forest File and Activities File



Activities File

Table D-25 describes each field contained in the activities file.

Table D-25. Fields Contained in the Activities File

Field name	Description
REMSOFT_ID	Unique polygon identifier.
Scenario	Alternative, either "Landscape" or "No Action"
Date	The date the data set was created.
DECADE	The decade in which the activity is scheduled to occur.
FIRST_ENTRY	The decade in which the first harvest entry occurs.
UTHEME1	Forest Inventory Unit or Forest Strata. See Table D-1.
UTHEME2	Silvicultural regime. See Table D-1.
UTHEME3	Deferral status. See Table D-1.
UTHEME4	Forest Management Unit. See Table D-1.
UTHEME5	Watershed and riparian assessment area. See Table D-1.
LPU	Landscape Planning Unit
RAW	Hydrologic Response Zone
RIP	Riparian assessment area, either "i", "75i", "100i", "150i", "e", or "x". See Table D-1.
DEIS_SCENARIO	Recommended buffering scenario (either A, B, or C) for the No Action alternative, from a simulation of the 12-step watershed assessment. For Scenario A, the recommended buffer includes all "i" features. For Scenario B, the recommended buffer includes all "i", "75i", "100i", and "150i" features. For Scenario C, the recommended buffer includes all "i", "75i", "100i", "150i", and "e" features.

Field name	Description
WAU_NM	Watershed Administrative Unit
WS_ID	Subwatershed identifier
T3_ID	Type 3 watershed identifier
ACTIVITY_CLASS	Classification of modeled harvest activities (1,2,3,4). • Activity class 1 refers to “inventory-based” thinnings. • Activity class 2 are action-based harvests with an edge density greater than 1103. • Activity class 3 are action-based harvests with an edge density greater than 523 and less than or equal to 1103. • Activity class 4 are action-based harvests with an edge density less than or equal to 523.
YAGE	A forest may be composed of multiple groups (or cohorts) of age classes. YAGE is a statistical estimate of the main tree cohort in the stand.
YTOPHTI	Average height (feet) of the 40 largest diameter live trees in the stand.
YBA8I	Basal area (square feet per acre) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
YQMD8I	Quadratic mean diameter (inches) of live trees in the stand with a diameter at breast height (dbh) greater than or equal to 7.5 inches.
BFTPA	Volume removal due to harvest, reported as Scribner board feet per acre of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
CFTPA	Volume removal due to harvest, reported as cubic volume per acre of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
BFT	Volume removal due to harvest, reported as Scribner board feet of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
CFT	Volume removal due to harvest, reported as cubic volume per acre of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches.
ACRES	Size of polygon, in acres
EDGE_DENSITY_WTDr	Stand-level estimate of edge-to-area ratio.

Additional fields, listed in Table D-26, were added in a separate post process to prepare the data for analysis of potential environmental impacts conducted for the Revised Draft EIS.

Table D-26. Additional Fields Added to the Activities File in a Post-Process

Field name	Description
LPU_NM_CLEAN	Landscape Planning Unit, consistent with HCP naming conventions.
WAU_NM_CLEAN	Watershed Administrative Unit, consistent with HCP naming conventions.
WAU_DNR_GT20	A Y/N flag to indicate if DNR-managed lands comprise more than 20 percent of the WAU.
T3_DNR_GT20	A Y/N flag to indicate if DNR-managed lands comprise more than 20 percent of the Type 3 watershed.
LAND_CLASS	A classification of the polygon as either RIPARIAN or UPLANDS. The riparian land class includes all “i”, “75i”, “100i”, and “150i” features. The uplands land class includes all “e” and “x” features.
HARVEST_TYPE_CD	Classification of harvest treatment based on edge density and activity class, code. See Table D-10.
HARVEST_TYPE_NM	Classification of harvest treatment based on edge density and activity class, text name. See Table D-10.
FOREST_TYPE	Four character code for the forest type. First 2 characters are the primary species, last 2 characters are the secondary species

Field name	Description
SITE_CLASS	Site class (1,2,3,4,5). For some records, it was not possible to distinguish site class 3 from site class 4. These are listed as site class "34". This data derived from aggregations of THEME 1 (Forest Inventory Unit).

State of the Forest File

Table D-27 describes each field contained in the state of the forest file.

Table D-27. Fields Contained in the State of the Forest File

Field name	Description
REMSOFT_ID	Unique polygon identifier.
Scenario	Alternative, either “Landscape” or “No Action”
COMPILE	The date the data set was created.
DECADE	The decade in which the activity is scheduled to occur.
FIRST_ENTRYr	The decade in which the first harvest entry occurs.
Acres	Size of polygon, in acres
UTHEME1	Forest Inventory Unit or Forest Strata. See Table D-1.
UTHEME2	Silvicultural regime. See Table D-1.
UTHEME3	Deferral status. See Table D-1.
UTHEME4	Forest Management Unit. See Table D-1.
UTHEME5	Watershed and riparian assessment area. See Table D-1.
RAW	Hydrologic Response Zone
RIP	Riparian assessment area, either “i”, “75i”, “100i”, “150i”, “e”, or “x”. See Table D-1.
DEIS_SCENARIO	Recommended buffering scenario (either A, B, or C) for the No Action alternative, from a simulation of the 12-step watershed assessment. For Scenario A, the recommended buffer includes all “i” features. For Scenario B, the recommended buffer includes all “i”, “75i”, “100i”, and “150i” features. For Scenario C, the recommended buffer includes all “i”, “75i”, “100i”, “150i”, and “e” features.
T3_ID	Type 3 watershed identifier.
WS_ID	Subwatershed identifier.
WAU_NM	Watershed Administrative Unit name.
WRIA	Water Resource Inventory Area
LPU	Landscape Planning Unit
EDGE_DENISTY_WTDr	Stand-level estimate of edge-to-area ratio.
EDGE33_TPA_WTDr	Stand level estimate of large edge trees per acre.
CANCOV	Stand-level estimate of canopy cover (0 to 100%)
VERDIV	Stand-level estimate of vertical diversity.
CANDEP	Stand-level estimate of canopy depth.
CANLFT	Stand-level estimate of canopy lift.
TOPHT	Stand-level estimate of top height.
FORCMP	Stand-level estimate of softwood composition, reported as a proportional value from 0 to 1.
TPA_2	Stand-level estimate of the number of trees per acre with a diameter at breast height greater than or equal to 1.5 inches.
LLT_30	Record-level estimate of the number of live trees per acre with a diameter at breast height greater than or equal to 29.5 inches.
LLT_40	Record-level estimate of the number of live trees per acre with a diameter at breast height greater than or equal to 39.5 inches.
LLT_50	Record-level estimate of the number of live trees per acre with a diameter at breast height greater than or equal to 49.5 inches.

Field name	Description
SNAGS_50	Record-level estimate of the number of dead, standing trees per acre with a diameter at breast height greater than or equal to 49.5 inches.
SNAGS20	Record-level estimate of the number of dead, standing trees per acre with a diameter at breast height greater than or equal to 19.5 inches.
SNAGS1520	Record-level estimate of the number of dead, standing trees per acre with a diameter at breast height greater than or equal to 14.5 inches and less than 19.5 inches.
DWD	Record-level estimate of coarse woody debris (cubic feet per acre)
MMK_POCC	Record-level estimate of the probability (measured on a continuous scale from 0 to 1) of marbled murrelet occupancy.
MMK_INT	Record-level estimate of marbled murrelet interior forest carrying capacity. Not used in the RDEIS.
MMK_EDGE	Record-level estimate of marbled murrelet exterior forest carrying capacity (edge influenced). Not used in the RDEIS.
OESD_SDS	Stand-level estimate of stand development stage
BFTPA	Stand-level estimate of net Scribner thousand board feet per acre of all live trees with a diameter at breast height greater than or equal to 7.5 inches
CFTPA	Stand-level estimate of net thousand cubic feet per acre of all live trees with a diameter at breast height greater than or equal to 7.5 inches
BFT	Stand-level estimate of total Scribner thousand board feet for all live trees with a diameter at breast height greater than or equal to 7.5 inches
CFT	Stand-level estimate of total thousand cubic feet for all live trees with a diameter at breast height greater than or equal to 7.5 inches
YAGE	Record-level estimate of dominant tree age
YTOPHTI	Record-level estimate of the average height (feet) of the 40 largest diameter trees in the stand
YBA3D5I	Record-level estimate of the total basal area (square feet per acre) of live trees in the stand with a diameter at breast height greater than or equal to 3.5 inches
YQMD3D5I	Record-level estimate of the quadratic mean diameter (inches) of live trees with a diameter at breast height greater than or equal to 3.5 inches.
YRD3D5I	Record-level estimate of Curtis' relative density (unitless) of live trees with a diameter at breast height greater than or equal to 3.5 inches
YBA8I	Record-level estimate of the total basal area (square feet per acre) of live trees in the stand with a diameter at breast height greater than or equal to 7.5 inches
YQMD8I	Record-level estimate of Curtis' relative density (unitless) of live trees with a diameter at breast height greater than or equal to 7.5 inches
YRD8I	Record-level estimate of Curtis' relative density (unitless) of live trees with a diameter at breast height greater than or equal to 7.5 inches
YSDII	Record-level estimate of Reineke's Stand Density Index, a unitless measure of stocking of live trees
yNSO_PHAB	Record-level estimate of potential OESF Northern Spotted Owl habitat type

Additional fields, listed in Table D-28, were added in a separate post process to prepare the data for analysis of potential environmental impacts conducted for the Revised Draft EIS.

Table D-28. Additional Fields Added to the State of the Forest File in a Post-Process

Field name	Description
LPU_NM_CLEAN	Landscape Planning Unit, consistent with HCP naming conventions.
WAU_NM_CLEAN	Watershed Administrative Unit, consistent with HCP naming conventions.
WAU_DNR_GT20	A Y/N flag to indicate if DNR-managed lands comprise more than 20 percent of the WAU.
T3_DNR_GT20	A Y/N flag to indicate if DNR-managed lands comprise more than 20 percent of the Type 3 watershed.
LAND_CLASS	A classification of the polygon as either RIPARIAN or UPLANDS. The riparian land class includes all “i”, “75i”, “100i”, and “150i” features. The uplands land class includes all “e” and “x” features.
OESF_SDS_GROUPED	Grouped stand development stages. “Ecosystem Initiation” = EIS; “Competitive Exclusion” = SES, PES, LTS; “Understory Development” = URS, DUS; “Botanically Diverse” = BDS; “Structurally Complex” = FFS, NDS.
FOREST_TYPE	Four character code for the forest type. First 2 characters are the primary species, last 2 characters are the secondary species
SITE_CLASS	Site class (1,2,3,4,5). For some records, it was not possible to distinguish site class 3 from site class 4. These are listed as site class "34". This data derived from aggregations of THEME 1 (Forest Inventory Unit).

Parameters Added in a Post Process

STAND DEVELOPMENT STAGES

As forest stands develop from planted seedlings or grow on their own through natural regeneration, they move through stand development stages. Each stage is defined not by the age of the trees, but by a particular set of measurable physical attributes such as tree height and diameter, stand density, canopy layers, understory vegetation, down wood, and snags. Stand development stages are more useful than age classifications for describing the structural conditions of a forest and are a good indicator of wildlife habitat conditions. For additional descriptions of stand development stages, including representative photographs, refer to Text Box 3-2 in the Revised Draft EIS.

Stand development stages were reported as part of the output of the forest estate model; they are included as an attribute in the “state of the forest file”. Stand development stage was calculated by considering forest conditions at the scale of the forest inventory unit (THEME 1) (refer to Table D-1 for a description of forest inventory units). Since a forest inventory unit may be composed of multiple forest management units (which themselves may be composed of operable and deferred areas), it is possible for forest cover to be retained in some portions of the forest inventory unit, but not in others. As harvest activities are conducted over time, the forest inventory unit becomes more heterogeneous and may contain a variety of age-classes, structural conditions, and canopy layers. The resulting variation in conditions within each forest inventory unit is incorporated into the classification of stand development stage.

At each decade, each forest inventory unit is assigned a stand development stage based on one or more of the following variables: stand structure complexity index, dominant tree height, coarse woody debris, canopy layers, and the size (quadratic mean diameter) of the reforestation.

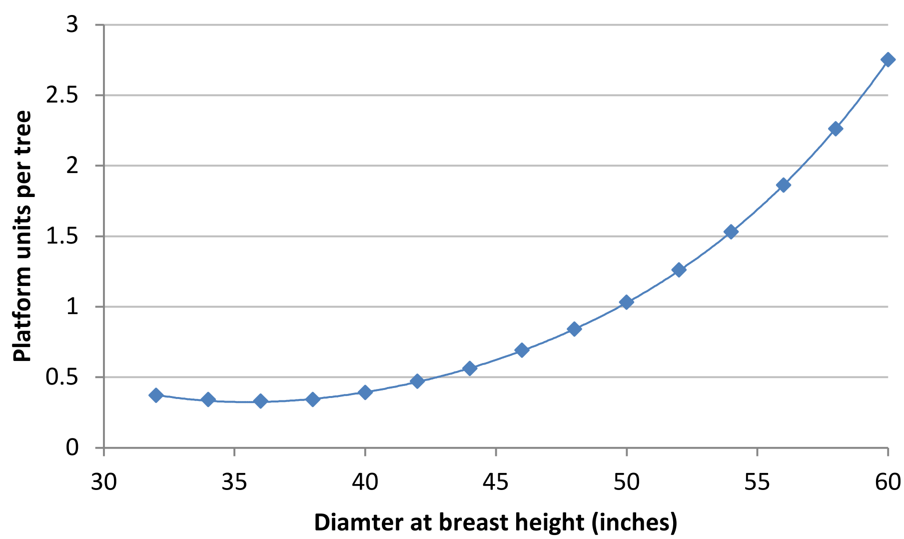
Stand structure complexity index is a measure of the structure and complexity of the given forest stand. It is a numerical index ranging from zero (simple) to one (complex), derived in a manner similar to that used by Raphael and others (2008) to estimate the abundance and availability of potential marbled murrelet nest sites. Raphael and others (2008) rely on a count of the number of nesting platforms[16] per acre and the number of canopy layers in the given forest stand (Equation D-8). Neither of these parameters was measured during the DNR's forest inventory; instead, they were inferred from other inventory-based parameters, as described below.

Equation D-8. Stand Structure Complexity Index, Adapted from Raphael and Others (2008)

$$stand\ strucure\ complexity\ index = \frac{e^{(-044-(0.94*canopy\ layers)+(0.19*platforms))}}{1+\ e^{(-044-(0.94*canopy\ layers)+(0.19*platforms))}}$$

Each yield table includes an initial estimate of the number of nesting platforms (yield parameter PPAALL, reported as platforms per acre). This estimate is derived by applying the *inventory model method* as described in section 15 of the Forest Practices Board Manual (WFPB 2004) to FVS projections of stand conditions. This method provides a means of estimating the number of nesting platforms in a given stand based on the presence of large trees (defined as those greater than 32 inches dbh). The expected contribution of platforms generally increases with tree diameter. That is, as trees grow larger, they provide a greater number of platforms (Chart D-2). The inventory model method specifies the expected contribution of platforms from large trees, in a series of two inch diameter classes. To derive the number of platforms per acre for the stand, the FVS estimate of the number of trees per acre in each diameter class was multiplied by the expected platform contribution for that diameter class.

Chart D-2. Estimate of Large Trees Growing Along Forest Edges, Adapted From WFPB (2004)



In a post-process, the initial FVS estimate described above was augmented to account for the accelerated tree growth along forest edges, which are created as management activities are conducted. Trees found along harvest edges are expected to grow faster as a result of reduced competition for resources (namely increased growing space and availability of light). The accelerated growth rate results in more rapid development of nesting platforms than is shown in Chart D-2. Therefore, the initial FVS estimate is considered to underestimate the number of nesting platforms. To compensate, a correction factor was added.

The correction factor was based on an estimate of the number of large trees found along the edge and how they are expected to respond over time to the creation of the edge. Large edge trees were assumed to have a 33-foot wide crown and occupy half the growing space of each edge. Based on these assumptions, the number of large edge growing along the edge of any given gap was estimated from the edge density of the gap using equation D-9.

Equation D-9.

$$large\ edge\ trees\ per\ acre\ for\ each\ gap = edge\ density\ of\ gap\ \left(\frac{ft}{ac}\right) * \frac{1\ tree}{33\ ft} * \frac{1}{2}$$

Growth rate along the forest edge was estimated using a logarithmic growth curve, and expressed as a proportional value (from 0 to 1) of the cumulative maximum (Equation D-10). Time (t) is expressed as the number of decades since the first harvest entry for the gap in question.

Equation D-10. Logarithmic Growth Curve

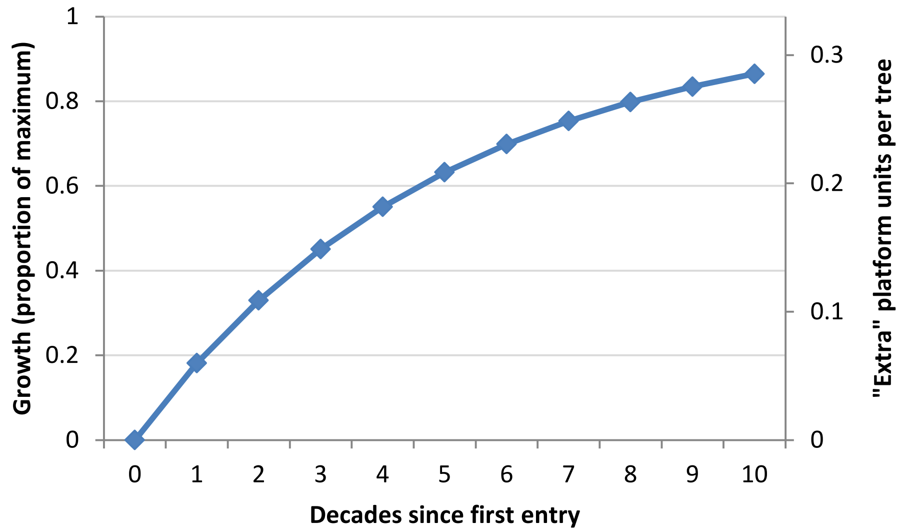
$$growth = 1 - e^{-0.2t}$$

From the growth curve, a correction factor of “extra platforms” was derived as follows; the correction factor was then added to the initial FVS estimate. A count of extra platforms provided by each gap at any given point in time was calculated by multiplying the number of large edge trees in the gap (equation D-9) by the growth curve (Equation D-10). A scalar constant 0.33 was included (Equation D-11. The change over time in cumulative growth and extra platforms contributed by a single tree are shown in the left and right vertical axes, respectively, of Chart D-3 As shown in Chart D-3, when the edge is first created, the number of extra platforms is zero. That is, the initial FVS estimate is correct, and the correction factor is zero. But as the large trees respond to the creation of the edge, the correction factor increases. The growth rate is logarithmic, and reaches a maximum of approximately 0.3 extra platforms per tree after 10 decades.

Equation D-11. Calculation of Extra Platforms Contributed by Large Edge Trees, at Time t. Time (t) is expressed as the number of decades since the first harvest entry for the gap in question.

$$extra\ platforms\ for\ each\ gap\ at\ time\ t = large\ edge\ trees\ per\ acre\ for\ each\ gap * growth\ at\ time\ t * 0.33$$

Chart D-3. Change Over Time in Cumulative Growth (Left Vertical Axis) and Platform Contribution per Tree (Right Vertical Axis)



The gap-level estimate of the number of extra platforms was aggregated to the scale of the Forest Inventory Unit (THEME 1) using an area-weighted sum (Equation D-12). The area-weighted sum of extra platforms was then added to the initial FVS estimate for the Forest Inventory Unit in question.

Equation D-12.

$$edge\ platforms\ \ per\ acre\ in\ the\ FIU = \frac{\sum_{i=1}^{n} platforms\ per\ acre\ in\ gap_i * area\ of\ gap_i}{area\ of\ the\ FIU}$$

Dominant tree height is the average height (feet) of the 40 largest diameter live trees in the stand.

Coarse woody debris: Estimated coarse woody debris volume, in cubic feet per acre. Includes both an estimate of the coarse woody debris from the forest inventory (subject to decay over time) and an FVS-derived estimate of the additional input of coarse woody debris from tree mortality, as trees dies, become snags, and fall down. Included in the yield tables as “YCWDI”.

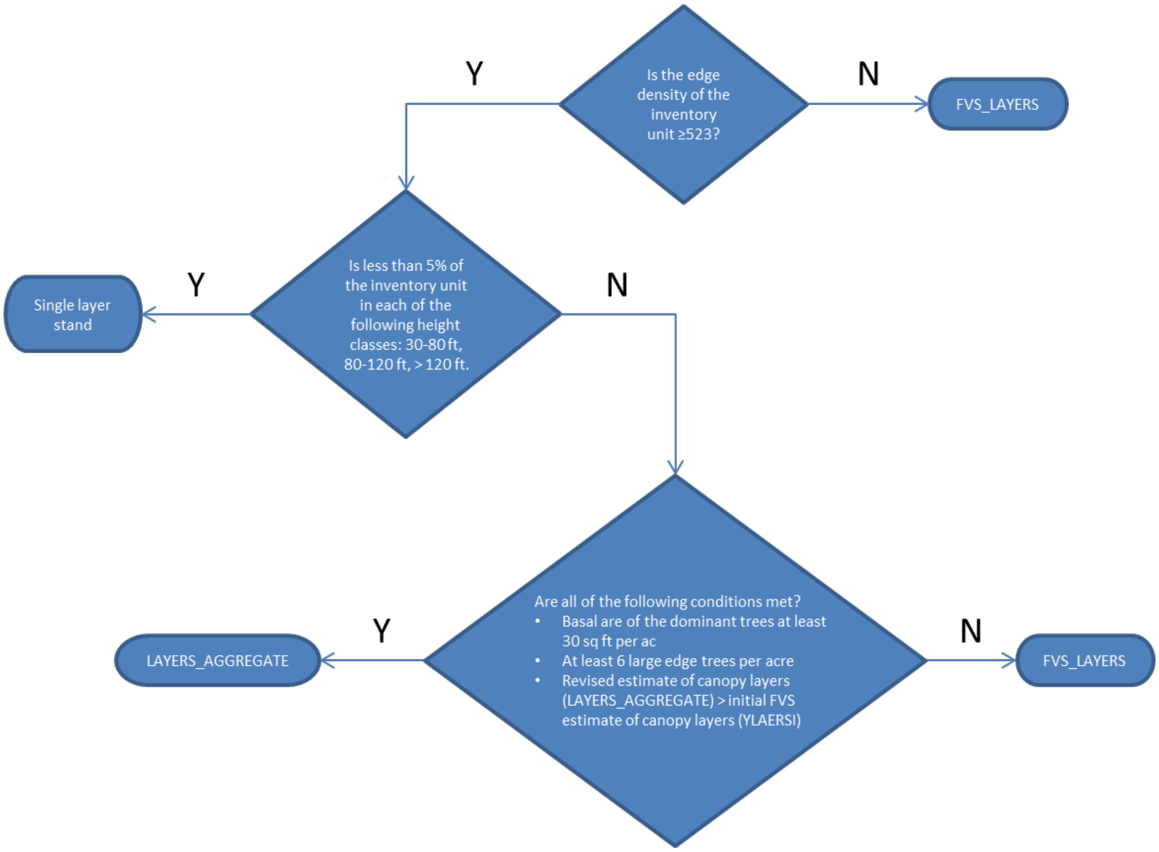
Canopy layers is an estimate of the vertical complexity of the forest stand, as measured by the presence of trees in discrete height classes (also known as strata). An initial estimate of the number canopy layers is included in the yield tables (yield parameter YLAYERSI, Table D-4), calculated at the scale of the Forest Inventory Unit (THEME 1) using default settings for the Pacific Northwest Coast variant of the USDA Forest Service Forest Vegetation Simulator.

In order to account for the increasing heterogeneity in stand conditions arise as portions of a forest inventory unit are harvested, two additional estimates of the number of canopy layers were developed: FVS_LAYERS, and LAYERS_AGGREGATE.

The first, FVS_LAYERS, is derived as an area-weighted sum of the individual FVS estimates canopy layers for each development type contained within the inventory unit. The second, LAYERS_AGGREGATE, is a count of discrete canopy layers (strata) within the inventory unit, calculated by evaluating for the presence of three strata: 30 to 80 feet, 80 to 120 feet, and greater than 120 feet. Each stratum was tallied if it comprised at least 5 percent of the inventory unit.

The revised estimate of canopy layers for the inventory unit utilized both FVS_LAYERS and LAYERS_AGGREGATE, following the process illustrated in Figure D-7.

Figure D-7. Calculation of the Number of Canopy Layers within a Forest Inventory Unit



Quadratic mean diameter (QMD) of the reforestation:

At each decade, a stand development stage was assigned to each forest inventory unit by sequentially applying the criteria shown in table D-29. The forest inventory unit was first queried to see if it met the criteria for the most complex stage - Fully Functional. That is, was its stand structure complexity index greater than 0.76? If not, then the criteria for the next stage were examined (Niche Diversification). The process was repeated through each of the remaining stand development stages.

Table D-29. Stand Development Stages

Stand development stage (grouped)	Stand development state (ungrouped)	Stand structure complexity index	Dominant tree height (feet)	Coarse woody debris volume (cubic feet per acre)	Canopy layers	Quadratic mean diameter of the reforestation (inches)
Structurally complex	Fully functional	> 0.76	Not used	Not used	Not used	Not used
	Niche diversification	≥ 0.47 and ≤ 0.76	Not used	≥ 1200	Not used	Not used
Biomass accumulation	Biomass accumulation	≥ 0.25 and ≤ 0.76	Not used	< 1200	Not used	Not used
Understory development	Developed understory	≥ 0.25 and < 0.47	Not used	≥ 1200	Not used	Not used
	Understory re-initiation	< 0.25	Not used	Not used	≥ 1.25	Not used
Competitive exclusion	Large tree exclusion	< 0.25	≥ 85	Not used	Not used	Not used
	Pole exclusion	< 0.25	< 85	Not used	Not used	≥ 5
	Sapling exclusion	< 0.25	< 85	Not used	Not used	≥ 2 and < 5
Ecosystem initiation	Ecosystem initiation	< 0.25	< 85	Not used	Not used	< 2

Forest inventory units that did not meet the criteria for the first eight stand development stages (Fully Functional through Sapling Exclusion) were classified as Ecosystem Initiation. However, a subset of these stands was re-classified based on a secondary set of criteria. Forest Inventory Units that reached the last line in Table D-29 above, but met the following conditions:

- an edge density of 523 feet per acre (calculated as an area-weighted average of all the forest management units within the forest inventory unit);
- a basal area of at least 30 square feet per acre for the dominant trees (40 largest trees);
- six large, tall trees per acres with deep broad crowns; and
- at least one or more canopy layers greater than 30 feet tall were classified as Understory Reinitiation.

The No Action Alternative

Under the No Action Alternative, DNR conducts a twelve-step watershed assessment process for each timber sale. This process involves assessing the condition of the watershed in which the sale will occur and determining the width of the riparian forest buffers necessary to protect local physical and biological features (DNR 1997). The riparian forest buffer is widened, where necessary, to protect potentially unstable slopes. The intent behind the twelve-step process is to ensure that proposed timber harvest activities do not conflict with the objectives of the riparian conservation strategy (DNR 1997). For more information on the twelve-step process, refer to the 1997 Habitat Conservation Plan (DNR 1997 p. IV.127-132) and procedure PR 14-004-160, *Identifying and Protecting Riparian Management Zones in the Olympic Experimental Forest.*

Modeling the No Action Alternative

As a pre-process to the forest estate model, the twelve-step assessment was simulated using three increasingly restrictive modeling scenarios (A, B, and C). Collectively, the three scenarios were used to represent the possible range of riparian management activities that could occur under the No Action Alternative. A separate forest estate model run was conducted for each scenario, and the results were analyzed to determine the riparian buffer width necessary to provide for riparian function.

Table D-30. Brief Description of Riparian Forest Management under the Three Forest-Estate Modeling Scenarios That Comprise the OESF No Action Alternative

Scenario	Description
A	Deferral all harvests within potentially unstable slopes and landforms, floodplains, and all areas within 25 feet of the floodplain for Type 1 through 4 waters. Action-based harvests are prohibited in wetlands and their associated buffers; inventory-based thinning harvests are permitted.
B	Same as A with the additional restriction of prohibiting action-based harvests within an area equivalent to the expected average width interior core buffer along Type 1-4 waters (DNR 1997, Table IV.5, p. IV.58); inventory-based harvests are permitted within this area.
C	Same as B with the additional restriction of prohibiting action-based harvests within an area equivalent to the expected average width exterior core buffer along Type 1-4 waters (DNR 1997, Table IV.8, p. IV.117); inventory-based harvests are permitted within this area.

Riparian function was analyzed under each scenario, and each Type 3 watershed was assigned the least-restrictive scenario necessary to prevent adverse impacts to riparian function. The modeling process provided a recommendation for the width of both the riparian interior core and exterior buffer for each Type 3 watershed.

Only a subset of indicators of riparian function was analyzed: large woody debris recruitment, leaf and needle litter recruitment, and shade[17]. Each indicator was analyzed using the methods described in the OESF Draft EIS (DNR 2010), with the following modifications:

- The area assessed for each indicator was expanded to approximate the expected average width interior core buffer (DNR 1997, Table IV.5, p. IV.58). This includes all areas within 150 feet of and including the floodplain of Type 1 and 2 waters, and within 100 feet of and including the floodplain of Type 3 and 4 waters.
- The mid-term condition of the indicator (decade 6) was assessed relative to a reference condition. In contrast, the Draft EIS assessed each indicator as a non-declining yield.

Microclimate, fine sediment delivery, coarse sediment delivery, and peak flow were not analyzed as a part of this process. Peak flow, while not analyzed as part of the scenario selection process, was incorporated as a constraint (goal) in each of the modeling scenarios.

For the purpose of determining the width of the interior core buffer, adverse impacts were defined as:

- More than a 10 percent adverse change in conditions from decade 0 to decade 1; OR
- More than a 10 percent adverse change in conditions from decade 1 to decade 2; OR
- Failure to maintain or restore riparian function by the 6th decade. A restored riparian condition was defined as comparable to at least 85 percent of the function that would be provided by a

reference condition. For this analysis, ten decades of no management within the riparian area was used as a reference condition.

A similar set of criteria was used to assess the need for an exterior buffer. DNR used a windthrow probability model (Mitchell and Lanquaye-Opoku 2007)) to determine the likelihood of experiencing severe endemic windthrow within the recommended interior core buffer, and to provide an estimate of the total acres expected to blow down. All areas within the interior core buffer not expected to blow down were considered windfirm. An exterior buffer was recommended for all interior core buffers in which:

- The extent of windfirm stands decreased by more than 10 percent from decade 0 to decade 1; OR
- The extent of windfirm stands decreased by more than 10 percent from decade 1 to decade 2; OR
- Less than 90 percent of the interior core is in a windfirm condition at decade 6

The scenario selection process is illustrated in Figure D-8. Each scenario is evaluated in succession, beginning with scenario A. If adverse impacts were projected *and* the impacts could be mitigated using the next scenario, the interior core buffer was widened. The interior core buffer was limited to either scenario A or B. The recommended interior core buffer (either A or B) was then evaluated using a windthrow probability model, and an exterior buffer was added as necessary. For Type 3 watersheds in which the interior core was represented by scenario A, the exterior buffer was represented using scenario B. For Type 3 watersheds in which the interior core was represented by scenario B, the exterior buffer was represented using scenario C.

The No Action Alternative was then constructed by compiling the recommended riparian buffers (i.e., scenarios) for each Type 3 watershed. The results are summarized in Table D-31 and D-32.

Table D-31. Summary of Modeling Scenario Selections for the No Action Alternative

Scenario	Count of Type 3 watersheds	Percent of Type 3 watersheds (by count)	Percent of Type 3 watersheds (by area)
A	77	13.0%	7.5%
B	403	67.8%	88.0%
C	27	4.5%	2.6%
None*	87	14.6%	1.9%

* Only DNR-managed lands were assessed within each watershed. For some watersheds, DNR-managed lands were located entirely in uplands, outside of the assessment areas for large woody debris, leaf and needle litter, or shade. These watersheds were not assigned a modeling scenario.

Areas within the recommended riparian buffers were deferred from action-based harvests. Since riparian function was addressed through the scenario selection process, the forest estate model for the No Action alternative did not incorporate constraints for large woody debris recruitment or shade (Table D-16). Since hydrologic processes were not assessed during the scenario selection process, the forest estate model for the No Action Alternative did incorporate a constraint to avoid detectable increases in peak flow (formulated as a goal).

Figure D-8. Simulating the 12-Step Watershed Assessment for the No Action Alternative

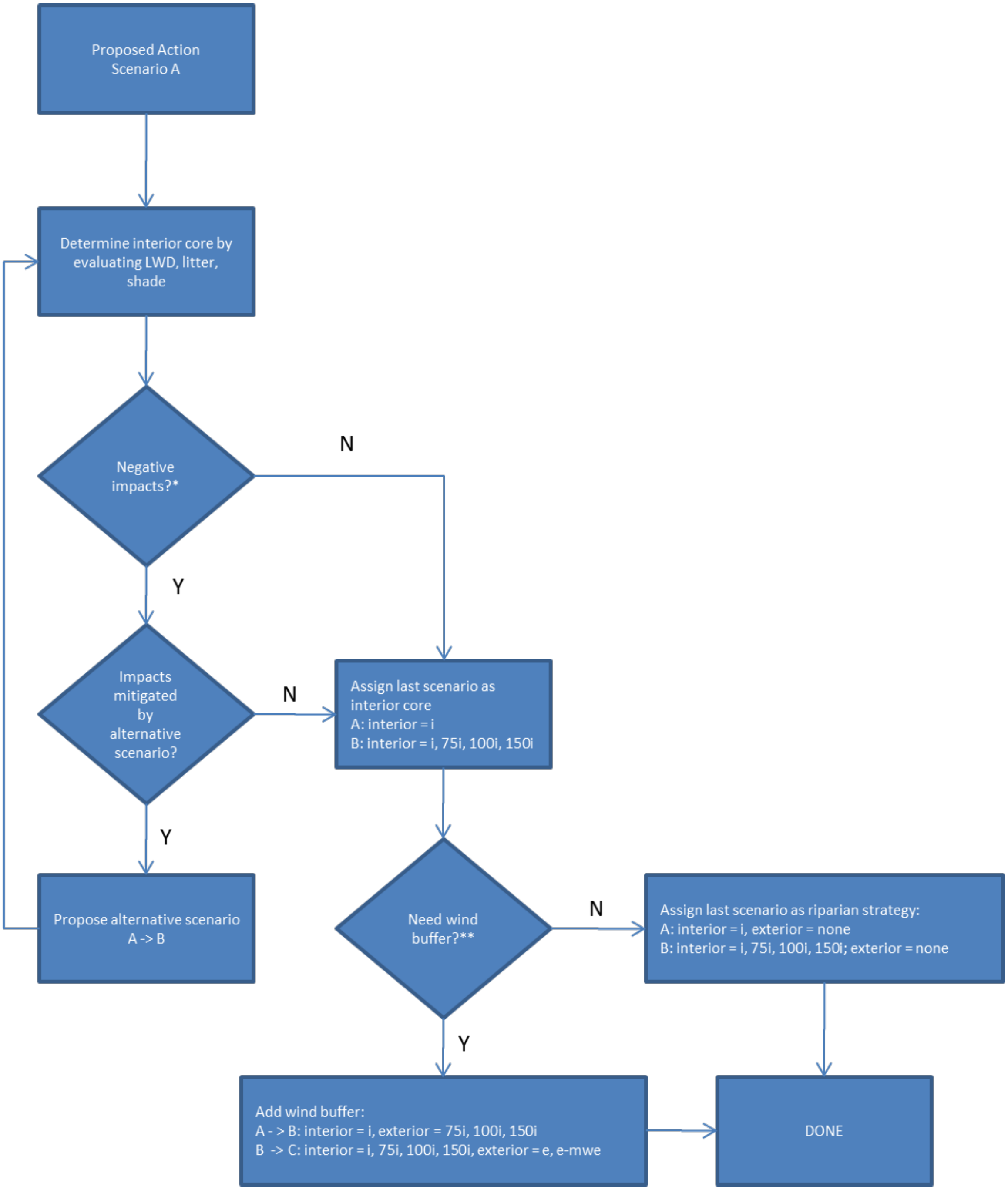


Table D-32. Summary of Impact Analysis Used to Select a Management Scenario for Each Type 3 Watershed for the No Action Alternative

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
12	160.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
16	400.8	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
27	21.5													
30	18.8													
31	256.9													
34	151.3													
45	70.5													
50	7.0													
52	191.9													
65	284.9													
69	589.1	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
73	223.4	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
74	15.1													
77	243.0	N	Y	N	N	Y	N	N	Y	N	N	i		A
84	199.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
85	601.0	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
86	1,084.6	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
88	140.9	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
89	610.7	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
95	123.6													
96	354.8	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
97	40.6													
98	0.5													
102	261.3	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
104	45.7	N	Y	N	N	Y	N	N	Y	N	N	i		A
105	1,840.9	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
107	10.3													
110	132.6													
114	0.1													
116	1.8													
117	238.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
119	526.7	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
122	236.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
124	590.4	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
126	8.7													
130	15.4													

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
131	16.7													
132	225.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
133	1,195.9	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
134	248.3	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
135	361.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
136	256.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
137	687.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
138	1,172.5	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
139	169.6	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
145	460.7	Y	Y	Y	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
146	18.3													
148	259.8	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
150	888.9	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
151	39.1	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
152	215.2	N	Y	N	N	Y	N	N	Y	N		i		B
153	84.3	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
155	92.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
157	427.8	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
158	519.1	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
160	746.4	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
161	225.5	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
163	60.8													
164	458.4	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
165	1,633.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
166	55.9	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
167	1,951.7	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
168	46.2	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
169	177.1	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
170	419.9	Y	Y	N	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
171	132.4	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
172	282.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
174	469.3	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
179	197.9													
180	161.5	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
183	47.9	Y	Y	N	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
184	248.1	N	Y	N	N	Y	N	N	Y	N	N	i		A
186	137.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
187	100.9													
188	504.3	Y	N	N	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
192	473.3	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
193	0.6													
194	31.0	N	N	N	N	N	N	N	N	N		i		B
195	495.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
196	614.4	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
197	69.5	N	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
200	579.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
203	195.4	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
205	294.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
207	33.5													
212	30.4													
213	85.9	N	Y	N	N	Y	N	N	Y	N	N	i		A
216	55.5													
220	384.6	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
222	229.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
224	66.8													
227	87.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
229	18.7													
230	188.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
232	9.8													
233	883.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
234	112.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
236	80.7													
238	118.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
241	830.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
242	19.7													
243	113.9													
245	5.4													
249	859.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
250	35.8													
251	45.3	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
252	214.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
255	17.0													
256	40.8													
258	26.0	Y	Y	Y	Y	N	N	Y	N	N	Y	i,75i,100i,150i	e,e-mwe	C

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
259	44.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
260	20.1													
262	92.1	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
267	103.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
268	18.5	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
269	28.5	Y	N	N	Y	N	N	Y	N	N	N	i		A
270	11.7	N	N	N	N	N	N	N	N	N		i		B
271	103.5	N	N	N	N	N	N	N	N	N	N	i		A
273	35.7													
274	46.7													
275	8.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
276	87.3	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
277	469.7	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
278	306.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
286	72.1	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
287	148.4	Y	Y	Y	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
289	269.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
290	1.4													
291	4.7													
292	33.7													
293	201.6	N	N	N	N	N	N	N	N	N	N	i		A
294	263.6	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
295	110.9	N	N	N	N	N	N	N	N	N	N	i		A
296	92.7	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
297	15.3	N	Y	N	N	Y	N	N	Y	N		i		B
301	266.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
302	425.3	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
303	1,069.6	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
308	314.3	N	Y	N	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
309	2,052.0	Y	Y	Y	Y	N	N	Y	N	N	Y	i,75i,100i,150i	e,e-mwe	C
310	23.6	Y	Y	N	Y	N	N	Y	N	N	Y	i,75i,100i,150i	e,e-mwe	C
311	301.6	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
313	373.4	Y	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
314	64.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
315	17.3													
316	166.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
317	10.7													

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
319	255.8	N	N	N	N	N	N	N	N	N	N	i		A
320	90.7	N	N	N	N	N	N	N	N	N	N	i		A
321	813.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
322	78.0													
323	45.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
324	949.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
325	76.2	N	Y	N	N	Y	N	N	Y	N		i		B
326	355.6	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
327	1,010.3	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
328	309.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
329	45.3													
333	2.0													
334	1,287.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
335	1,025.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
336	35.6													
338	179.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
339	116.1	N	N	N	N	N	N	N	N	N	N	i		A
341	120.0	N	Y	N	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
343	171.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
344	642.5	N	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
345	1,358.4	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
346	1.2													
347	548.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
348	153.3	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
349	179.8	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
350	83.2													
352	61.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
353	358.0	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
354	589.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
356	156.7													
357	3,665.9	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
358	123.6	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
360	232.1	Y	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
361	107.2	Y	N	N	Y	N	N	Y	N	N	Y	i	75i,100i,150i	B
362	33.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
363	42.2													
365	15.8													

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
370	276.2	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
371	119.1	Y	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
372	156.1	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
374	71.4	Y	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
377	35.9	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
378	311.7	Y	Y	Y	Y	Y	N	Y	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
379	1,226.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
380	1,602.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
381	78.8													
382	246.4	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
383	574.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
385	268.6	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
387	449.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
388	312.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
389	172.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
390	406.2	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
391	106.6	N	Y	N	N	Y	N	N	Y	N	N	i		A
393	154.5	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
395	313.1	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
396	41.8													
397	383.3	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
399	19.2													
401	475.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
402	30.9	N	Y	N	N	Y	N	N	Y	N		i		B
403	640.9	N	Y	N	N	Y	N	N	Y	N	N	i		A
405	864.8	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
408	1,390.1	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
411	398.4	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
413	539.6	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
414	1,867.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
416	168.1	N	Y	N	N	Y	N	N	Y	N	N	i		A
417	1.3													
418	199.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
419	142.6	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
421	39.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
422	31.6	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
424	112.8	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
430	6.2													
431	15.7													
433	1,329.2	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
434	111.9	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
435	11.5													
436	272.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
439	1,594.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
440	133.7	N	N	N	N	N	N	N	N	N	N	i		A
441	1,239.6	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
442	512.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
443	182.4	N	Y	N	N	Y	N	N	Y	N	N	i		A
444	73.6													
445	268.2	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
446	513.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
447	316.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
448	49.3													
450	32.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
452	23.5													
453	172.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
454	111.7	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
455	851.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
456	72.1													
457	539.7	Y	Y	Y	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
458	210.4	N	Y	N	N	Y	N	N	Y	N	N	i		A
459	57.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
460	128.4	N	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
461	69.7	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
463	60.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
464	101.4	Y	Y	N	Y	Y	N	Y	Y	N		i		B
465	20.3													
466	323.5	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
467	42.5	Y	Y	Y	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
468	291.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
470	73.8	Y	Y	Y	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
471	221.1	N	Y	N	N	Y	N	N	Y	N	N	i		A
472	188.3	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
474	33.5													

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
477	14.0	N	Y	N	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
478	311.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
479	1,315.6	Y	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
480	11.7	N	Y	N	N	Y	N	N	Y	N		i		B
481	71.4	Y	N	N	Y	N	N	Y	N	N	Y	i	75i,100i,150i	B
482	192.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
483	767.5	N	N	N	N	N	N	N	N	N	N	i		A
484	88.8	N	N	N	N	N	N	N	N	N	N	i		A
487	930.3	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
488	171.4	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
489	72.2	Y	Y	N	Y	N	N	Y	N	N	N	i,75i,100i,150i		B
490	989.3	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
491	44.8	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
492	68.8													
493	26.9													
494	489.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
496	647.8	Y	N	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
497	432.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
498	1,472.9	Y	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
499	166.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
500	148.1	N	N	N	N	N	N	N	N	N	N	i		A
501	598.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
503	24.9													
504	2,937.4	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
505	117.6	N	Y	N	N	Y	N	N	Y	N	N	i		A
506	360.4	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
508	1,294.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
509	699.4	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
510	628.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
512	225.5													
513	1,056.8	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
514	2,048.0	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
515	81.7	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
517	28.1	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
518	293.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
519	198.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
520	757.6	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
521	802.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
522	200.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
523	2,036.7	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
524	54.4	Y	Y	Y	Y	N	N	Y	N	N	Y	i,75i,100i,150i	e,e-mwe	C
525	93.7	N	Y	N	N	Y	N	N	Y	N	N	i		A
526	9.2	N	N	N	N	N	N	N	N	N	Y	i	75i,100i,150i	B
527	204.5	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
528	78.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
530	1,350.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
534	1,171.5	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
538	263.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
539	44.7	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
540	31.8	N	Y	N	N	Y	N	N	Y	N	N	i		A
541	336.6	N	Y	N	N	Y	N	N	Y	N	N	i		A
542	382.4	N	Y	N	N	N	N	N	N	N	N	i,75i,100i,150i		B
543	961.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
544	125.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
545	114.1	N	Y	N	N	Y	N	N	Y	N	N	i		A
546	641.7	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
547	235.2													
548	106.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
550	245.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
551	698.4	N	Y	N	N	Y	N	N	Y	N	N	i		A
552	153.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
553	899.0	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
555	16.7	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
556	13.1													
557	316.0	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
558	162.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
559	29.3	N	Y	N	N	Y	N	N	Y	N	N	i		A
560	28.7	N	Y	N	N	Y	N	N	Y	N	N	i		A
561	125.1	N	Y	N	N	Y	N	N	Y	N	N	i		A
562	2,543.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
563	2,976.3	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
564	1,815.2	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
565	1,954.7	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
566	613.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
567	283.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
568	462.5	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
569	390.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
570	347.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
571	388.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
572	263.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
573	629.5	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
574	850.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
575	136.0	N	Y	N	N	Y	N	N	Y	N	N	i		A
576	645.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
577	821.1	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
578	158.0	N	Y	N	N	Y	N	N	Y	N	N	i		A
579	175.2	N	Y	N	N	Y	N	N	Y	N	N	i		A
580	61.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
581	556.8	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
582	180.9	N	Y	N	N	Y	N	N	Y	N	N	i		A
583	933.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
584	995.4	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
585	293.9	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
586	374.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
587	680.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
588	337.8	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
589	196.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
590	141.3	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
591	219.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
592	165.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
593	190.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
594	18.7	N	N	N	N	N	N	N	N	N	N	i		A
595	18.1	N	N	N	N	N	N	N	N	N	N	i		A
596	131.2	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
597	564.6	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
598	401.4	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
599	4.3	N	N	N	N	N	N	N	N	N		i		B
600	5.1													
601	1,003.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
602	519.3	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
603	240.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
604	169.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
605	87.6	N	Y	N	N	Y	N	N	Y	N	N	i		A
606	276.4	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
607	0.3	N	Y	N	N	Y	N	N	Y	N		i		B
608	339.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
609	2,383.8	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
610	256.0	N	N	N	N	N	N	N	N	N	Y	i	75i,100i,150i	B
611	61.8	N	Y	N	N	Y	N	N	Y	N	N	i		A
612	11.0													
613	94.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
614	249.1	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
615	650.6	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
616	148.0	N	N	N	N	N	N	N	N	N	N	i		A
617	328.0	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
618	321.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
619	201.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
620	321.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
621	220.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
622	222.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
623	175.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
624	132.1	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
625	537.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
627	479.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
628	99.0													
629	55.2	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
630	1,227.9	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
631	25.4	N	Y	N	N	Y	N	N	Y	N	N	i		A
632	20.3	N	N	N	N	N	N	N	N	N	N	i		A
633	5.1	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
635	318.1	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
636	479.9	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
637	293.9	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
638	779.1	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
639	327.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
640	1,646.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
641	34.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
642	263.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
643	1,092.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
644	525.5	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
645	837.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
647	101.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
648	1,278.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
649	1,169.6	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
650	57.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
651	398.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
653	149.5	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
654	1,503.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
656	15.0													
658	550.2	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
659	22.9	N	Y	N	N	Y	N	N	Y	N	N	i		A
660	1,501.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
662	296.8	N	Y	N	N	Y	N	N	Y	N	N	i		A
663	13.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
664	249.9	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
666	486.5	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
667	1,184.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
668	659.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
669	4,765.9	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
670	317.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
671	534.0	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
672	1,864.0	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
673	3,747.0	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
674	2,374.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
675	292.0	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
676	3,337.9	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
677	3,300.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
678	111.3	Y	Y	N	Y	Y	N	Y	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
679	116.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
680	197.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
681	433.7													
682	404.9	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
683	436.3													
684	1,053.8	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
685	788.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
686	584.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
687	736.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
688	482.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
689	1,047.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
690	1,085.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
691	8.0	Y	Y	Y	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
692	377.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
693	996.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
694	528.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
695	254.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
696	1.4													
697	1,434.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
698	200.8	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
699	111.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
700	404.3	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
701	262.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
702	1,092.7	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
703	534.0	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
704	6.3													
705	160.6	N	N	N	N	N	N	N	N	N	N	i		A
706	869.3	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
707	655.8	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
708	627.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
709	1,006.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
710	1,830.2	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
711	1,224.5	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
712	475.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
713	152.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
714	102.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
715	63.1	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
716	901.0	N	N	N	N	N	N	N	N	N	N	i		A
717	149.6	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
718	493.5	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
719	82.7	N	Y	N	N	Y	N	N	Y	N	N	i		A
720	999.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
721	807.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
722	850.1	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
723	62.9	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
724	176.8	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
725	99.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
726	469.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
727	1,787.0	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
728	65.5	N	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
729	1,293.9	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
730	775.2	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
731	160.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
732	199.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
733	472.0	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
734	29.1	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
735	2,112.8	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
736	393.0	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
737	159.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
738	225.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
739	94.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
740	111.3	N	N	N	N	N	N	N	N	N	N	i		A
741	93.9	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
742	276.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
743	291.2	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
744	1,831.1	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
745	368.3	N	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
746	1,408.3	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
747	179.2	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
748	1,523.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
749	339.5	N	N	N	N	N	N	N	N	N	N	i		A
750	298.1	N	N	N	N	N	N	N	N	N	N	i		A
751	1,579.1	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
752	414.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
753	223.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
754	286.1	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
755	75.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
756	118.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
757	131.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
758	1,192.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
759	501.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
760	279.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
761	29.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
762	53.7	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
763	342.5	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
764	111.4	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
765	101.3	N	Y	N	N	Y	N	N	Y	N	N	i		A
766	290.9	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
767	112.2	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
768	72.0	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
769	75.9	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
770	1,894.9	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
771	109.1	N	Y	N	N	Y	N	N	Y	N	Y	i	75i,100i,150i	B
772	117.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
773	413.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
774	171.0	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
775	553.9	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
776	176.4	N	N	N	N	N	N	N	N	N	N	i		A
777	206.4	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
778	1,335.4	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
779	132.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
780	970.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
781	1,246.0	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
782	64.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
783	330.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
784	911.8	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
785	28.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
786	2,672.0	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
787	621.5	N	Y	N	N	Y	N	N	Y	N	N	i		A
788	131.5	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
789	1,211.3	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
790	849.3	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
791	130.6	Y	Y	Y	N	N	N	N	N	N	Y	i,75i,100i,150i	e,e-mwe	C
792	345.3	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
793	220.7	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
795	354.6	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
796	1,552.2	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
797	713.3	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
798	326.7	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
799	357.2	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
800	108.4	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
801	1,118.8	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
802	1,189.4	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
804	432.2	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
805	207.6	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
806	1,498.9	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
807	95.7	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
808	1,902.6	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
809	19.7													
810	1,852.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
811	281.1	N	Y	N	N	Y	N	N	Y	N	N	i		A
812	113.8													
815	28.1	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
818	41.7	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
819	1.9													
820	1,275.3	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
823	577.3	N	N	N	N	N	N	N	N	N	N	i		A
829	645.4	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
830	8.1													
832	99.0	Y	Y	Y	N	N	N	N	N	N	N	i,75i,100i,150i		B
833	969.0	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
834	35.9	N	N	N	N	N	N	N	N	N	N	i		A
836	393.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
837	1,255.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
838	661.3	N	Y	N	N	Y	N	N	Y	N	N	i		A
839	1,198.3	N	N	N	N	N	N	N	N	N	N	i		A
840	47.5	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
841	31.2													
842	1,701.3	Y	Y	N	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
844	700.9	Y	Y	N	Y	Y	N	Y	Y	N	N	i		A
845	440.0	N	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
846	1,791.3	Y	Y	N	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
847	576.0	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B
849	2,140.8	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B
852	761.8	Y	Y	Y	Y	Y	N	Y	Y	N	N	i,75i,100i,150i		B

Type 3 watershed	Acres	Scenario A Adverse impacts?			Scenario B Adverse impacts?			Scenario C Adverse impacts			Exterior buffer?	Interior core	Exterior buffer	Scenario
		LWD	Litter	Shade	LWD	Litter	Shade	LWD	Litter	Shade				
856	109.8	Y	Y	Y	N	Y	N	N	Y	N	Y	i,75i,100i,150i	e,e-mwe	C
858	17.7													
860	385.9	Y	Y	Y	N	Y	N	N	Y	N	N	i,75i,100i,150i		B

References

Berris, S.N.; Harr, R.D. 1987. Comparative snow accumulation and melt during rainfall in forested and clear-cut plots in the western Cascades of Oregon. Water Resources Research. 23(1): 135–142.

Carey, A.B. 2003. Managing for Wildlife: A Key Component for Social Acceptance of Compatible Forest Management. Pages 401-425 In: R.A. Monserud, R.W. Haynes, and A.C. Johnson (eds.). Compatible Forest Management. Kluwell Academic Publishers, Norwell, Massachusetts.

Carey, A.B. 2007. Aiming for Healthy Forests: Active, Intentional Management for Multiple Values. USDA Forest Service General Technical Report PNW-GTR-721. Pacific Northwest Research Station, Portland, Oregon.

Christner, J.; Harr, R.D. 1982. Peak streamflows from the transient snow zone, western Cascades, Oregon. In: Proceedings of the 50th western snow conference. Fort Collins, CO: Colorado State University Press: 27–38.

Di Lucca, Mario, Ken Polsson, Jim Goudie, and Tim Bogle. 2003. Yield Implications of Variable Retention Harvesting. Western Mensurationist Meeting Victoria, July 3, 2003.

Di Lucca, Mario. 2004. Development of Variable Retention Adjustment Factors (VRAF) for Coastal Douglas-fir, Western Hemlock, Lodgepole Pine and White Spruce. Ministry of Forests, Research Branch Victoria, BC April 7, 2004.

DNR see Washington Department of Natural Resources

Grant, G. E., S. L. Lewis, J.F. Swanson, J.H. Cissel, J.J. McDonnell. 2008. Effects of Forest Practices on Peak Flows and Consequent Channel Response: A State-of-Science Report for Western Oregon and Washington. United State Department of Agriculture, Forest Service, Pacific Northwest Research Station. p.76

Harr, R.D. 1986. Effects of clearcutting on rain-on-snow runoff in western Oregon: a new look at old studies. Water Resources Research. 22: 383–392.

Holmberg, P. and B. Aulds. 2007. Developing Westside Silviculture Prescriptions: an Inter-Active Self Study and Reference Pamphlet. Washington State Department of Natural Resources. Olympia, WA

Jones, J.A.; Grant, G.E. 1996. Peak flow responses to clear-cutting and roads in small and large basins, western Cascades, Oregon. Water Resources Research. 32: 959–974.

McDade, M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. Van Sickle. 1990. Source distances for coarse woody debris entering small streams in Western Oregon and Washington. Canadian Journal of Forest Research. 20: 326–330.

Mitchell, S. and N. Lanquaye-Opoku. 2007. Windthrow Hazard Mapping Using GIS, Washington State Trust Lands. Final Report – December 2007. Washington State Department of Natural Resources, Olympia, WA.

Pentec Environmental, Inc. 1997. North Fork Calawah Watershed Analysis Watershed Administrative Unit 200315, Final Report.

Raphael, M.G., S.K. Nelson, P. Sweeden, M. Ostwald, K. Flotin, S. Desimone, S. Horton, P. Harrison, D. Prenzlow Escene, and W. Jaross. 2008. Recommendations and Supporting Analysis of Conservation Opportunities for the Marbled Murrelet Long-Term Conservation Strategy. Washington State Department of Natural Resources, Olympia, WA.

Snyder, C. 2010. Large Data Overlay Documentation – Iteration: 2010xxxx. Washington Department of Natural Resources, Land Management Division, Data Stewardship Section. Olympia, WA. Unpublished report.

TIPSY, 2007. TIPSY 4.1d February 12, 2007. Research Branch, Ministry of Forests, British Columbia, Canada. http://www.for.gov.bc.ca/hre/gymodels/TIPSY/index.htm

USDA Forest Service. 2008. Forest Vegetation Simulator. Pacific Northwest Coast Variant. USDA Forest Service, Forest Management Service Center. Fort Collins, CO.

Washington Forest Practices Board. 1997. Standard Methodology for Conducting Watershed Analysis, Version 4.0. Washington Department of Natural Resources, Olympia, WA.

Washington State Department of Natural Resources. 1997. Final Habitat Conservation Plan. Washington State Department of Natural Resources, Olympia, Washington.

Washington State Department of Natural Resources. 2004. Final Environmental Impact Statement on Alternatives for Sustainable Forest Management of State Trust Lands in Western Washington and for Determining the Sustainable Harvest Level. Washington State Department of Natural Resources, Olympia, Washington.

Washington State Department of Natural Resources. 2006. Policy for Sustainable Forests. Washington State Department of Natural Resources, Olympia, WA.

Washington State Department of Natural Resources. 2010. Olympic Experimental State Forest (OESF) HCP Planning Unit Forest Land Plan Draft Environmental Impact Statement. Washington Department of Natural Resources, Olympia, WA.

Washington Forest Practices Board. 2004. Washington Forest Practices Board Manual. Washington State Department of Natural Resources, Olympia, WA.

Welty, J.W., T. Beechie, K. Sullivan, D.M. Hyink, R.E. Bilby, C. Andrus, and G. Pess. 2002. Riparian Aquatic Interaction Simulator (RAIS): a model of riparian forest dynamics for the generation of large woody debris and shade. Forest Ecology and Management 162:299-318.

Winter, T.C. 2001. The concept of hydrologic landscapes. Journal of the American Water Resources Association. 37(2): 335–349.

---

[1] Source: Large Data Overlay, December 2010

[2] Although the spatial extent of the road network was excluded from the forest estate model, the financial costs associated with road use and maintenance were analyzed. Please refer to *Costs*, p. D-73. In addition, environmental impacts associated with roads and road use were analyzed in the Revised Draft EIS. For example, the RDEIS evaluated the effects of sediment delivery from roads on water quality; and the RDEIS treated the road network and associated right-of-way as hydrologically immature in its calculation of peak flow. However, areas such as roads (and their right-of-way) or water bodies such as lakes and ponds were excluded from the forest estate model. These areas were treated as if they did not and would not contain forests. They were excluded from all projections of forest conditions in the determination of the harvest schedule.

[3] The first character "L" refers to the **low** residual Curtis' RD following DNR's small wood thinning guidelines. The second character "M" refers to a **multiple**-entry thinning regime. The third character "P" indicates the understory re-initiation.

[4] The duration of the "lock" is specified in the corresponding *transition* associated with the *action* (Table D-9). A different lock may be specified for each action.

[5] The edge-to-area ratio is calculated using THEME 4. THEME 4 is intended to represent the Forest Management Unit. For some locations, however, Forest Management Units have not yet been created. In these cases, the underlying Forest Inventory Unit was used instead. For a description of THEME 4, refer to Table D-1.

[6] Opening size is reported using a geometric model based on the equivalent size circle.

[7] Retention levels based on an estimate of crown width of 21 feet for 11.5" dbh trees and 33 feet for 30" and larger dbh trees.

[8] Standing timber can be sold as either a lump sum sale, or by scale. In a lump sum sale, trees are marked and tallied by a forester and sold outright, with payment in advance. Potential buyers know which trees they are bidding on and the estimated volume. In a scale sale, payment is received for the volume of trees removed.

[9] Data from stumpage value areas 1 and 2 were used. All harvested timber was assumed to be of timber quality code 3; hauling distance zone 5. As DOR stumpage valuation tables report by individual species, stumpage values for mixed-species forest types were calculated by weighting the species-specific stumpages using the assumed proportions: DFRA (80/20), DFRC (80/20), DFWH (60/40), RADF (60/40), WHDF (60/40), WHRA (80/20), WHRC (80/20), WH or SF (100 or 100).

[10] The **Producer Price Index** (PPI) is an index of the prices received by domestic producers for their goods and services, reported on an annual basis.

[11] For both the analysis of the no-management scenario and the forest estate model used in the RDEIS, landscape planning units were identified using groupings (known as "aggregations") of THEME 4 (Forest Management Units). Forest Management Units that straddled landscape planning unit boundaries were assigned to the landscape that contained the largest proportion of its area. For this reason, the threshold habitat acres differ slightly from those used for HCP compliance monitoring. Refer to Table D-1 for a description of THEME 4.

[12] Action-based harvests are those that result from a decision by the forest estate model to conduct an active management intervention in the development of the stand in question. Depending on the edge-density of the Forest Management Unit in question, these harvests may be classified as variable retention harvests, variable density thinnings, or uniform thinnings. In constrast, inventory-based harvests are the variable density thinnings that comprise each silvicultural regime. Inventory based harvests are limited by this constraint. For additional information on the distinction between action-based and inventory-based harvests, refer to *Descriptions of Management Activities*, p. D-24.

[13] Structural habitat, as defined in the settlement agreement, includes stands that are not Old Forest, but have the structural characteristics of sub-mature or young-forest marginal habitat. For the OESF forest estate model, structural habitat is considered synonymous with Young Forest habitat.

[14] Within the forest estate model, "riparian forests" include channel migration zones, wetlands, the 100-year floodplain, areas within 150 feet of the 100-year floodplain along Type 1 and 2 streams, and areas within 100 feet of the 100-year floodplain of Type 3 and 4 streams. These areas were identified using theme 5 of the land classification, and include "i", "75i", "100i" and "150i" features.

[15] A non-declining yield refers to a flow of goods or services (in this case, large woody debris recruitment potential) that does not decrease in successive periods (Society of American Foresters, Dictionary of Forestry).

[16] A nesting platform is defined as any large limb or other structure, such as a mistletoe broom, at least 50 feet above ground and at least 7 inches in diameter (DNR 1997, p IV.42).

[17] It was only during the process used to assign a scenario to each Type 3 watershed that a subset of riparian indicators was used. The resulting No Action Alternative, constructed from the individual riparian buffer recommendations for each Type 3 watershed, was analyzed using the full suite of riparian indicators for the Environmental Impact Statement.