Development and Application of a Decision Support Tool to Analyze Alternatives for Landscapes Composed of Multiple Ownerships

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Introduction

Forest management has evolved through the 20th Century from focusing on commodity production on a stand-by-stand basis to meeting many objectives, including sustaining ecosystem structures, functions and processes. The new paradigm, ecosystem management or landscape management, broadens the scope of planning and analysis spatially and temporally. Common analysis units now include watersheds and landscapes in addition to individual stands.

Despite a range of interpretations, ecosystem management typically requires consideration of a wider range of social and environmental objectives and greater understanding and application of ecological and silvicultural knowledge than previously. Decision support has been identified as a critical component to ensure values, available information, and current scientific knowledge are included in the ecosystem management decision-making process (Oliver and Twery, 1999). Existing and new technologies are necessary to facilitate analysis and provide decision support for landscape planning. These technologies include computer applications such as geographic information systems (GIS) and the Landscape Management System (LMS) (McCarter et al., 1998).

A difficulty of planning at the landscape or watershed scale is that frequently the area is divided among multiple ownerships. Sample (1992) stated that:

> There are few areas of the U.S. in which the delineation of these ecosystems at an ecologically-significant scale does not encompass a mixture of both public and

private lands, often in an intermingled pattern inconsistent with ecological boundaries. This suggests the need for a higher level of coordination and cooperation among adjacent public and private landowners in the planning and management of forest and range lands for the protection of biological diversity, water quality, and other ecosystem values.

This study will demonstrate the use of GIS, LMS, and a prototype decision support tool named Toggle for development and analysis of a management plan by one owner in context of estimated management activities by a neighboring owner. Multiple objectives will be analyzed at both the single-ownership level and the multiple-ownership level. The Toggle program will be demonstrated in the context of decision support for landscape management and for use in the rational-iterative decision making process. Results for the study site, a landscape in Oregon comprised of United States Department of Interior Bureau of Land Management (BLM) and private industry lands, will also be discussed.

Literature Review

Spatial and Temporal Complexity in Forest Ecosystems

The Ecosystem Concept

Developing and implementing management plans for a forested area is difficult because of the complexity of the natural world. This complexity is defined with the concept of the ecosystem. Tansley first used the term in 1935, including both organisms and the surrounding physical factors (Tansley, 1935). Odum later defined the ecosystem as "any unit that includes all of the organisms (i.e. the "community") in a given area interacting with the physical environment so that a flow of energy leads to clearly defined trophic structure, biotic diversity, and material cycles (i.e. exhange of materials between living and nonliving parts) within the system (Odum, 1971).

The ecosystem concept indicates a systems approach to dealing with the complex natural world. This approach reduces complexity by grouping common entities and dealing with the interactions between groups (Oliver et al., 1992). It also allows the ecosystem to be delineated in many ways by organizing groups differently (Kimmins, 1987). Tansley and Odum implied this variability by not indicating a specific spatial scale in their definitions. Later definitions explicitly identified the hierarchical nature of ecosystems (O'Neill et al., 1986). The appropriate delineation depends on the issue being addressed and can include an individual organism, a landscape, or a larger region.

Stand Development

Complexity is further increased by the temporal dimension of forest ecosystems. Trees and other vegetation grow through time, and stands and landscapes experience competition related mortality and other small and large scale disturbances. These include fire, wind, insects, and disease. Oliver and Larson (1996) identified four stand development stages: stand initiation (open), stem exclusion (dense), understory reinitiation, and old growth (complex).

The open stage exists from the time of a stand replacing disturbance, during regeneration, until further regeneration is excluded by competition from established trees. Stem exclusion then occurs while trees grow and compete, until competition related mortality and other disturbances create openings in the previously dense main canopy. Increased growing space allows trees, shrubs and other herbaceous plants in the understory to become established during the understory reinitiation stage. Finally, large overstory trees die and multiple canopy layers develop during the old growth stage, creating an uneven-aged structure (Oliver and Larson, 1996).

The names for these processes also apply to corresponding stand structures, which are the physical arrangement of trees and other vegetation. At any point in time, a forest and landscape are comprised of various amounts of one or several stand structures. These proportions vary through time (Oliver, 1992).

<u>Ecosystem Management in a Single Ownership</u>

Landscape Management

A common objective of ecosystem management is maintaining ecosystem functions and processes (Vogt et al., 1997). This can include maintaining biodiversity and forest health, such as maintaining stands resistant to local disturbance agents (fire, wind, insects, and disease). Other management objectives include optimizing harvest volume, revenue, recreation, aesthetics, and many more.

Many ecosystem processes and functions occur at broad spatial scales. Examples include biodiversity and the home range of some species (Oliver et al., 1992). Common planning units in forest management now include landscapes and watersheds. The watershed has been identified as a necessary planning level by the Federal Ecosystem Management Assessment Team (FEMAT) and the Washington State Department of Natural Resources (Sessions et al., 1997).

To achieve the various objectives, a landscape approach has been proposed that maintains a mix of all stand structures across the landscape at all times (Oliver, 1992; Hunter, 1990). This approach utilizes systems theory by identifying five hierarchical management levels, determining appropriate objectives to be achieved at each level, and coordinating activities between each level. The five levels of forest management, from the most "specific" to the most diffuse, are: silvicultural operations, silvicultural regimes (silvicultural pathways), landscape patterns, forest plans, and broader policy (Oliver et al., 1999). Salwasser (1991) identified the necessity to conduct ecosystem management on similar scales (Stand/Site, Watershed, Landscape, and Region), and similar corresponding management levels (Project, District, Forest, Regional, and National/Congressional) have been identified in the Forest Service (Carwse, 1994 as cited in Hobbs, 1998).

Silvicultural operations are the most specific level. These include harvesting and planting trees, pruning, fertilizing, road construction, and others. Decisions requiring the most site specific information must be made at this level. For some objectives, operations can be designed to mimic natural disturbances.

Silvicultural regimes are the stand level treatments applied through time to achieve desired objectives, including future stand characteristics. Each stand structure provides a unique set of values, including habitats, aesthetics, recreation, and resistance to various disturbance agents (Oliver et al., 1992). Knowledge of stand dynamics is important to understand how trees and other vegetation will respond to treatments in order to achieve desired future conditions. "Windows", or periods of time when stands respond effectively to treatments, should be identified for each stand (Oliver and Larson, 1996). These windows of opportunity exist for many operations, including planting and thinning (Oliver et al., 1999).

The landscape level coordinates silvicultural treatments to all stands at all times to ensure a desired mix of stand structures. Through a "coarse filter" approach, managing at this level ensures habitat will be provided for most species, since most habitats can be associated with one or more stand structures (Oliver, 1992). Spatial arrangement of structures may also be important for reasons such as habitat, corridors, and operation implementation. Planning at the landscape level can ensure that objectives with spatial criteria are achieved and spatially feasible plans are developed (Oliver et al., 1999).

The next hierarchical level, the forest, manages the flows of outputs from various landscapes. It is not concerned with spatial feasibility. This level coordinates landscapes and utilizes economies of scale to manage implementation costs and marketing of commodity products and other outputs (Oliver et al., 1999).

Finally, the policy level coordinates the flow of values within a uniform political unit. This can include companies or state and federal governments. Instruments at this level include incentives and regulations. Incentives can be tax reductions, market incentives, education, research, and monetary grants. Regulations can be laws and other procedural rules (Lippke and Oliver, 1993).

Through coordination between the hierarchical levels, management objectives are achieved. Coordination can include analysis, decision-making, and implementation; and information can move from the specific level to the diffuse level as well as from diffuse to specific. For example, final selection of a chosen management plan to implement occurs at more diffuse levels; however, implementation and the effects of implementation occur first at the specific level. Identifying the appropriate level at which to manage for a particular task is important to ensure efficient management of the system (Oliver et al., 1999).

Rational-Iterative Decision Making Process

The systems approach reduces ecosystem complexity and improves management for desired objectives. Additional problems with managing ecosystems include the variability in the spatial and temporal dimensions of ecosystem boundaries and the related variability of associated management objectives defined by those boundaries. Societal weights or values associated with those objectives can also be difficult to determine (Oliver and Twery, 1999). An appropriate decision-making process must be utilized which incorporates this degree of uncertainty.

A variety of decision-making processes exist. The Expert/Intuitive method relies on the judgment of an expert or group of experts, and can result in "groupthink" and decisions based on charisma. The "Muddling Through" approach addresses needs on a case-by-case basis to reduce present conflicts without extensive analysis of values and consequences. With the crisis approach, a manager assumes broader authority than needed to avert a perceived impending catastrophe. The Normative/Rational non-iterative approach is appropriate when all objectives, weights, and interactions between modules are known or uncertainty can be quantified. This approach allows optimization to determine the best solution. Finally, the Normative/Rational iterative method is appropriate when objectives and weights are not well understood, but interactions between modules or uncertainty can be predicted (Oliver and Twery, 1999).

The rational-iterative decision-making process is the most appropriate for ecosystem management. Through this process, multiple alternatives are presented, and alternatives can be refined by working "iteratively" with the decision-maker. This approach allows decision-makers to understand trade-offs and select a chosen alternative through iteration. The steps of the rational-iterative decision-making process are:

1) Identify the decision-makers,
2) Identify the problem, define the objectives, and develop measurable criteria,
3) Develop alternatives,
4) Compare alternatives,
5) Choose an alternative,
6) Implement the chosen alternative,
7) Monitor and evaluate.

The person with authority to make a decision must be identified first. Although many stakeholders may have a very high interest in the selection of a particular alternative, the person with legal authority or jurisdiction must be specified. Next, the problem must be defined, and objectives determined. This step includes scoping the planning area to determine initial conditions, identifying objectives, and converting objectives to measurable criteria. Scoping the planning area is necessary to identify the appropriate spatial scale and to examine initial landscape conditions to determine if perceived problems actually exist (Oliver and Twery, 1999). Management objectives must then be identified and converted to measurable criteria. Measurable criteria convert vague objectives to specific conditions defined numerically to indicate the degree of success each management alternative has in meeting objectives. Measurable criteria in forest management can frequently be defined by stand characteristics, such as number of trees per acre of a given size or percent canopy closure to define stand structures. The spatial and temporal dimensions of the analysis is must also be determined. This step may also include development of models to describe vegetation growth, habitat for various species, or models for many other objectives (Oliver and Twery, 1999).

Next, a range of management alternatives must be developed. This is a creative step and can include many role-playing “games” to avoid “groupthink.” All interested stakeholders could be allowed to develop an alternative, ensuring a wide range to analyze and compare (Oliver and Twery, 1999). A useful baseline alternative is no action, where the forest vegetation is allowed to grow through time with no silvicultural operations.

Each alternative is then compared to each objective to determine trade-offs. A decision matrix, which lists the impact of each alternative on each objective in a single table, can be useful for the decision-maker. Also, using normalized values, which lists results as a proportional score to a maximum value, can ensure decision-makers are not biased between objectives which commonly have large numbers, such as harvest volume, and objectives which commonly have small numbers (Oliver and Twery, 1999).

Next, the decision-maker must select a chosen alternative to implement. Prior to selecting an alternative, an analyst may need to explain the results, including assumptions embedded in models and measurable criteria, to ensure the decision-maker makes an informed decision. Because the process is iterative, the decision-maker may require additional alternatives to be developed after considering the initial set. The decision-maker selects an alternative based on the trade-offs between objectives, and can ignore one or many objectives at this point. Management objective weights and social values, previously not accounted for during the rational-iterative process, are implied with this step in the selection of a chosen alternative.

The remaining steps are implementation of the chosen alternative and monitoring and evaluation. Implementation includes coordinating the hierarchical management levels to ensure overall policy objectives are achieved. Because planning and implementation are rarely perfect, monitoring and evaluation must be conducted to determine when objectives are not being achieved and why. In forest management, because implementation of an alternative generally occurs over many years, early monitoring can allow alternatives to be adjusted or implementation of later activities to be improved (Oliver and Twery, 1999). Adjustments may include improving models and measurable criteria, increasing scientific understanding, and adjusting scientific and management paradigms.

Technical Tools: GIS, LMS, and Toggle

Analysis of ecosystems over broad spatial scales for many objectives requires large amounts of data and many computations. Projecting landscapes through time and analyzing each objective at periodic increments increases the number of computations further. Advancements in computing power and development of several computer applications have been important in making landscape management practical. These computer applications include geographic information systems (GIS) and the Landscape Management System (LMS).

GIS is a commonly used forest management tool that displays and analyzes spatially referenced information (Star and Estes, 1990). In forestry, this information commonly includes location of stand boundaries, streams, roads, and soils as well as many other features. GIS is capable of performing spatial analyses required for ecosystem management.

LMS is a Microsoft Windows® application that combines existing growth models, including the Forest Vegetation Simulator (FVS), visualization tools, and analysis tools to conduct analyses rapidly for a landscape comprised of a number of forest stands (Stage, 1973). The program organizes tree list inventories for each stand, stand boundaries, and a digital elevation model. Landscapes are analyzed as the aggregate of all stands. Silvicultural operations can be modeled and applied to one or many stands, and treated inventories projected through time. Tables can be produced which analyze any treated and projected inventories (McCarter et al., 1998). Growth models allow LMS to perform temporal analyses required for ecosystem management.

An additional companion program for LMS is Toggle. Toggle is a Microsoft Excel® spreadsheet program that allows users to conduct a multiple objective, landscape level analysis for many time periods. Toggle is a strata-based area allocation model, in which the user manually adjusts the percentage of acres in each stratum (group) subject to a particular silvicultural pathway. Each adjustment affects the outputs provided for each objective. Graphs, summary values, and normalized values for all objectives update immediately as percentages are changed in the program. Groups are typically defined by common significant ecological characteristics, such as dominant species, stand density, and stand age. Silvicultural pathways for each group are then modeled in LMS. Output tables which analyze objectives are obtained from each group from LMS and are input into Toggle for analysis. Toggle programs with the capacity for 6 groups and 15 pathways for each group have been used in studies by Johnson (2001) and Hall (2001).

Analysis in Toggle is based on the concepts that any stand can follow a range of silvicultural pathways leading to different stand structures; each stand structure provides a unique set of outputs and values; and achieving a desired mix of ecological, economic, and social values can be attained by providing some mix of all stand structures across the landscape. To provide a more detailed explanation of the program, the most significant steps for using the spreadsheet will be described. The Toggle spreadsheet organizes 58 separate worksheets, with functions including input data storage, preliminary and summary calculations, graphical and tabular output, storing alternatives, and storing adjustable model values. Microsoft Visual Basic for Applications® code is also used to add functionality. A screen capture of the opening Toggle page is provided in Figure 1. From this sheet, most other Toggle functions can be accessed.

Modeling alternatives in Toggle begins with identifying groups and representative stands for the landscape. For each group, a range of silvicultural pathways are modeled in LMS. These pathways represent different potential management options based on identical initial conditions. Tables that report outputs for all objectives at each point in time are obtained from LMS and pasted into Toggle. An example of a portion of an input table is provided in Figure 2. Each silvicultural pathway to be included in Toggle requires an input table. A screen capture of the input page for one group is provided in

Figure 3. In addition to loading Toggle with tables from LMS, the total number of acres in each group must also be inputted (Figure 4).

Certain aspects of Toggle can be adjusted by the user, including threshold values and maximum values. Threshold values are components of measurable criteria that indicate the point of success or failure for achieving an objective. It may be necessary to adjust threshold values depending on local conditions or the performance of a particular growth model. For example, a landscape on more exposed aspects may have a different wind safety threshold value (height/diameter ratio) than a landscape on less exposed aspects. For Toggle to report accurate normalized values, maximum values must also be determined and inputted. Maximum values are necessary to scale current values for an objective to calculate the proportional normalized value. Screen captures for worksheets where threshold values and maximum values can be adjusted are provided in Figure 5 and Figure 6, respectively.

Analysis can then be completed in Toggle. Beginning with group one, the user allocates a percentage of the total group area to follow each potential silvicultural pathway for that group, until 100% of the area has been allocated. As area is allocated to a pathway, output values, previously per acre values, are multiplied by the number of committed acres to calculate total values. These calculations are accomplished automatically by the spreadsheet and immediately when the user adjusts any pathway percentages. The same process of area allocation to silvicultural pathways is completed for each group. To obtain output values for the entire landscape, the spreadsheet sums the outputs for all pathways (after being multiplied by the allocated acreage factor) for all groups. When the user has committed 100% of the area in all groups, the landscape alternative is complete. Figure 7 shows the Toggle output page where percentages allocated to silvicultural pathways can be controlled, and output values are graphed. Figure 8 shows a portion of the output page before and after acres are allocated to illustrate how graphs change immediately in response to new output total values.

After an alternative is developed it can be stored in the program, allowing the user to develop additional alternatives. The spreadsheet stores pathway percentages for each group, and can automatically reconstruct alternatives. Toggle also generates a decision matrix of normalized values from each saved alternative. A screen capture of the worksheet where alternatives can be saved is provided in Figure 9.

Technical Tools: Other Computer Programs

Many other computer applications have been developed to facilitate forest management and ecosystem management. Two programs will be briefly discussed to provide context for LMS and Toggle. These are FORPLAN (Johnson et al., 1986) and SNAP (Sessions and Sessions, 1992). This should not be considered an extensive critique of the tools, or an in-depth comparison between any of the applications. FORPLAN is a forest level, strata-based decision support tool developed for the Forest Service which utilizes linear programming to optimize an objective under given constraints. Criticisms of FORPLAN include: it utilizes the rational non-iterative decision-making process, which is not considered appropriate where objectives and weights are not well known (Oliver and Twery, 1999); both the model and the outputs are extremely complex and difficult to understand (O'Toole, 1983); and model outputs fail to account for spatial criteria or cumulative effects and are thus difficult to implement successfully (Johnson, 1992). SNAP is a GIS based harvest scheduling model. This program can identify near-optimal solutions for location of harvest units based on spatial constraints such as adjacency ("green-up"), maximum opening sizes, minimum habitat levels, and road networks. SNAP is more limited in the spatial scale it can analyze. Also, neither FORPLAN nor SNAP maintains tree-level resolution for each stand, limiting the ability of these programs to analyze additional objectives as necessary.

Ecosystem Management Across Multiple Ownerships

A difficulty of practicing ecosystem management at broad spatial scales is that watersheds and landscapes are frequently divided among multiple ownerships or agencies. Many potential barriers exist for collaboration, including state and federal laws. Where successful collaboration has occurred, key components have been identified.

Examples of Comanagement

Examples of comanagement include the Shelton Cooperative Sustained Yield Unit and the Plum Creek Habitat Conservation Plan. The Shelton Cooperative Sustained Yield Unit (CSYU) was formed in 1946 through an agreement between Simpson Timber Company and the Forest Service. The CSYU is on the Olympic Peninsula of Washington

State. The CSYU was intended to be comanaged for sustained yield timber volume to stabilize the local communities of Shelton and McCleary and to ensure the general forest health of the contiguous area (U.S.D.A. Forest Service, 1946).

The Plum Creek Cascades Habitat Conservation Plan (HCP) was developed in 1996 for company land in the central Cascade Mountains in Washington State. The planning area was of the "checkerboard" configuration, with alternating sections of Plum Creek ownership and National Forest. Although the HCP did not establish a cooperative agreement, consideration of the contiguous landscape, rather than only the fragmented company land, was critical for successful application for an incidental take permit (Plum Creek, 1996). An incidental take permit allows a company to conduct operations in areas with endangered species without penalty for incidentally harming or killing an individual of the species. This consideration included assumptions of the activities that would occur on federal land during the 50-year plan, resulting forest conditions, and cumulative impacts when analyzed with projected Plum Creek activities (Plum Creek, 1996).

Finally, an analogous cooperative situation outside forestry may be the Clean Air Act of 1990, where many industries in an area must coordinate to reduce pollution below a certain level. This cooperation includes market functions, such as the selling of excess pollution quotas by companies efficient at pollution reduction to companies which are inefficient (Bryner, 1995). It also includes regulations, in the form of the collective pollution limit.

Legal Barriers to Comanagement

Legal barriers to comanagement include the Federal Advisory Committee Act (FACA) and the Sherman Anti-Trust Act. FACA requires any advisory committee formed by the federal government that includes individuals who are not federal, state, tribal, or local officials to include a balanced membership in terms of points of view represented. Comanagement on landscapes with federal and private land will be subject to FACA. This may result in inappropriate federal control and bureaucratic delay and cost (Meidinger, 1997). Between private companies, the Sherman Anti-Trust Act prohibits cooperation or exchange of information that would result in any form of price fixing (Meidinger, 1997).

Other laws can indirectly influence comanagement as well. Many private landowners may not want to improve wildlife habitat for fear an endangered species would inhabit the ownership. The Endangered Species Act could then severely limit potential activities (Sample, 1995). Many landowners are also hesitant to enter into a comanagement agreement because flexibility in future decision-making may be limited (Sample, 1995). For example, inheritance taxes may eventually require a landowner to harvest timber without regard to ecological values or the effect to a comanaged landscape (Sample, 1995).

Overcoming these laws to conduct comanagement may require clarification of certain points specific to natural resource management. For example, concerning the Sherman Anti-Trust Act, cooperating companies may be prohibited from sharing harvest volume information, but instead could share stand structures and agree to manage for a desired mix. Other laws, such as the Endangered Species Act, may require reauthorization to ensure a consistent national policy for forest ecosystem management (Sample, 1995). Finally, new legal mechanisms also exist which encourage collaboration for ecosystem management, such as conservation easements (Meidinger, 1997). These legal issues are important but beyond the scope of this paper.

Key Components of Successful Collaboration

Disregarding legal deterrents and other disincentives, several important criteria have been identified in successful partnerships. These include need, presence of a catalyst organization, peer-to-peer networking, communication, and trust (Sample, 1995). Because comanagement requires additional effort, a perceived need is critical for successful partnership. Even with a need, Sample (1995) identified a catalyst organization as the most important element for success. The topics covered in this study, including application of specific computer programs within an appropriate decision support system framework, are a component of communication. Sample (1995) also identified that communication includes sharing of experiential, historical, and cultural knowledge as well as technical knowledge.

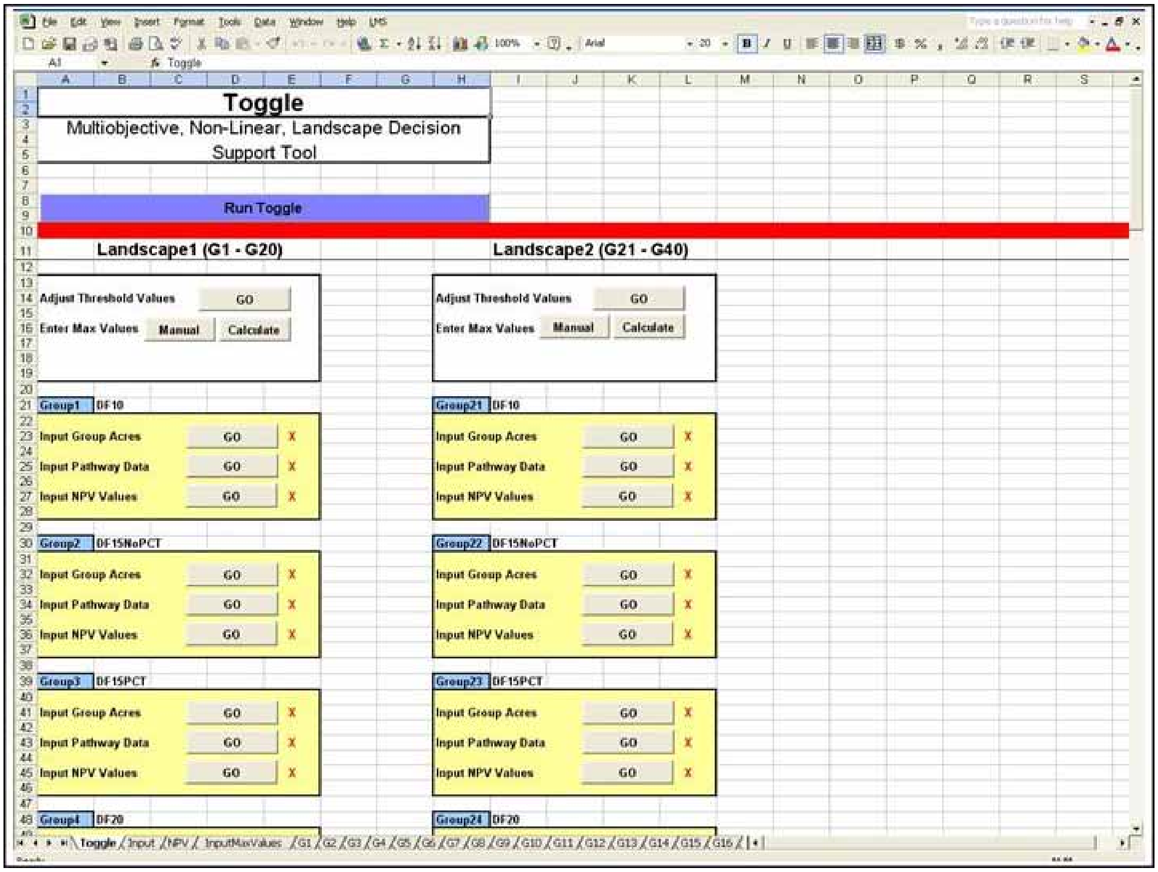


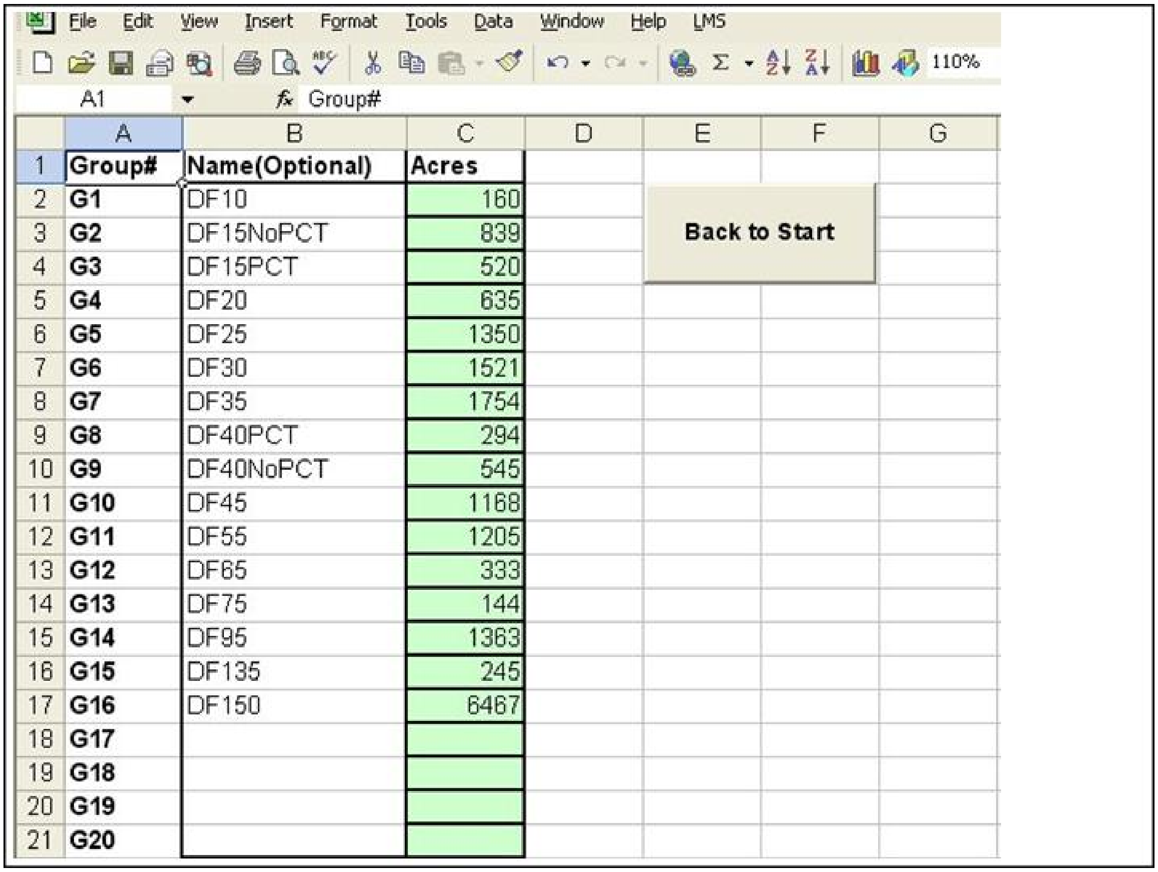
Figure 1. Toggle main page. When the Toggle spreadsheet is opened, this is the active page. From this page, most program functions can be accessed, including silvicultural pathway data input, group acreage input, maximum value data input, adjusting threshold values, and performing the analysis.

Year	Stand	Acres	InitAge	Oliver5c	HCSSPT	Carey	StandingVol	CutVol	VolGrowth	DomSPP	H/D(100)	HT(100)	TPA	
2002	DF10	1	10	1_SI	1_SI	1_SI	0	0	0	DF	86.55	24.1	448.2	…
2007	DF10	1	10	2_SE	2_SE	1_SI	871.75	0	871.75	DF	59.85	36.48	445.54	…
2012	DF10	1	10	2_SE	2_SE	2_ES	12812.29	0	11940.54	DF	56.77	47.17	436.09	…
2017	DF10	1	10	2_SE	2_SE	2_ES	25802.36	0	12990.07	DF	56.65	57.51	417.42	…
2022	DF10	1	10	2_SE	3_UR	2_ES	34497.61	0	8695.25	DF	58.72	66.96	393.08	…
2027	DF10	1	10	2_SE	2_SE	2_ES	41518.4	0	7020.79	DF	60.44	76.4	365.63	…
2032	DF10	1	10	2_SE	2_SE	2_ES	50274.54	0	8756.14	DF	61.8	85.18	338.18	…
2037	DF10	1	10	2_SE	2_SE	2_ES	58413.26	0	8138.72	DF	63.19	93.4	312.05	…
2042	DF10	1	10	2_SE	2_SE	2_ES	66160.01	0	7746.75	DF	64.74	101.29	287.75	…
2047	DF10	1	10	2_SE	2_SE	3_UR	71982.6	0	5822.59	DF	65.96	108.36	265.7	…
2052	DF10	1	10	3_UR	2_SE	3_UR	76381.88	0	4399.28	DF	67.2	115.56	245.9	…
2057	DF10	1	10	3_UR	2_SE	3_UR	83032.71	0	6650.83	DF	68.25	121.98	227.9	…
2062	DF10	1	10	3_UR	2_SE	3_UR	87539.09	0	4506.38	DF	69.52	128.33	212.15	…
2067	DF10	1	10	3_UR	2_SE	3_UR	94722.39	0	7183.3	DF	70.94	134.44	197.75	…
2072	DF10	1	10	3_UR	2_SE	3_UR	97672.01	0	2949.62	DF	71.86	139.65	184.95	…
2077	DF10	1	10	3_UR	2_SE	3_UR	103307.87	0	5635.86	DF	72.93	144.7	173.66	…
2082	DF10	1	10	3_UR	2_SE	5_BD	107612.68	0	4304.81	DF	73.81	149.03	163.31	…
2087	DF10	1	10	3_UR	2_SE	5_BD	113171.42	0	5558.74	DF	74.38	152.4	153.86	…
2092	DF10	1	10	3_UR	2_SE	5_BD	118059.22	0	4887.8	DF	74.94	155.48	145.31	…
2097	DF10	1	10	3_UR	2_SE	5_BD	120547.77	0	2488.55	DF	75.37	158.28	137.66	…

Figure 2. Toggle input table for one silvicultural pathway. Values are provided for all objectives every projection cycle. Outputs are based on calculations performed on standing and cut inventories by LMS. Output values include stand structure, standing, harvest, and growth volumes, species mix, height/diameter ratio, average stand height, trees per acre, harvest volume by species, basal area by species, and others.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	
1																		
2			Back to Start															
3	Input Data																	
4																		
5	Year	Stand	Acres	InitAge	Oliver5c	HCSSPT	Carey	StandingV	CutVol	VolGrowt	DomSPP	PropMix	H/D(100)	HT(100)	TPA	SnagBA/A	Snags/Acr	Lo
6	**Consequences Table**																	
7	**Pathway1**																	
8	2002	DF10	1	10	1_SI	1_SI	1_SI	0	0	0	DF	1	86.55	24.1	448.2	0	0	
9	2007	DF10	1	10	2_SE	2_SE	1_SI	871.75	0	871.75	DF	1	59.85	36.48	445.54	0	0	
10	2012	DF10	1	10	2_SE	2_SE	2_ES	12812.29	0	11940.54	DF	1	56.77	47.17	436.09	0	0	
11	2017	DF10	1	10	2_SE	2_SE	2_ES	25802.36	0	12990.07	DF	1	56.65	57.51	417.42	0	0	
12	2022	DF10	1	10	2_SE	3_UR	2_ES	34497.61	0	8695.25	DF	1	58.72	66.96	393.08	0	0	
13	2027	DF10	1	10	2_SE	2_SE	2_ES	41518.4	0	7020.79	DF	1	60.44	76.4	365.63	0	0	
14	2032	DF10	1	10	2_SE	2_SE	2_ES	50274.54	0	8756.14	DF	1	61.8	85.18	338.18	0	0	
15	2037	DF10	1	10	2_SE	2_SE	2_ES	58413.26	0	8138.72	DF	1	63.19	93.4	312.05	0	0	
16	2042	DF10	1	10	2_SE	2_SE	2_ES	66160.01	0	7746.75	DF	1	64.74	101.29	287.75	0	0	
17	2047	DF10	1	10	2_SE	2_SE	3_UR	71982.6	0	5822.59	DF	1	65.96	108.36	265.7	0	0	
18	2052	DF10	1	10	3_UR	2_SE	3_UR	76381.88	0	4399.28	DF	1	67.2	115.56	245.9	0	0	
19	2057	DF10	1	10	3_UR	2_SE	3_UR	83032.71	0	6650.83	DF	1	68.25	121.98	227.9	0	0	
20	2062	DF10	1	10	3_UR	2_SE	3_UR	87539.09	0	4506.38	DF	1	69.52	128.33	212.15	0	0	
21	2067	DF10	1	10	3_UR	2_SE	3_UR	94722.39	0	7183.3	DF	1	70.94	134.44	197.75	0	0	
22	2072	DF10	1	10	3_UR	2_SE	3_UR	97672.01	0	2949.62	DF	1	71.86	139.65	184.95	0	0	
23	2077	DF10	1	10	3_UR	2_SE	3_UR	103307.9	0	5635.86	DF	1	72.93	144.7	173.66	0	0	
24	2082	DF10	1	10	3_UR	2_SE	5_BD	107612.7	0	4304.81	DF	1	73.81	149.03	163.31	0	0	
25	2087	DF10	1	10	3_UR	2_SE	5_BD	113171.4	0	5558.74	DF	1	74.38	152.4	153.86	0	0	
26	2092	DF10	1	10	3_UR	2_SE	5_BD	118059.2	0	4887.8	DF	1	74.94	155.48	145.31	0	0	
27	2097	DF10	1	10	3_UR	2_SE	5_BD	120547.8	0	2488.55	DF	1	75.37	158.28	137.66	0	0	
28	**Pathway2**																	
29	2002	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	0	0	0	DF	1	86.35	24.04	448.2	0	0	
30	2007	DF10u_b_t1	1	10	2_SE	2_SE	1_SI	870.87	0	870.87	DF	1	59.85	36.48	445.09	0	0	
31	2012	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	2391.83	10248.6	11769.56	DF	1	56.64	47.56	50	0	0	
32	2017	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	5218.71	0	2826.88	DF	1	57.3	58.09	49.74	0	0	
33	2022	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	7329.63	0	2110.92	DF	1	58.74	68.48	49.39	0	0	
34	2027	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	9858.18	0	2528.55	DF	1	60.01	78.31	48.99	0	0	
35	2032	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	9737.47	2620.28	2499.57	DF	1	60.95	87.63	38	0	0	
36	2037	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	13015.18	0	3277.71	DF	1	61.63	96.29	37.69	0	0	
37	2042	DF10u_b_t1	1	10	1_SI	1_SI	1_SI	12118.07	4389.4	3492.29	DF	1	61.92	104.64	27	0	0	
38	2047	DF10u_b_t1	1	10	1_SI	1_SI	5_BD	14047.57	0	1929.5	DF	1	62.27	112.46	26.81	0	0	
39	2052	DF10u_b_t1	1	10	1_SI	1_SI	5_BD	16220.51	0	2172.94	DF	1	62.69	119.95	26.61	0	0	
40	2057	DF10u_b_t1	1	10	1_SI	1_SI	5_BD	19261.59	0	3041.08	DF	1	62.74	126.8	26.41	0	0	
41	2062	DF10u_b_t1	1	10	1_SI	1_SI	5_BD	23494.7	0	4233.11	DF	1	62.82	133.36	26.2	0	0	
42	2067	DF10u_b_t1	1	10	1_SI	1_SI	5_BD	26827.84	0	3333.14	DF	1	62.68	139.19	25.95	0	0	
43	2072	DF10u_b_t1	1	10	1_SI	1_SI	5_BD	30364.91	0	3537.07	DF	1	62.63	144.91	25.7	0	0	
44	2077	DF10u_b_t1	1	10	3_UR	3_UR	5_BD	34249.69	0	3884.78	DF	1	62.58	150.45	25.44	0	0	
45	2082	DF10u_b_t1	1	10	3_UR	3_UR	5_BD	37586.64	0	3336.95	DF	1	62.35	155.44	25.18	0	0	
46	2087	DF10u_b_t1	1	10	3_UR	3_UR	5_BD	41518.61	0	3931.97	DF	1	62.13	160.08	24.91	0	0	
47	2092	DF10u_b_t1	1	10	3_UR	3_UR	5_BD	46571.51	0	5052.9	DF	1	62.01	164.84	24.61	0	0	
48	2097	DF10u_b_t1	1	10	3_UR	3_UR	5_BD	50188.67	0	3617.16	DF	1	61.62	168.78	24.3	0	0	
49	**Pathway3**																	
50	2002	DF10u_b_t2	1	10	1_SI	1_SI	1_SI	0	0	0	DF	1	86.35	24.04	448.2	0	0	
51	2007	DF10u_b_t2	1	10	2_SE	2_SE	1_SI	870.87	0	870.87	DF	1	59.85	36.48	445.09	0	0	

Figure 3. Toggle input page for silvicultural pathway data for group one. One input table (see Figure 2) is pasted into the appropriate cells on the page for each silvicultural pathway modeled for the current group. A similar page exists for each group to store pathway input data.



Group#	Name(Optional)	Acres
G1	DF10	160
G2	DF15NoPCT	839
G3	DF15PCT	520
G4	DF20	635
G5	DF25	1350
G6	DF30	1521
G7	DF35	1754
G8	DF40PCT	294
G9	DF40NoPCT	545
G10	DF45	1168
G11	DF55	1205
G12	DF65	333
G13	DF75	144
G14	DF95	1363
G15	DF135	245
G16	DF150	6467
G17		
G18		
G19		
G20		

Figure 4. Toggle group acreage input page. The total number of acres in each group must be entered. Analysis in Toggle is based on allocating percentages of groups to silvicultural pathways. These percentages are multiplied by the total acres in that group to calculate the actual number of acres committed to that pathway. All per acre input values can then be multiplied by the number of committed acres to calculate total output values.

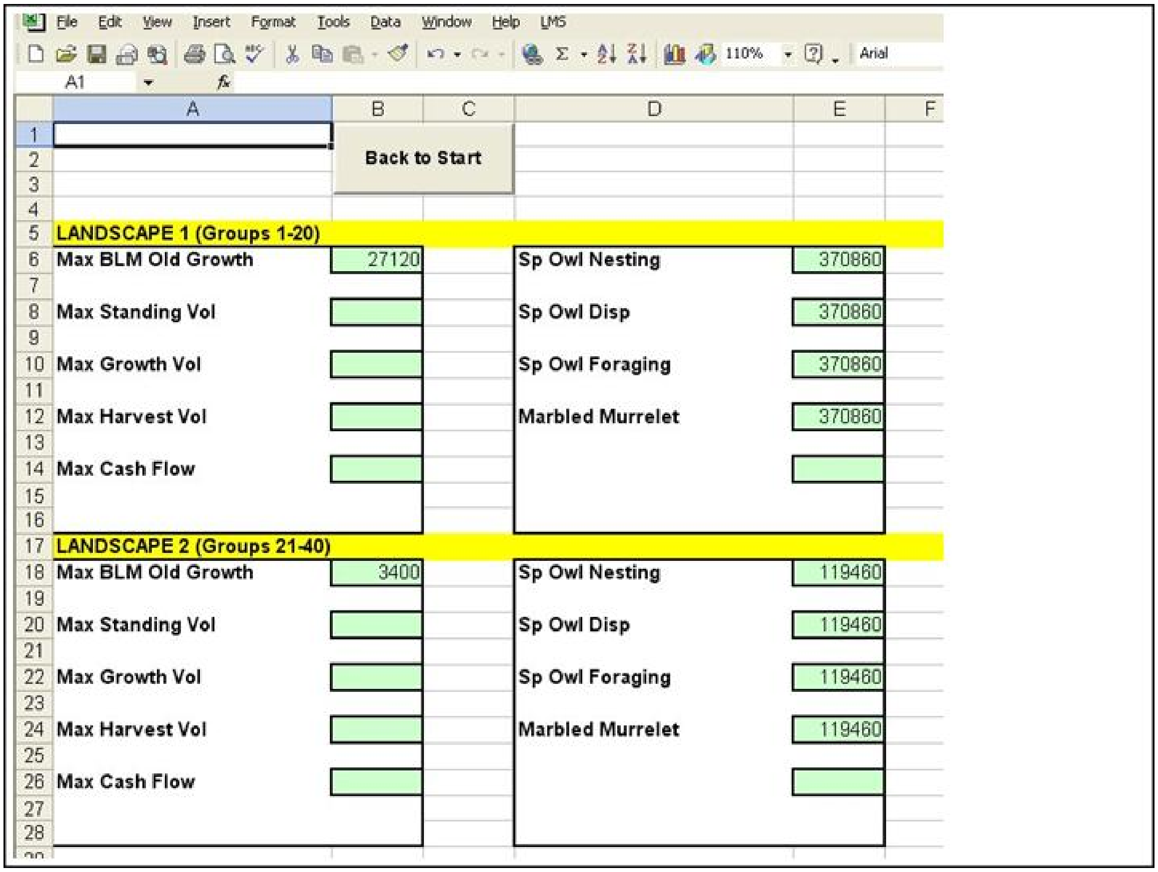


Figure 5. Toggle maximum value input page. Maximum values must be input to calculate accurate normalized values. Maximum values can be input for complex structure (acres), standing, growth, and harvest volume (mbf), cash flow (dollars), spotted owl nesting, foraging, and dispersal habitat (acres), and marbled murrelet habitat (acres). Normalized values are calculated by dividing the current value for an objective by the maximum value to determine the proportional score.

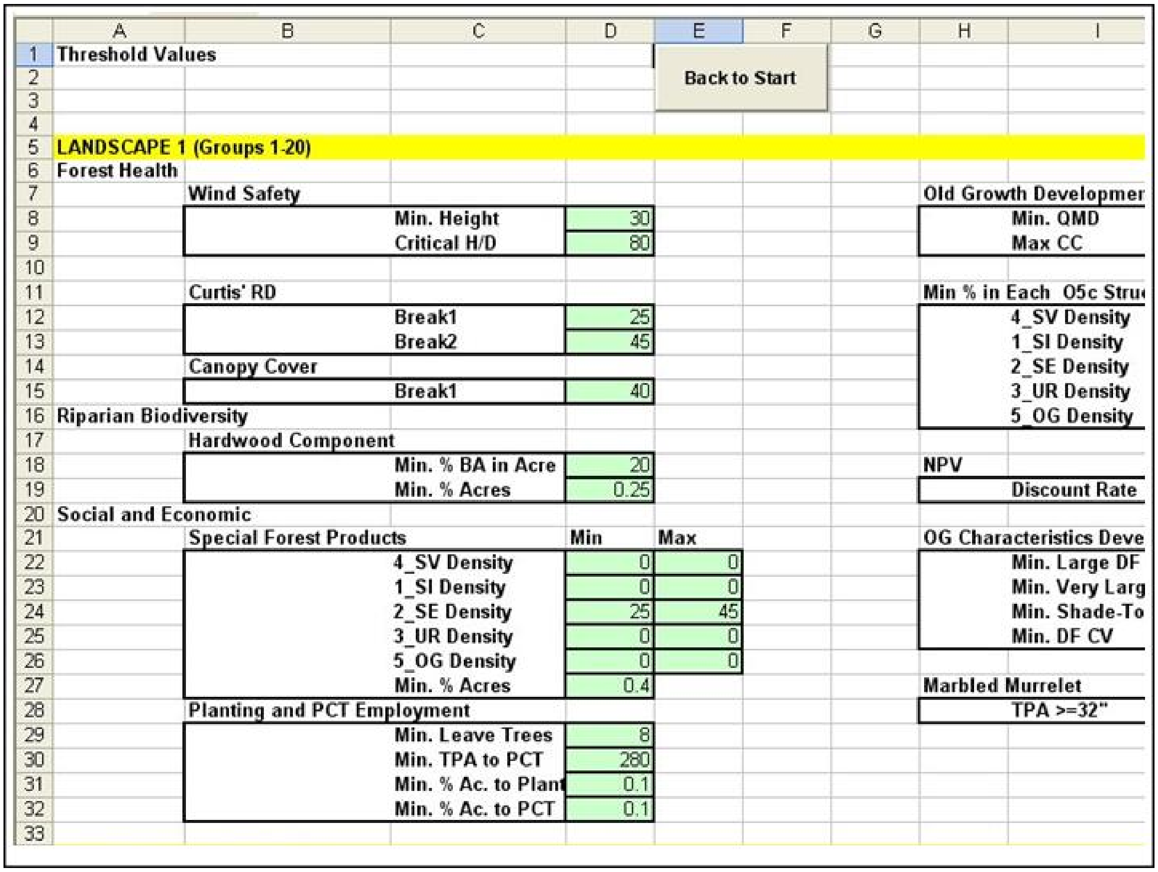


Figure 6. Toggle threshold values page. Threshold values for many objectives can be adjusted in Toggle. Threshold values indicate the point of success or failure for an objective. Adjusting these values may be necessary to calibrate the model for local conditions or performance by a particular growth model variant. A sensitivity analysis can also be performed by altering threshold values slightly and restoring a previously modeled alternative to determine the degree of change for Toggle results.

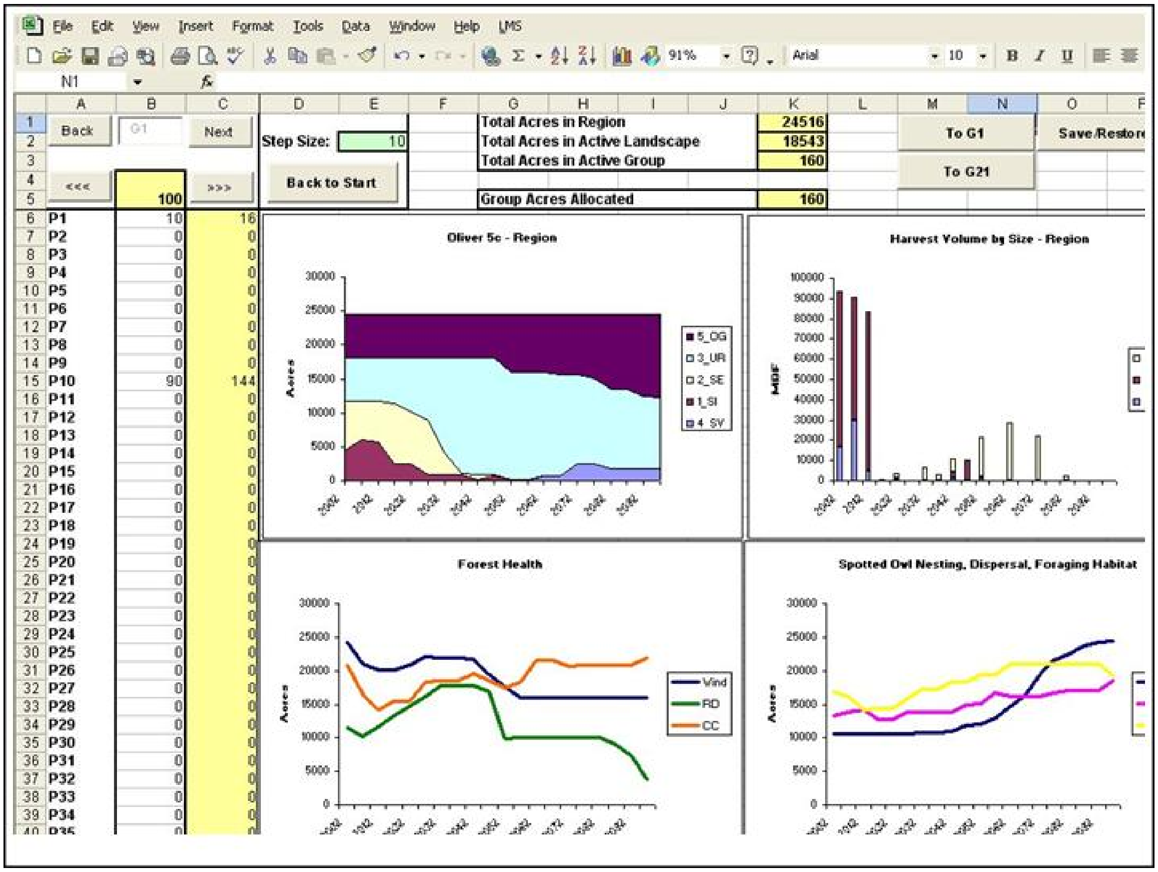


Figure 7. Toggle output page. From this page, the user can allocate group acres to silvicultural pathways, and graphs update immediately to display the new mix of outputs. Each graph is displaying output units (acres or MBF) over time (years). Larger versions of these graphs can be examined in later figures. The list of the silvicultural pathways appear in column A, with the corresponding percentage in column B. Each group utilizes the same space, with only one group active at a time. By clicking on the 'Back' and 'Next' buttons on this page, other groups can be selected as the active group and toggled.

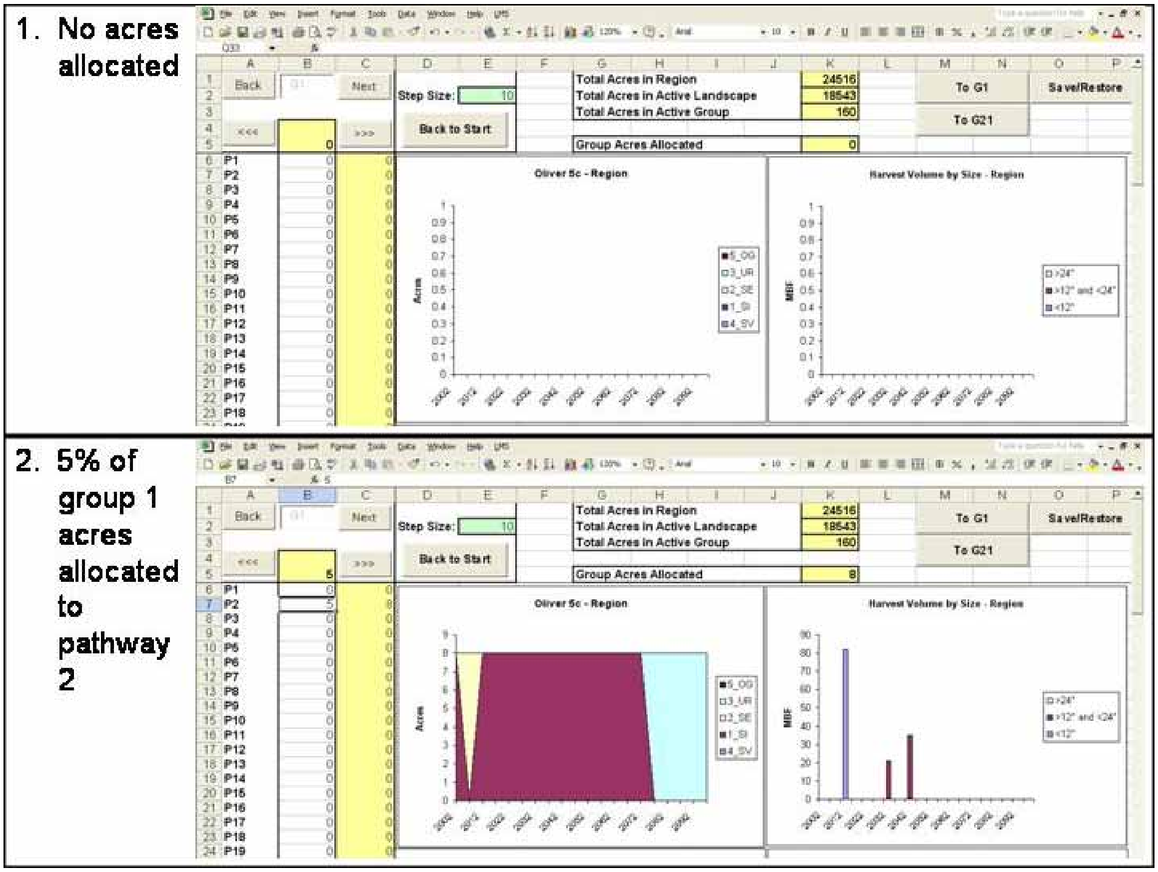
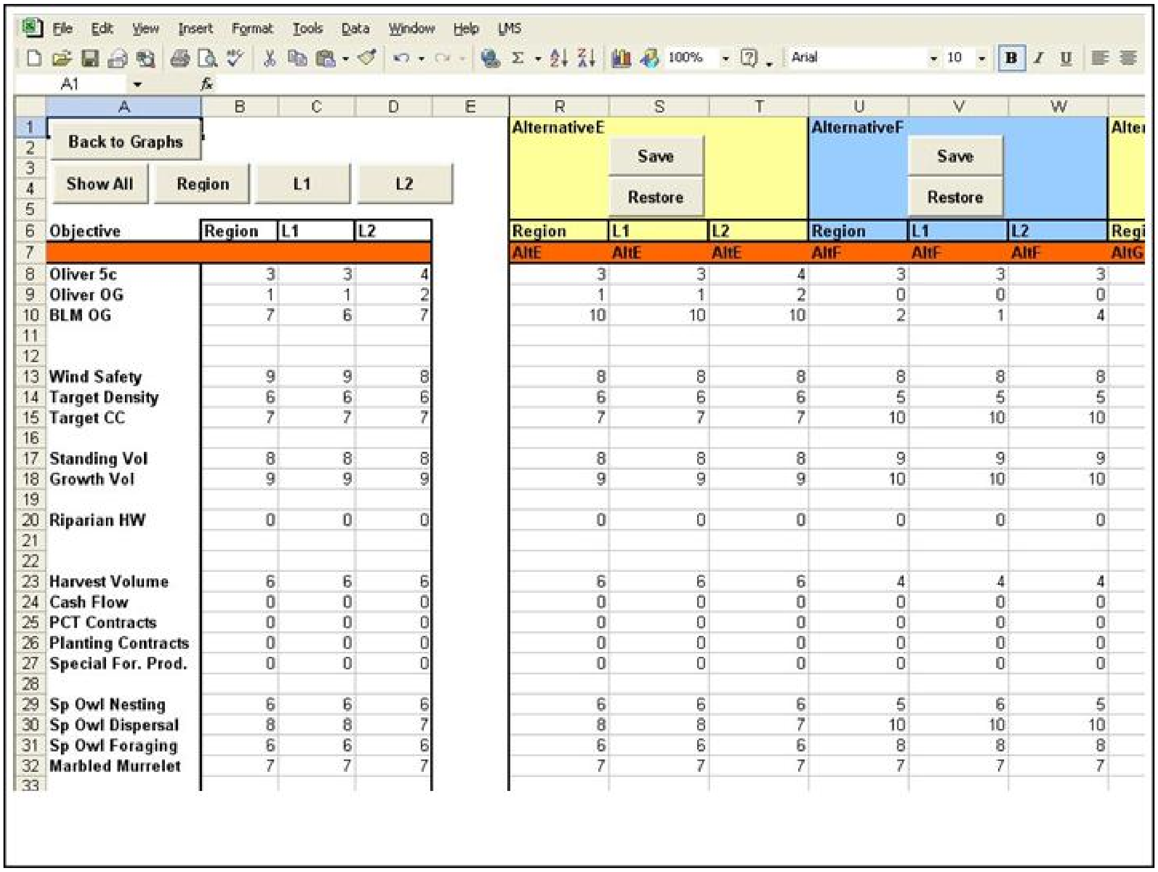


Figure 8. Toggle output page before and after area allocation. This figure demonstrates how outputs change when area is allocated to silvicultural pathways and how alternatives are developed. The top screen capture shows all pathways for all groups set to 0%. The bottom screen capture shows 5% of group 1 allocated to pathway 2. The output graphs for stand structure (left) and harvest volume (right) change immediately. Larger versions of these graphs can be examined in later figures. All graphs not shown also change. As the user allocates more area to this pathway or other pathways, the graphs change in response to the new set of output values.



Objective	Region	L1	L2	Region AltE	L1 AltE	L2 AltE	Region AltF	L1 AltF	L2 AltF
Oliver 5c	3	3	4	3	3	4	3	3	3
Oliver OG	1	1	2	1	1	2	0	0	0
BLM OG	7	6	7	10	10	10	2	1	4
Wind Safety	9	9	8	8	8	8	8	8	8
Target Density	6	6	6	6	6	6	5	5	5
Target CC	7	7	7	7	7	7	10	10	10
Standing Vol	8	8	8	8	8	8	9	9	9
Growth Vol	9	9	9	9	9	9	10	10	10
Riparian HW	0	0	0	0	0	0	0	0	0
Harvest Volume	6	6	6	6	6	6	4	4	4
Cash Flow	0	0	0	0	0	0	0	0	0
PCT Contracts	0	0	0	0	0	0	0	0	0
Planting Contracts	0	0	0	0	0	0	0	0	0
Special For. Prod.	0	0	0	0	0	0	0	0	0
Sp Owl Nesting	6	6	6	6	6	6	5	6	5
Sp Owl Dispersal	8	8	7	8	8	7	10	10	10
Sp Owl Foraging	6	6	6	6	6	6	8	8	8
Marbled Murrelet	7	7	7	7	7	7	7	7	7

Figure 9. Toggle matrix page. On this page, alternatives can be saved or restored. Saving alternatives saves the percentages allocated to all silvicultural pathways for all groups, and copies the normalized values for all objectives into a decision matrix containing the normalized values for all other saved alternatives. When an alternative is restored the spreadsheet automatically reallocates the percentages to the appropriate pathways for each group, and outputs are graphed as before.

Methods

Study Area Description

Location

The study area is located in western Oregon, approximately 20 miles southwest of the city of Eugene in Lane County (Figure 10). Most of the study area is located in the Upper Siuslaw watershed, a 5th field drainage. The ownership pattern is of the "checkerboard" configuration, with alternating sections of primarily BLM and private industry ownership (Figure 11). The study area is located in the Coast Ranges physiographic province (Franklin and Dyrness, 1973).

Site Discription

The Coast Ranges province contains often steep mountain slopes with ridges because of streams and west-flowing rivers (Franklin and Dyrness, 1973). The study area is generally defined by the drainage for the west running Siuslaw River, which runs through the site. Many streams on both the north and south facing slopes run into the river. Site quality within the study area ranges from a high site class 3 to a low site class 2 (DeMoss, June 10, 2002). The region is characterized by a wet, maritime climate (Franklin and Dyrness, 1973). The Upper Siuslaw watershed occurs in the *Tsuga heterophylla* vegetational area, with common species including Douglas-fir (*Pseudotsuga* *menziesii*), western hemlock (*Tsuga heterophylla*), and western red cedar (*Thuja plicata*). More specific vegetational characteristics will be discussed in the Methods section.

Applicable State and Federal Laws

Management activities on BLM land are subject to many federal laws. The most significant of these are the Federal Land Policy Management Act (FLPMA), the National Environmental Policy Act (NEPA), and the Northwest Forest Plan. The FLPMA was enacted in 1976, and requires the BLM to manage its land for multiple-use to best meet the needs of present and future generations (U.S.D.I. Bureau of Land Management, 2001). NEPA, enacted in 1969, requires the preparation of an Environmental Impact Statement for any proposed management action that will impact the natural environment (Bass and Herson, 1993). NEPA also encourages ecosystem management by requiring federal agencies to use a systematic, interdisciplinary approach to decision-making (Black and Herrington, 1974).

The Northwest Forest Plan was enacted in 1993. It was developed from the work of the Forest Ecosystem Management Assessment Team (FEMAT), which analyzed the viability of species associated with old growth forests, particularly the northern spotted owl (FEMAT, 1993). This law allocated all federal land within the range of the spotted owl into one of seven designations. These are Congressionally Reserved Areas, Administratively Withdrawn Areas, Late-Successional Reserves (LSR), Riparian Reserves, Adaptive Management Areas, Managed Late-Successional Areas, and Matrix lands. Generally, Congressionally Reserved Areas and Administratively Withdrawn

Areas are permanent reserves. Adaptive Management Areas are designed to test a landscape management approach providing social, economic, and ecological values. Late-Successional Reserves and Managed Late-Successional Areas allow some silvicultural activities to produce and maintain forests with complex structures. The remaining land is designated as Matrix, and allows more typical forest management activities, including thinnings and harvesting for timber production (Tuchmann et al., 1996). The BLM land comprising the study area is in the LSR category.

The private land is owned by several industrial timber companies. Management on these lands is subject to laws including the Endangered Species Act, the Oregon State Forest Practices Act (State of Oregon, 1998), and company policy. These lands are managed for commodity production primarily through intensive silviculture.

Modification of the Toggle Program

To complete the multiple ownership and cumulative effects analysis, the Toggle tool was modified and functionality was expanded. Generally, flexibility was increased in all existing aspects of the model, and organization of the calculations and spreadsheets was improved to allow construction of a larger model with a smaller file size. An additional component was also added to sum outputs from individual Toggle programs and display aggregate results for each objective as graphs, summary values, and normalized values.

Existing functionality expansions included increasing the number of groups and pathways to allow development of a more complex model. Potential groups were increased from six to 20. Potential pathways were increased from 15 to 50.

More significant for this study, the Toggle program was redesigned to display outputs at multiple levels (i.e., single ownership and multiple ownerships) simultaneously. Within each Excel Toggle workbook, two 20 group landscapes can be modeled, each with unique representative stands, objectives, and silvicultural pathways. Outputs for common objectives were displayed at the cumulative level as well by summing the outputs for the individual landscapes. Further, a new Excel workbook was designed to sum the total outputs from two separate Toggle programs. Although adjusting group percentages allocated to silvicultural pathways can only be done at the individual Toggle level, outputs at all levels change immediately. A screen capture of this system is provided in Figure 12. This linked Toggle system can model four unique landscapes with objectives tracked at three distinct levels.

A significant improvement over the previous Toggle program was the improved organization, allowing many more groups and pathways while maintaining a very similar file size. This modification makes operating several Toggle programs at the same time more reasonable on computers with average hardware. Because of the flexibility of Excel and the improved organization of Toggle, the system could be expanded rapidly to allow more landscapes, more levels, or both. For example, for two neighboring ownerships each with riparian and upland zones, outputs could be reported first for both riparian and upland zones, then aggregated and reported at the ownership level, then further aggregated and reported and the multiple ownership level.

The increased flexibility and size of Toggle required certain calibration steps to be improved as well. These included determining maximum values and setting threshold values. To display outputs as normalized values at each level, maximum values had to be determined at each level. Flexibility was added to allow the program to calculate maximum values automatically based on the inputs from pathways for each group, or to allow the user to input the values manually. The previously laborious step (Johnson, 2001) of manually determining which pathway provided the most of a particular objective for each group, then setting 100% of that group to that pathway to calculate a maximum value was automated, a necessity with 20 potential groups and 50 potential pathways. Maximum values at aggregate levels were calculated as the sum of corresponding maximum values for individual landscapes.

Finally, the functionality of the threshold values was expanded. Threshold values are components of measurable criteria that indicate the point of success or failure. The newly designed Toggle allowed more measurable criteria to be adjusted through threshold values in Toggle rather than LMS. Also, the Toggle allowed each landscape and each level of output to be measured with a unique set of threshold values.

Modeling the Study Area in Toggle

Several major steps were required to model alternatives for the entire landscape and for just the BLM portion in Toggle. Each step will be discussed in detail, including differences required between the BLM and the private lands. The steps completed can be identified as a subset of the rational-iterative decision making process, and will be presented in the corresponding order. The first step of the rational-iterative decision making process, identifying roles, will be assumed completed. Potential roles include a decision-maker (BLM personnel), analysts (the author and BLM personnel), and stakeholders (BLM, neighboring private lands, and other interested parties). The final steps (steps 5-7) of the process, including selecting a chosen alternative, implementation, and monitoring and feedback, will be considered beyond the scope of this paper.

Scoping the Study Area

For this project, scoping the study area for the BLM included grouping stands with similar tree and stand characteristics, identifying the number of acres in each group, and identifying a representative stand for each group. Stands used to complete the scoping process were forest operations inventory polygons within the LSR and associated tree lists where they existed. More frequently, where tree list information did not exist, stand history information was used. This information included year of establishment for the current stand, planting density, and date and description of subsequent silvicultural treatments up to the present time. Specific stand characteristics used to identify groups were age, density, and species. Using these criteria, the BLM land was divided into 16 groups:

1) **DF10**: Pure Douglas-fir, average age 10 years, 447 TPA
2) **DF15NoPCT**: Douglas-fir dominated, average age 15 years, 455 TPA
3) **DF15PCT**: Pure Douglas-fir, average age 15 years, 219 TPA
4) **DF20**: Douglas-fir dominated, average age 20 years, 158 TPA
5) **DF25**: Douglas-fir dominated, average age 25 years, 223 TPA
6) **DF30**: Douglas-fir dominated, average age 30 years, 244 TPA
7) **DF35**: Douglas-fir dominated, average age 35 years, 266 TPA
8) **DF40**: Douglas-fir dominated, average age 40 years, 386 TPA
9) **DF45NoPCT**: Douglas-fir dominated, average age 40 years, 259 TPA
10) **DF45PCT**: Douglas-fir dominated, average age 45 years, 242 TPA
11) **DF55**: Pure Douglas-fir, average age 55 years, 219 TPA
12) **DF65**: Pure Douglas-fir, average age 65 years, 290 TPA
13) **DF75**: Pure Douglas-fir, average age 75 years, 248 TPA
14) **DF95**: Pure Douglas-fir, average age 90 years, 90 TPA
15) **DF135**: Douglas-fir dominated, average age 135 years, 102 TPA
16) **DF150**: Douglas-fir, western hemlock, big leaf maple mixed, greater than 150 years, 39 TPA

After the groups were identified, a tree list for each representative stand was generated. For the DF95, DF135, and DF150 groups, an average tree list was created from existing stand inventories. These tree lists were created to have representative distributions for species, diameters, heights, and crown ratios. For the 13 groups with younger stands, a representative tree list was generated by modeling the silvicultural history from the point of establishment of the current stand in LMS. The West Cascades variant of the FVS growth model was used, with five year growth intervals (Stage, 1973). A keyfile was applied to calibrate the model to induce density related mortality at lower densities. The keyfile is provided in Appendix B. The expert opinion of the local BLM forester was used to validate that the tree lists were reasonable representative inventories (DeMoss, January 31, 2002).

Inventory data for the private land was not readily available. To approximate the coverage types, two sources were used. First, broad classification types were determined from the Coastal Landscape Analysis and Modeling Study (CLAMS) (Ohmann and Gregory, 1996). Classifications which composed less than 10% of the total acres were grouped with similar types to produce six significant coverages. The private land was divided into the following groups:

1) **Broadleaf**: Red alder dominated, average DBH 10.3 inches, 202 TPA
2) **Mixed**: Douglas-fir, hardwood mixed, average DBH 12.4 inches, 227 TPA
3) **Open Forest**: Pure Douglas-fir, average DBH 1.1 inches, 350 TPA
4) **Small Conifer**: Pure Douglas-fir, average DBH 3.5 inches, 347 TPA

5) **Medium Conifer**: Pure Douglas-fir, average DBH 14.6 inches, 269 TPA

6) **Large Conifer**: Douglas-fir, western hemlock, western red cedar, big leaf maple mixed, average DBH 22.8 inches, 43 TPA

Second, with input from the local field forester, typical silvicultural pathways were estimated for the surrounding private industry (DeMoss, March 28, 2002). Using the same modeling technique utilized for the BLM data, the estimated stand type silvicultural histories were modeled in LMS to produce current tree list inventories for the private land.

With the completion of the scoping step, an LMS portfolio was created for the BLM with 16 representative stands, and for the private land with six representative stands. The number of acres in each group is provided in Appendix B. In LMS, however, each representative stand was modeled as a single acre. The stands were also given average slope, aspect, and elevation values for that portion of the middle Siuslaw watershed for use by the FVS growth model (DeMoss, January 31, 2002).

Identifying Objectives and Creating Measurable Criteria

Simultaneously with the development of the data set used to model the LSR, objectives were identified and measurable criteria were defined to assess their fulfillment. A large set of objectives and measurable criteria were identified by the BLM Eugene District LSR interdisciplinary (ID) team. Some objectives, such as development of complex forest structure and amount of spotted owl nesting, foraging, and dispersal habitat, had been identified as the primary objectives when the LSR was established by the Northwest Forest Plan (Tuchmann et al., 1996). A subset of the larger set was selected for this study. The objectives chosen were coarse filter biodiversity, total harvest volume, stand density, and spotted owl nesting, foraging, and dispersal habitat. Because the analysis was performed from the perspective of the BLM, the same objectives were used for the private lands and for the cumulative landscape (both BLM and private lands). Measurable criteria for all objectives were based on standing or harvested inventory characteristics, including values that could be derived from the basic inventory information.

The coarse filter biodiversity objective was evaluated using a modified Oliver stand structure classification (Oliver and Larson, 1996). Based on the measurable criteria, each stand on the landscape was classified as either complex (OG), understory reinitiation (UR), dense (SE), open (SI), or savanna SV). Complex structure was defined by the BLM ID team as having at least 7.7 Douglas-fir trees per acre (TPA) greater than 32" DBH, at least 0.4 Douglas-fir TPA greater than 40" DBH, at least 7 western hemlock or western red cedar TPA greater then 10" DBH, and a coefficient of variation for all Douglas-fir trees greater than 0.4. For all other structures, existing definitions within LMS were used. Stands that were in the complex structure using the existing LMS definition but not using the BLM definition were considered in the understory reinitiation structural stage. Stands that qualified in both BLM complex structure and any other existing LMS structure were considered to be in the complex structural stage. The measurable criteria for each of the structural stages are below:

Complex

Minimum 7.7 DF TPA greater than 32”

Minimum 0.4 DF TPA greater than 40”

Minimum 7 WH or RC TPA greater than 10”

CV for all DF trees greater than 0.4

Understory Reinitiation

Minimum QMD of 23”

Minimum Canopy Closure of 40%

Dense

Maximum QMD of 23”

Minimum Canopy Closure of 40%

Savanna

Maximum 20 TPA with DBH greater than 18”

Minimum 8 TPA with DBH less than 18”

Maximum 16 TPA with DBH between 5” and 18”

Open

Stands that do not qualify under any other structure

The harvest volume objective was measured by the total amount of merchantable board foot volume harvested during each five year projection period. Merchantability was considered a minimum small-end diameter of four inches, using 40-foot log lengths. Measurable criteria for the stand density objective were based on a desired range using

Curtis' Relative Density measure (Curtis, 1982). Stands with a relative density value between 25 and 45 were within the target range.

Measurable criteria for the spotted owl nesting, foraging, and dispersal habitat were developed by the BLM LSR ID team. Nesting habitat was defined as stands with at least two Douglas-fir trees with DBH greater than 38 inches. Foraging habitat was defined as stands with at least two canopy layers and a minimum stand height of 80 feet. The number of canopy layers was calculated using the algorithm developed by Baker and Wilson (2000). Dispersal habitat was defined as stands with a minimum QMD of 12 inches and a minimum canopy closure of 40%. Canopy closure was calculated using the equation in FVS by Crookston and Stage (1999).

Using the measurable criteria, output tables were created in LMS to analyze treated and projected inventories. A Toggle program was also created for both the BLM and private lands with appropriate measurable criteria to analyze all objectives for all groups simultaneously, and the landscape level output program to analyze cumulative effects of both ownerships was developed as well. Group names and acres determined during the scoping step were input into the BLM and private Toggle programs at this time. Development of alternatives in the Toggle will be discussed in the next section.

Developing Alternatives

The BLM and private land management alternatives were developed first by modeling the necessary silvicultural pathways for each group in LMS. All pathways were modeled for 95 years using five year age steps with the West Cascades variant of

FVS. The same keyfile was used to calibrate the growth model. For both ownerships, silvicultural pathways were designed to develop specific ownership alternatives in Toggle.

Two types of silvicultural pathways modeled for each BLM group included no action and heavy thinnings designed to promote the complex structure. The DF95, DF135, and DF150 groups were modeled only with the no action pathway because treatments cannot occur in the LSR in stands older than 80 years old (Tuchmann et al., 1996). For the thinning pathways, each group with average age 75 years or younger received a similar set of treatments. During one of the first three planning periods, the stand was thinned to 40 or 50 TPA. Most stands were also underplanted with an even mix of Douglas-fir, western hemlock, and western red cedar. Between 20 and 40 years later, most stands were entered a second time to thin the understory and fell some larger trees to create coarse woody debris. For each BLM group, between 8 and 13 silvicultural pathways were modeled. The scenario files and regeneration files used to model each silvicultural pathway are provided in Appendix B.

Three types of silvicultural pathways were modeled on the private land. These were no action, 45-year clearcut harvest rotations, and 85-year clearcut harvest rotations with a commercial thin at stand age 35. For each clearcut harvest, two Douglas-fir leave trees per acre were retained according to the Oregon State Forest Practice Act (State of Oregon, 1998). The stands were replanted to 350 TPA with Douglas-fir. The commercial thin was modeled as a thin from below to retain the 100 largest trees per acre. A set of silvicultural pathways was modeled for the 45-year and 85-year rotations, with the year of the first harvest staggered in time through the set. Between 27 and 37 silvicultural pathways were modeled for the private land groups. The scenario files and regeneration files used to model each silvicultural pathway are provided in Appendix B.

Output tables were next generated in LMS that evaluated the treated and projected inventories for each silvicultural pathway for each group against the measurable criteria for each objective. These output tables were then loaded into the appropriate BLM or private land Toggle program. This procedure involved manually copying the necessary range from the output table Excel file and pasting it into a corresponding range for that pathway for that group in the Toggle program. The final step prior to developing alternatives in Toggle was determining maximum values for each objective. This step was also completed at this time, but is relevant only to displaying normalized output values in a decision matrix. Therefore, it will be discussed in more detail in a following section.

The final step for developing alternatives was using the Toggle program to indicate what percentage of each group would follow each silvicultural pathway. Two alternatives were developed for the BLM: a "no action" alternative and Alternative "E". Under the no action alternative, 100% of each group followed the no action pathway. Percentages followed by each pathway for Alternative E are provided in Appendix B.

Three alternatives were developed for the private land. One alternative was no action (Private Alternative 1). The Private Alternative 2 modeled the ownership under a 45-year clearcut harvest rotation with an even-flow constraint. Percentages of each group were distributed across the set of 45-year clearcut rotation pathways to achieve the even-flow constraint. Even-flow was evaluated visually using the Total Harvest Volume graph in the Toggle program (Figure 13). The Private Alternative 3 modeled the private land under an 85-year clearcut harvest rotation with an even-flow constraint. This alternative was developed in the same manner as the 45-year rotation alternative. The exact percentages for each group following each silvicultural pathway for the private land is provided in Appendix B.

Comparing Objectives and Alternatives

The final step of the rational-iterative decision making process completed in this study was comparing each alternative with each objective. Generally, the Toggle program facilitated this by displaying outputs as graphs, summary values, and as normalized values in a decision matrix as alternatives were developed. Because normalized values can be calculated multiple ways, the method used in this study will be discussed.

The normalized values for all objectives except coarse filter biodiversity compared the current value to a predetermined maximum value to assign a proportional score. The following equation was then used to calculate the normalized value:

Normalized Value = Current Value/ Maximum Value * 10

The coarse filter biodiversity objective did not require a maximum value. Instead, the normalized value was calculated first by determining if a minimum percentage of the ownership was in each of the five structural stages during each time period. The minimum percentage was chosen to be 10%, or 2451.6 acres for the BLM and 3469.1 acres for private. The structural stage received a 0 for each period that it had too few acres, and a 1 for each period with sufficient acres. The scores for all structural stages and time periods were then averaged and multiplied by 10 to calculate the normalized value. For the landscape, the number of acres for each ownership in each structural stage and time period was summed, then the same method was applied, this time for the combined ownerships. The 10% threshold value on the landscape equaled 5920.7 acres.

The maximum value for each objective was determined by calculating or estimating the absolute maximum value possible. Because the maximum value needed to be a single number, all output values throughout the simulation for a particular objective were summed together. For the target stand density and spotted owl nesting, foraging, and dispersal habitat objectives, the maximum value was the total number of acres in the ownership multiplied by the number of projection periods. This calculated the absolute maximum amount of target density or habitat acres possible throughout the simulation. For the BLM this value was 490,320 acres. For the private land, this value was 693,820 acres. The landscape maximum value was calculated by summing the maximum values for each ownership. For the landscape, this value was 1,184,140 acres.

The maximum value for the harvest volume objective was calculated first for the private land. An assumption was made that the 45-year clearcut rotations would be very close to the absolute biological growth maximum (culmination of mean annual increment), and could reasonably represent this number. For each group, the silvicultural pathway that provided the most harvest volume was then determined, and 100% of the acres were allocated to that pathway. The harvest volume values for all groups and time periods were then summed to estimate a single maximum value. The harvest volume maximum value used for the private land was 3,205,527 MBF.

Because clearcut pathways were not modeled for the BLM, a percentage of the private land maximum harvest value was used based on the proportion of the BLM to private land base. An assumption was made that the BLM land could potentially be as productive as the surrounding, intermixed private land if similar silvicultural pathways were used. The BLM land area was 71% as large as the private land area. Therefore, the BLM harvest volume maximum value used was 2,265,334 MBF, 71% of the private land harvest volume maximum value. The landscape level harvest volume maximum value was calculated by summing the maximum values for each ownership. This value was 5,470,861 MBF.

At this point, alternatives were developed in Toggle as described above. The BLM land was modeled using a no action alternative and Alternative E. The private lands were modeled with a no action alternative, Alternative 1 (45-year rotations) and Alternative 2 (85-year rotations) in order to model cumulative effects with BLM management. The results of these alternatives will be described next.

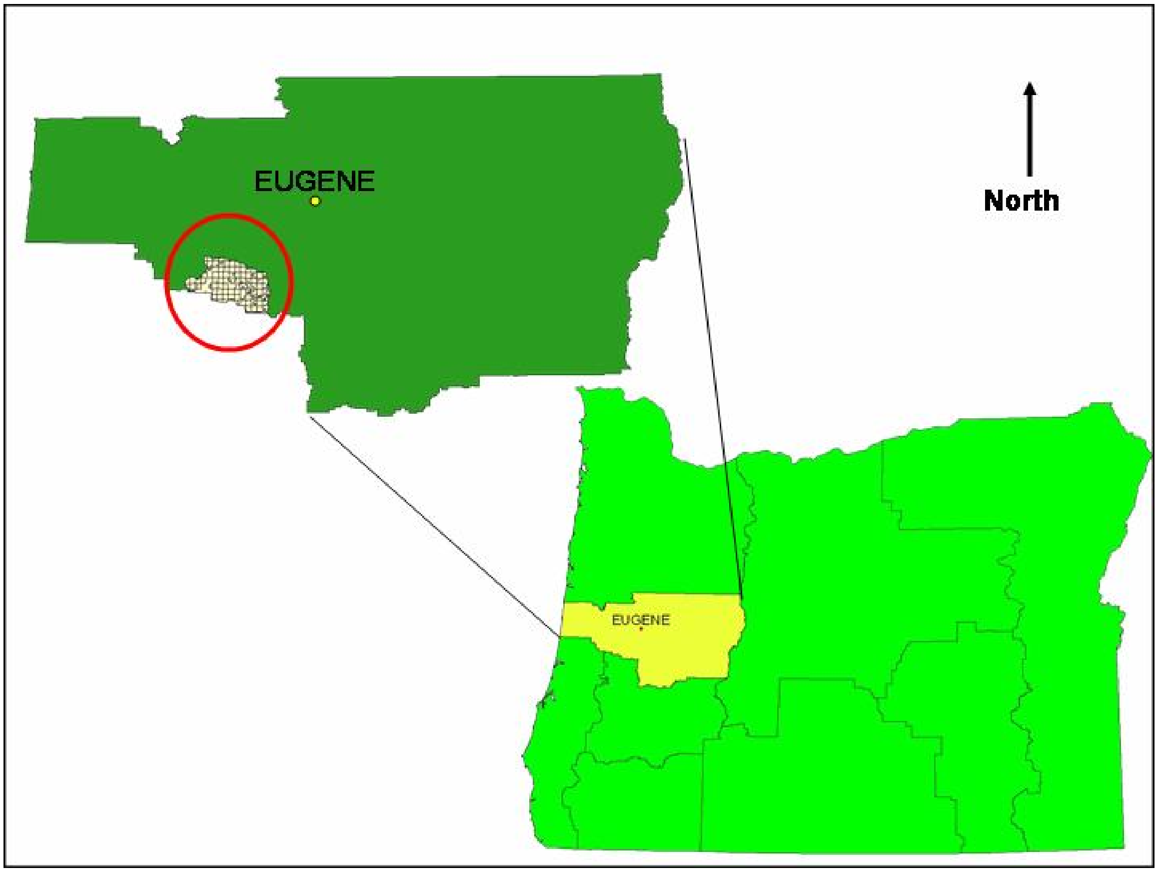


Figure 10. Location of study area in Oregon State.

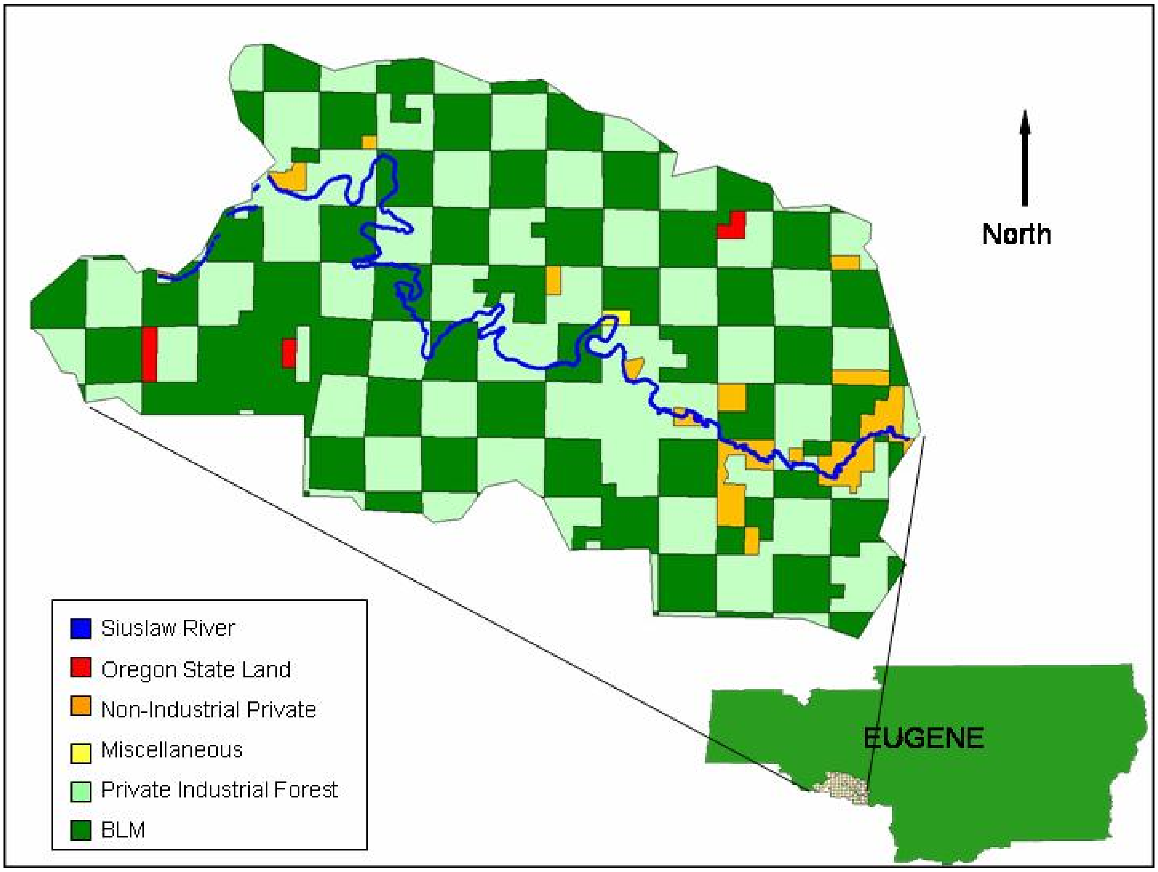


Figure 11. Ownership pattern within study area.

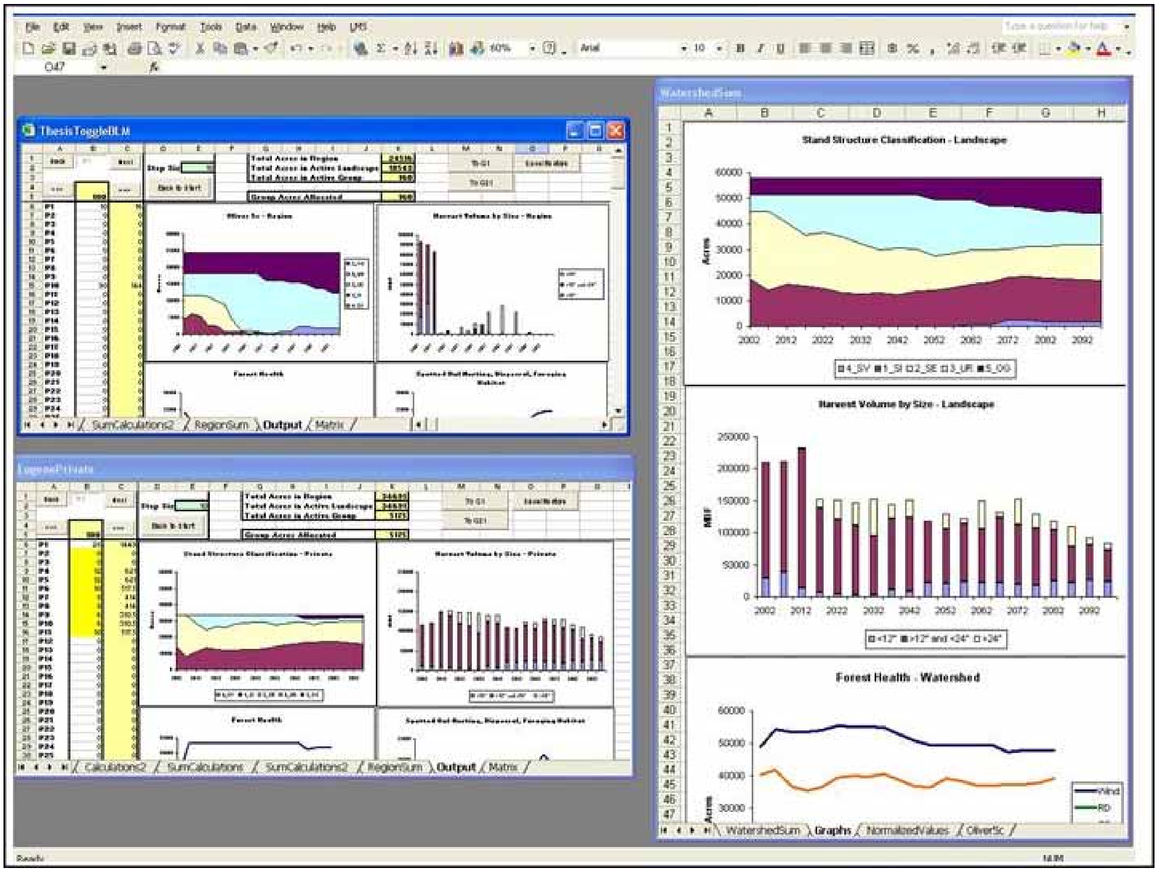


Figure 12. Multiple-Toggle program. This figure shows two Toggle programs (smaller windows on left) and an additional worksheet (single window on right) that sums the cumulative results. Silvicultural pathway percentages are controlled in the individual Toggle programs, but results immediately change at both the individual Toggle and cumulative levels.

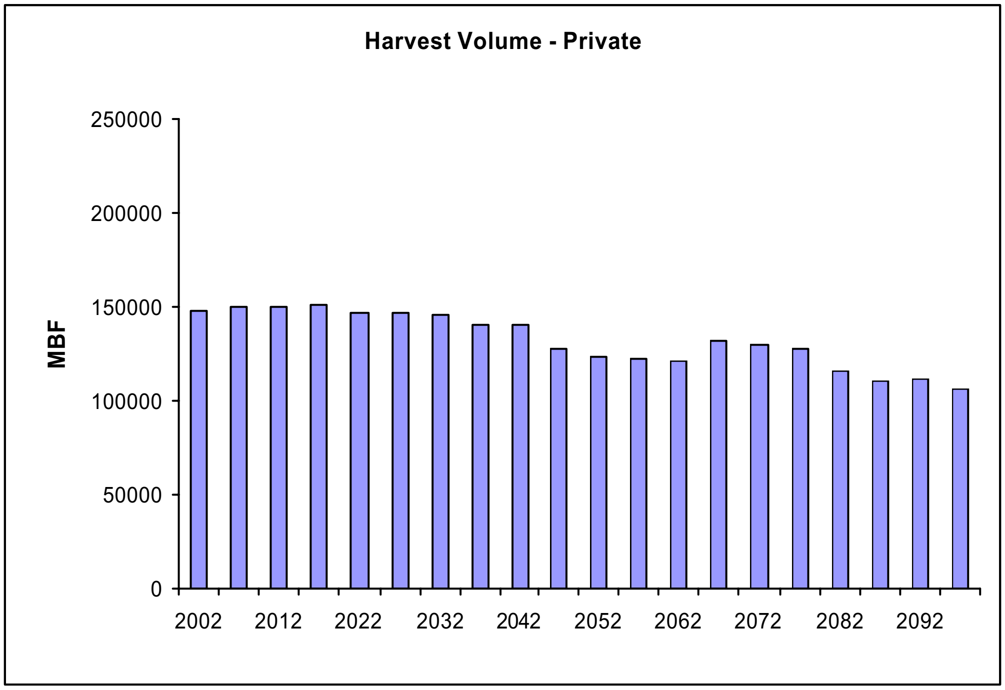


Figure 13. Total Harvest Volume. An even-flow constraint was analyzed visually for the private lands alternatives using this graph.

Results

Outputs for Each Objective for BLM and Landscape Alternatives

The results of the BLM and Landscape Alternatives demonstrate a specific application of the linked-Toggle program, and the ability of the program to account for a variety of objectives at multiple hierarchical levels under changing management alternatives. Results for the BLM only alternative will be presented first to analyze objectives and outputs important to the BLM individually. Landscape alternatives comprised of selected BLM alternatives and potential private land alternatives will then be discussed to examine cumulative effects.

Tables with normalized values (Figure 14) and summary values (Figures 15, 16, and 17) for each objective and each alternative are provided at the end of this section. Graphs of some objectives for each alternative are also provided at the end of this section. For all graphs, the Y-axis range is scaled to display the outputs for an objective provided by the combined landscape. All graphs not provided in this section are provided in the Appendix A.

BLM Only: No Action

Under the no action alternative, the number of stand structures on the ownership decreased through time from four to two as all acres developed into the understory reinitiation or complex structures. During the initial time period, open, dense, understory reinitiation, and complex stand structures were present, with dense accounting for the largest single classification. With no active management, the open structure was gone by 2007 and the dense structure was gone by 2052. This change is illustrated in Figure 18, and resulted in a biodiversity normalized value of 6.

No action also resulted in 0 harvest volume and a very low target density value. The BLM land averaged only 4,541 acres within the desired density range and 0 acres after 2052 (Figure 19). This resulted in a normalized value of 2.

No active management provided the most spotted owl foraging and dispersal habitat, and very slightly less nesting habitat than Alternative E. Through time, no action on the BLM land resulted in 14,232 average nesting acres, 19,844 average foraging acres, and 24,079 average dispersal acres. Normalized value scores were 6, 8, and 10 for the nesting, foraging, and dispersal objectives, respectively. Figure 20 illustrates the development of spotted owl habitats through time.

BLM Only: Alternative E

Alternative E was designed to accelerate the development of complex structure, and resulted in a higher average and final number of acres in this structure (Figure 21). Figure 21 also illustrates that, like no action, the open and dense structures were gone from the ownership by 2052. The heavy thinnings did increase the amount of open structure, and increased the number of time periods when it was present. Some acres were also classified as savanna structure during the later time periods, resulting in a slightly higher normalized value of 7 for the biodiversity objective.

Alternative E provided significant harvest volume during the first three time periods, with scattered and lower volumes during the remainder of the simulation (Figure 22). Harvest volume during the first three time periods was primarily from medium log sizes (12-24”), with some from small log sizes (<12”). Later harvest volume was generally from the larger log sizes (>24”). Alternative E resulted in a harvest volume normalized value of 2 for the BLM.

Finally, Alternative E resulted in significantly lower spotted owl foraging and dispersal habitat acres compared to no action. Alternative E provided very slightly higher nesting acreage values (Figure 23). The normalized values for spotted owl nesting, foraging, and dispersal habitat objectives were 6, 6, and 8, respectively.

Landscape Alternative 1: No Action (BLM and Private)

With the BLM no action alternative, cumulative effects were simultaneously modeled using a no action alternative for the private land. Like the BLM only, the landscape initially provided open, dense, understory reinitiation, and complex structures, but provided only understory reinitiation and complex structures at the end of the simulation with no management. No open structure was provided after 2022, and no dense structure after 2072. The biodiversity normalized value score for the landscape was 6.

No action on the landscape resulted in 0 harvest volume and a very low target density normalized value of 1. After 2052, only 1,433 acres each time period met the measurable criteria for density.

Landscape Alternative 1 (No Action) provided the most spotted owl foraging and dispersal habitat and very slightly less nesting habitat compared to Landscape Alternative 3. Nesting habitat showed very little separation between the three landscape alternatives. Landscape level normalized values for spotted owl nesting, foraging, and dispersal habitat objectives were 4, 4, and 9, respectively.

Landscape Alternative 2: Alternative E (BLM) and Alternative 2 (Private)

Landscape Alternative 2 modeled Alternative E for the BLM land and Private Alternative 2 on the private land to analyze cumulative effects. Landscape Alternative 2 resulted in a much higher biodiversity objective normalized value of 10, even though individually BLM Alternative E resulted in a 7 and the private land alternative resulted in a 6. Figure 24 shows that open, dense, understory reinitiation, and complex structures were provided in significant amounts at each time period during the simulation. Figure 21 illustrates that the BLM provided nearly all the complex and understory reinitiation. Figure 25 shows that the private land provided nearly all the dense and open structure.

The harvest volume objective for Landscape Alternative 2 received a normalized value of 6. Most of the harvest volume was contributed by the private land (normalized value of 8). During the first three time periods, significantly more volume was harvested due to the heavy BLM thinnings. Through the remainder of the simulation, harvest volume was relatively even, primarily because of the private land alternative (Figure 26).

Landscape Alternative 2 resulted in an improved target density objective score compared to Landscape Alternative 1. The normalized value increased to 3, and the average number of acres within range increased from 6,922 to 18,680.

Spotted owl nesting habitat was nearly identical for each of the three landscape alternatives. Under Landscape Alternative 2, much less foraging habitat was provided compared to the no action alternative, and the normalized value was reduced to a 3. Dispersal habitat showed the greatest reduction under Landscape Alternative 2, falling from a normalized value of 9 for no action to a 5. Spotted owl habitat development for this alternative is displayed in Figure 27.

Landscape Alternative 3: Alternative E (BLM) and Alternative 3 (Private)

Like Landscape Alternative 2, Landscape Alternative 3 received a biodiversity normalized value of 10. Figure 28 illustrates that open, dense, understory reinitiation, and complex structures were provided each time period. However, the average amount of open structure each time period was reduced from 16,144 acres to 10,836 acres, and the average amount of dense and understory reinitiation structure increased.

Under Landscape Alternative 3, the average amount of harvest volume during each 5-year planning period decreased from 151,400 MBF for Landscape Alternative 2 to 139,700 MBF. Significantly more volume was harvested from the largest log size class (>24") as well. Like Landscape Alternative 2, increased harvest volume occurred during the first three time periods because of the BLM thinnings (Figure 29).

The target density objective was highest under Landscape Alternative 3 (Figure 30). The average number of acres within the desired range was 23,321. This resulted in a normalized value of 4.

Under Landscape Alternative 3, spotted owl nesting and foraging habitat performed very similar to Landscape Alternative 2 (Figure 31). The amount of foraging habitat provided was much less than the no action alternative. Landscape Alternative 3 was more successful in providing dispersal habitat than Landscape Alternative 2, but less successful than the no action alternative. The normalized value for dispersal habitat was 6, compared to 9 and 3 for Landscape Alternatives 1 and 2, respectively.

Discussion on Whether the Toggle Program Achieved the Design Goals

The Toggle decision support tool was designed to facilitate completion of certain steps of the rational-iterative decision making process. These steps include developing management alternatives and analyzing and comparing alternatives. The multiple-Toggle model additionally was designed to communicate within and across hierarchical levels, such as within an organization or between ownerships. The Toggle program appeared successful in achieving these design goals.

Each of the landscape alternatives demonstrated that cumulative effects can be modeled for a range of objectives. The linked-Toggle decision support tool facilitated development of individual ownership alternatives with consideration for cumulative effects by displaying results at multiple levels. Further, as group percentages applied to silvicultural pathways were adjusted, results at all levels changed immediately. This allowed users to examine trade-offs immediately, and to perform cost-benefit analyses between all or any objectives. The relative simplicity of using the program, once loaded and calibrated, and of displaying outputs as graphs, summary values, and normalized values also appeared to improve the process of developing alternatives and analyzing results. Stakeholders could be given the loaded and calibrated Toggle to generate alternatives with little additional instruction required.

	BLM Alternatives		Private Alternatives			Landscape Alternatives		
Objective	**No Action**	**Alt. E**	**No Action**	**Alt. 2**	**Alt. 3**	**No Action**	**Alt. 2**	**Alt. 3**
Coarse Filter Biodiversity	6	7	5	6	7	6	10	10
Harvest Volume	0	2	0	8	8	0	6	5
Target Density	2	5	1	2	3	1	3	4
Spotted Owl Nesting	6	6	3	2	3	4	4	4
Spotted Owl Foraging	8	6	2	1	1	4	3	3
Spotted Owl Dispersal	10	8	9	3	6	9	5	6

Figure 14. Normalized values for each objective for all BLM, Private, and Landscape alternatives. Alternative E for the BLM was developed with most acres for each group following silvicultural pathways with early thinnings designed to promote complex structure. Private Alternative 2 was developed using 45-year harvest rotations. Private Alternative 3 was developed using 85-year harvest rotations. Landscape Alternative 2 was developed using Alternative E for the BLM and Alternative 2 for the private lands. Landscape Alternative 3 was developed using Alternative E for the BLM and Alternative 3 for the private lands

	No Action			Alternative E		
Objective	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**
Oliver 5c (acres)						
SV	0	0	0	674	2,399	0
SI	45	895	0	1,232	6,115	0
SE	3,434	11,662	0	2,394	8,706	0
UR	13,572	17,858	6,387	12,041	17,224	6,387
OG	7,465	8,462	6,467	8,174	12,208	6,467
Harvest Volume (MBF)	0	0	0	18,800	93,300	0
>12”	0	0	0	2,700	29,900	0
12”-24”	0	0	0	11,600	78,400	0
<24”	0	0	0	4,600	28,600	0
Target Density (acres)	4,541	11,296	0	11,948	17,859	3,860
Spotted Owl (acres)						
Nesting	14,232	24,516	10,621	14,986	24,516	10,621
Foraging	19,884	21,047	13,322	15,187	18,587	12,827
Dispersal	24,079	24,516	19,900	18,400	20,981	14,116

Figure 15. Summary (extremes and averages) of values occurring over time for each objective and BLM alternatives.

	No Action			Alternative 2			Alternative 3		
Objective	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**
Oliver 5c (acres)									
SV	0	0	0	0	0	0	0	0	0
SI	1,115	11,768	0	14,911	17,950	9,500	9,604	14,164	7,712
SE	8,802	29,748	0	15,310	23,758	11,190	17,399	24,956	10,640
UR	21,530	29,748	0	2,934	7,291	0	6,256	9,976	0
OG	3,244	6,608	1,433	1,537	1,951	1,433	1,433	1,433	1,433
Harvest Volume (MBF)	0	0	0	132,600	151,600	105,600	120,800	130,200	100,400
>12”	0	0	0	16,800	32,700	2,100	7,200	12,500	2,100
12”-24”	0	0	0	99,500	137,800	56,600	81,300	111,300	51,100
<24”	0	0	0	16,300	51,900	0	32,400	62,100	1,100
Target Density (acres)	2,380	9,691	1,433	6,732	9,691	1,433	11,372	19,037	1,433
Spotted Owl (acres)									
Nesting	9,515	22,923	1,433	8,172	22,740	1,433	8,912	22,923	1,433
Foraging	6,608	6,608	6,608	3,621	5,832	1,951	3,009	6,349	1,433
Dispersal	31,811	34,691	22,923	9,988	19,813	3,266	19,314	21,524	13,792

Figure 16. Summary (extremes and averages) of values occurring over time for each objective and private alternatives.

	No Action			Alternative 2			Alternative 3		
Objective	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**
Oliver 5c (acres)									
SV	0	0	0	674	2,399	0	674	2,399	0
SI	1,160	12,663	0	16,144	19,259	12,504	10,836	18,546	7,712
SE	12,237	41,410	0	17,704	29,305	11,864	19,793	30,502	13,357
UR	35,102	45,802	6,387	14,974	20,379	6,387	18,297	23,734	6,387
OG	10,709	15,070	7,900	9,711	13,641	7,900	9,607	13,641	7,900
Harvest Volume (MBF)	0	0	0	151,400	241,600	105,600	139,700	213,400	114,700
>12”	0	0	0	19,500	41,600	2,100	9,900	40,200	2,100
12”-24”	0	0	0	111,100	216,200	56,600	92,800	188,600	54,300
<24”	0	0	0	20,900	58,600	0	37,000	68,800	1,100
Target Density (acres)	6,922	19,935	1,433	18,680	25,282	12,246	23,321	29,172	13,192
Spotted Owl (acres)									
Nesting	23,747	47,439	12,054	23,158	46,465	12,054	23,898	47,439	12,054
Foraging	26,492	27,655	19,930	18,809	21,420	15,750	18,196	20,020	16,681
Dispersal	55,890	59,207	42,823	28,388	36,753	22,747	37,714	42,505	28,086

Figure 17. Summary (extremes and averages) of values occurring over time for each objective and landscape alternatives.

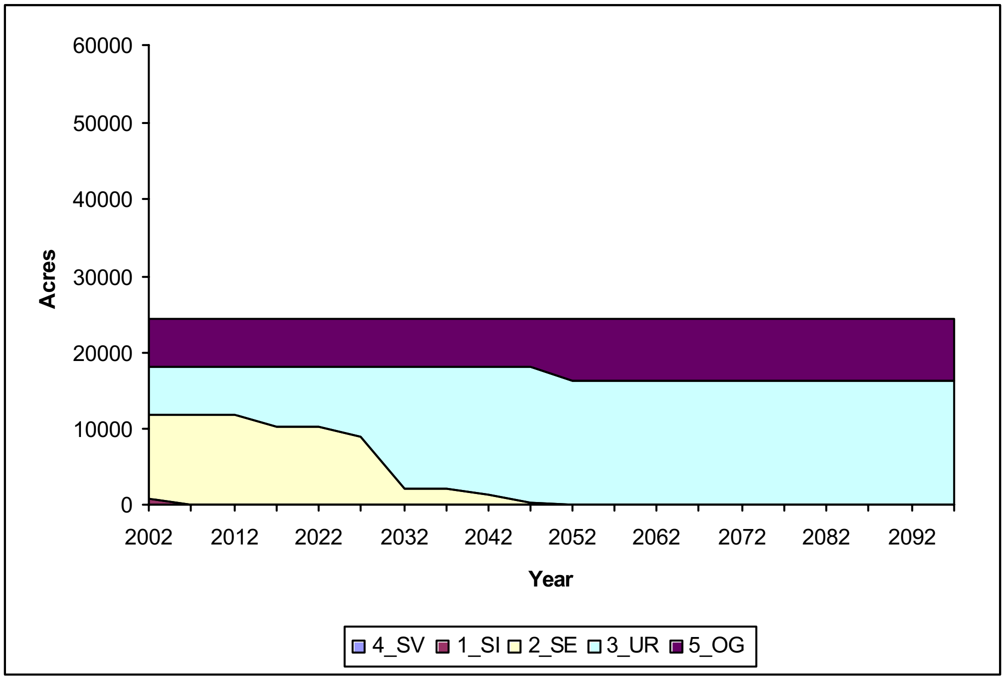


Figure 18. Number of acres in each stand structure for BLM No Action alternative over time.

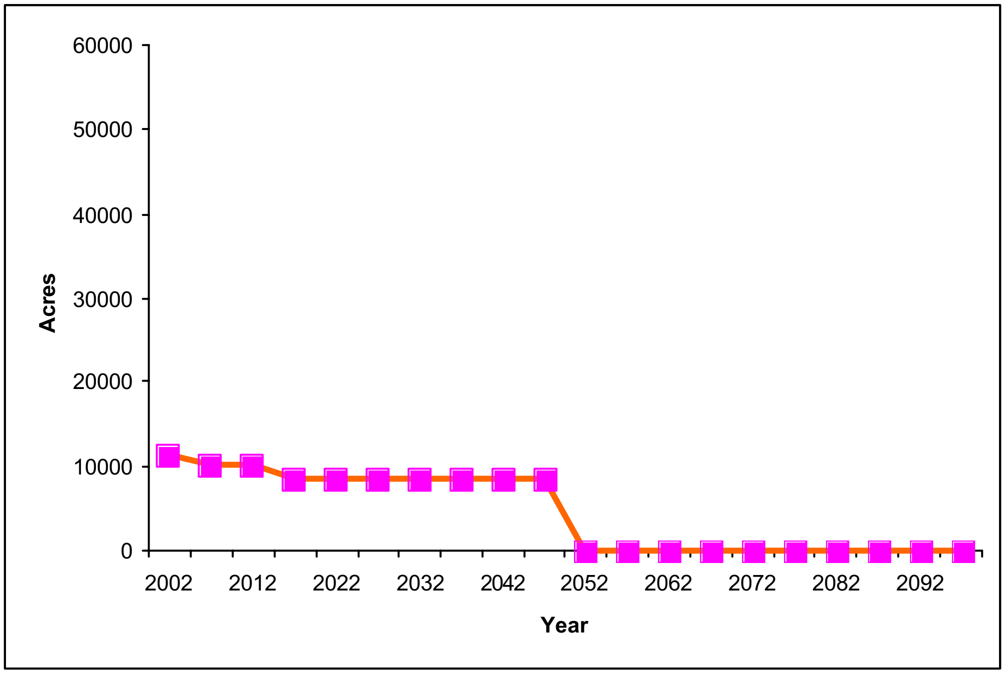


Figure 19. Number of acres within the target density range (Curtis' Relative Density 25-45) for BLM No Action alternative through time.

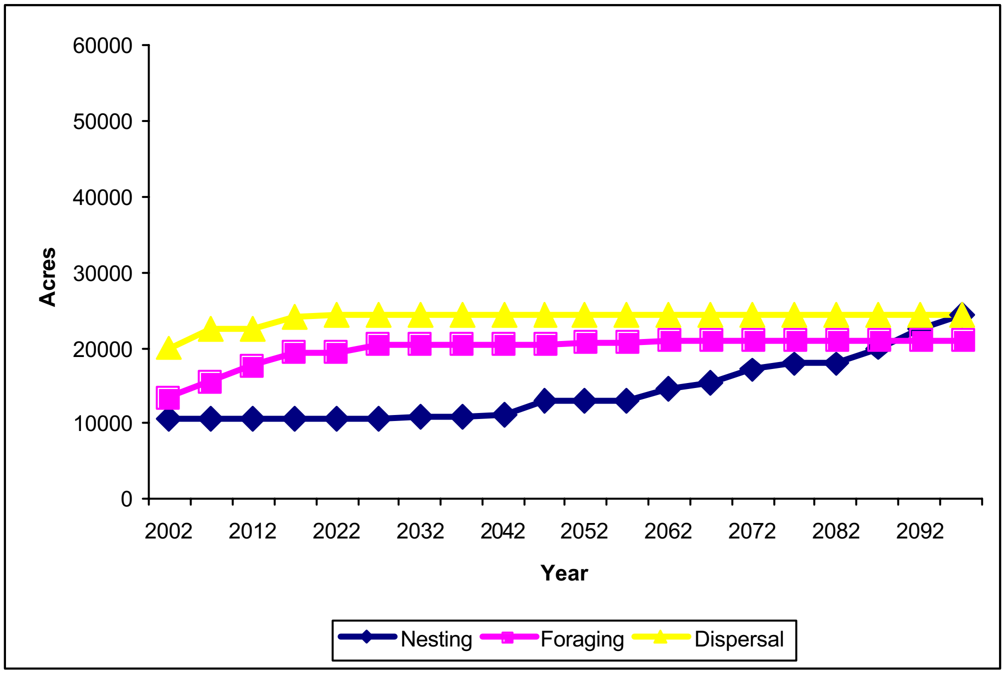


Figure 20. Number of acres in spotted owl habitat for BLM No Action alternative through time.

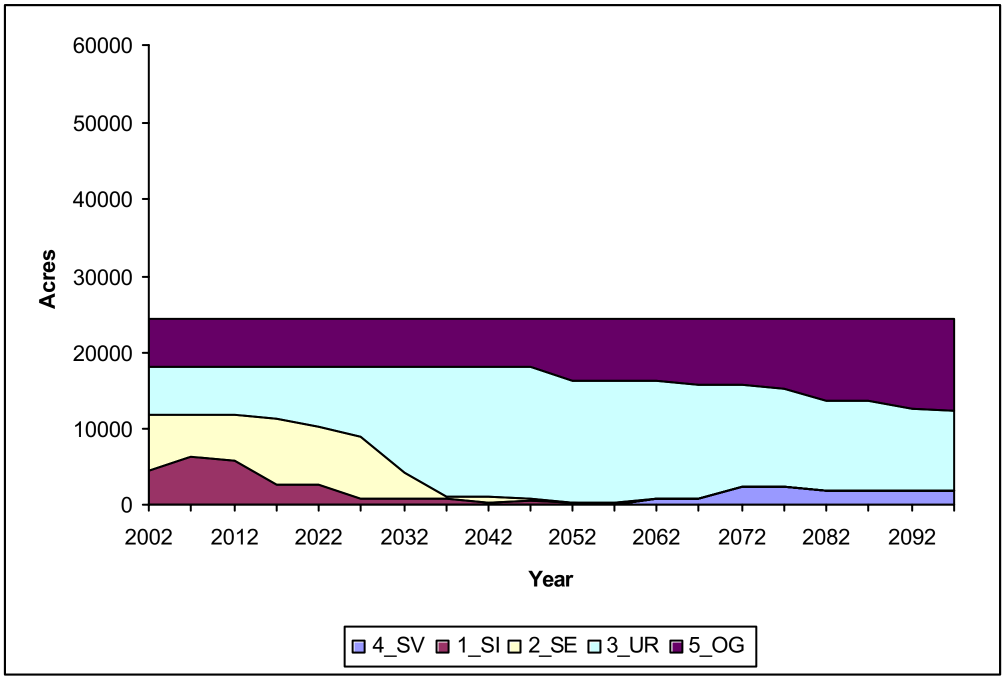


Figure 21. Number of acres in each stand structure for BLM Alternative E over time.

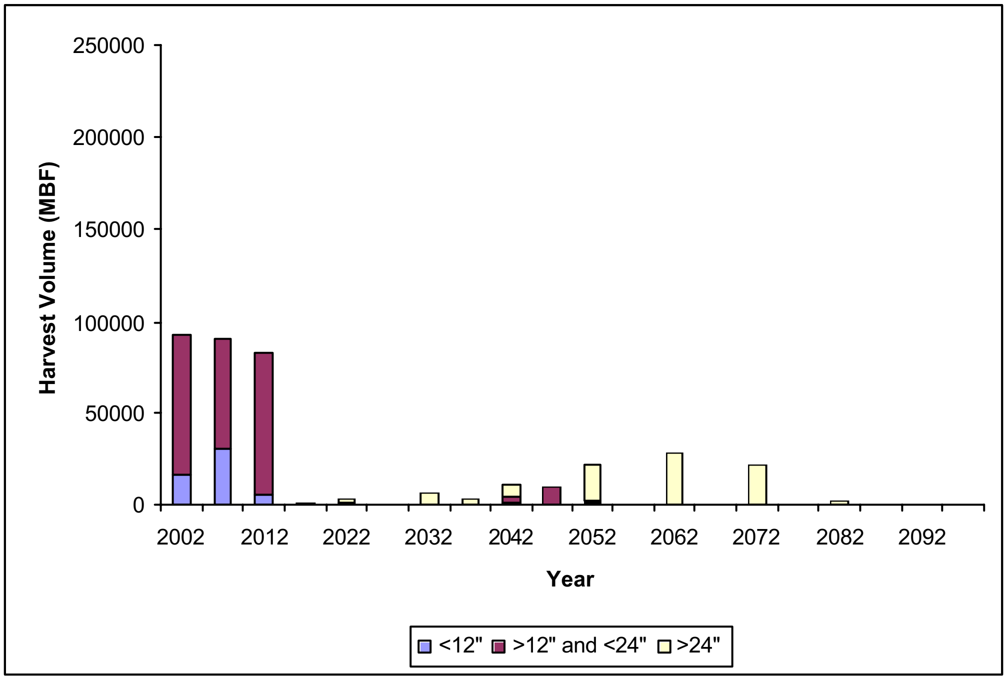


Figure 22. Harvest Volume in three size classes for BLM Alternative E through time.

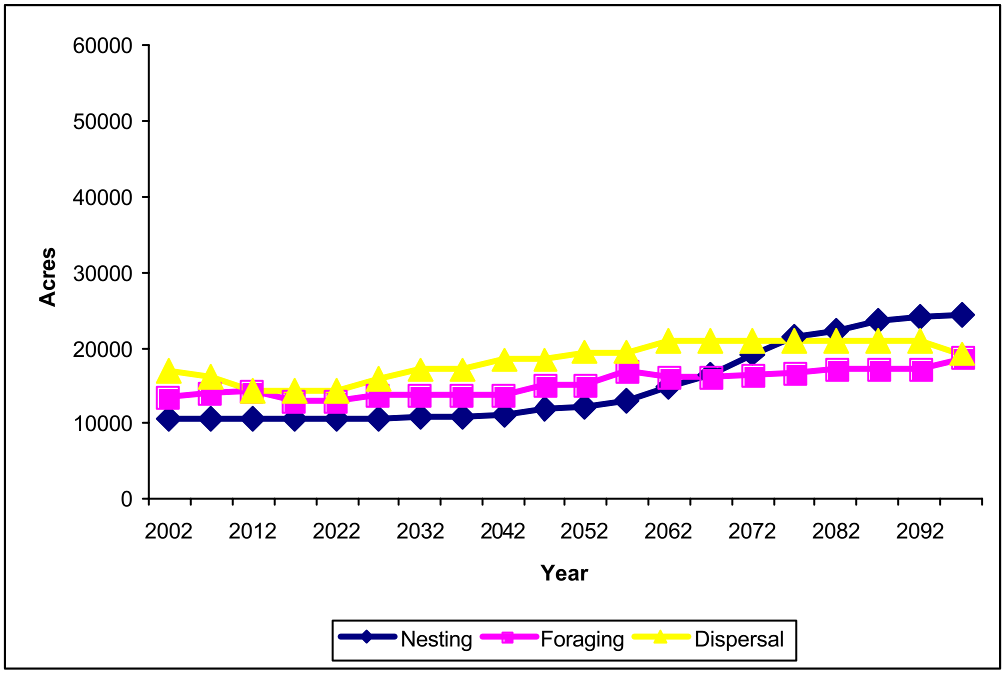


Figure 23. Number of acres in spotted owl habitat for BLM Alternative E through time.

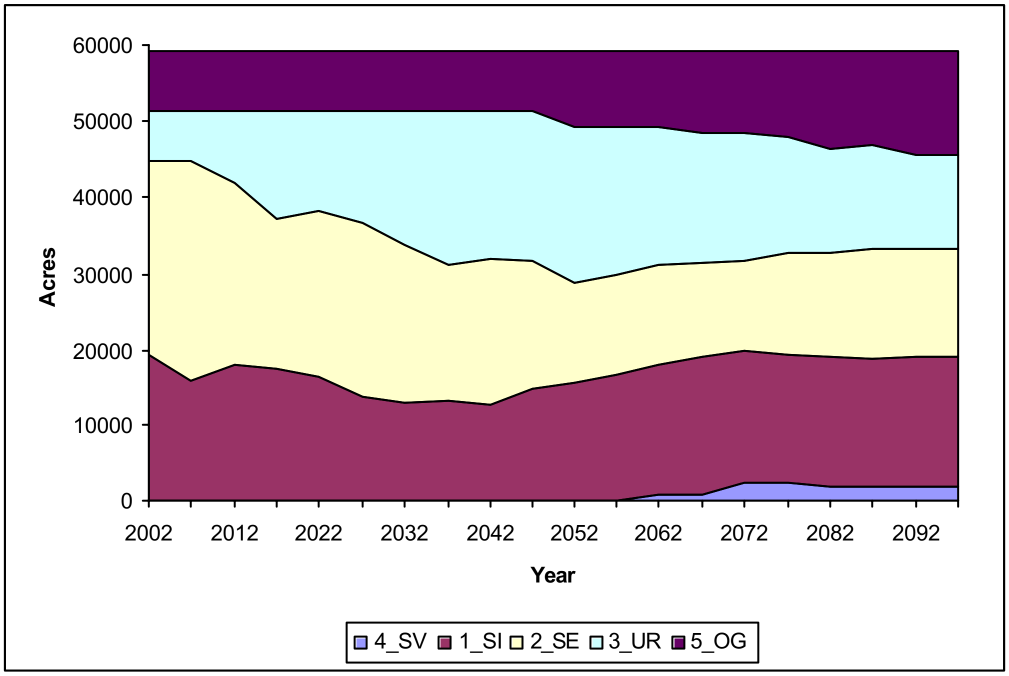


Figure 24. Number of acres in each stand structure for Landscape Alternative 2 over time.

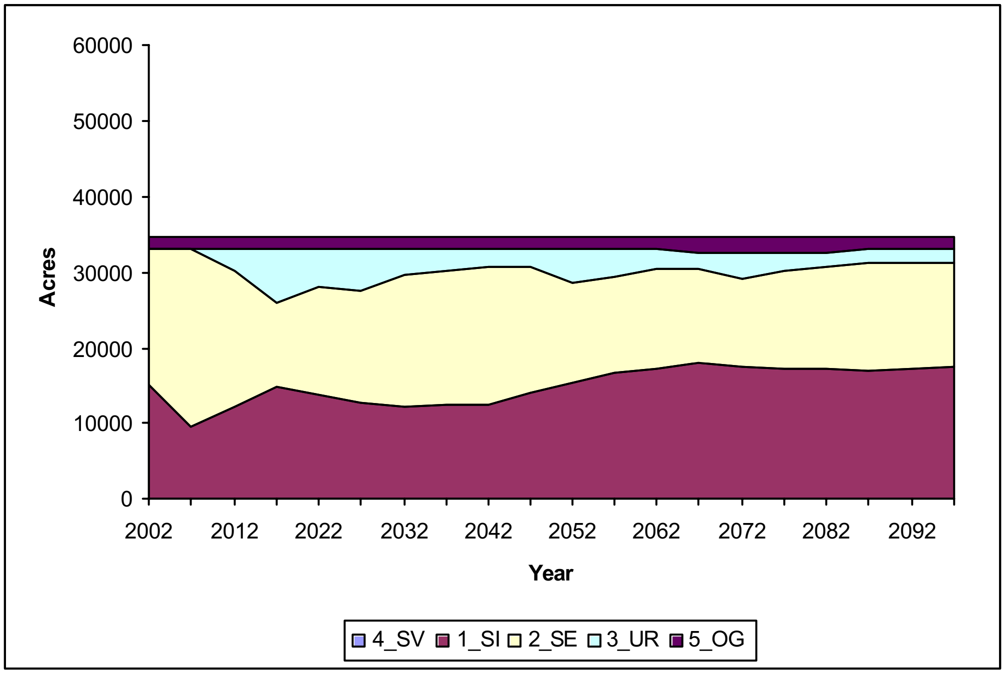


Figure 25. Number of acres in each stand structure for Private Alternative 2 over time.

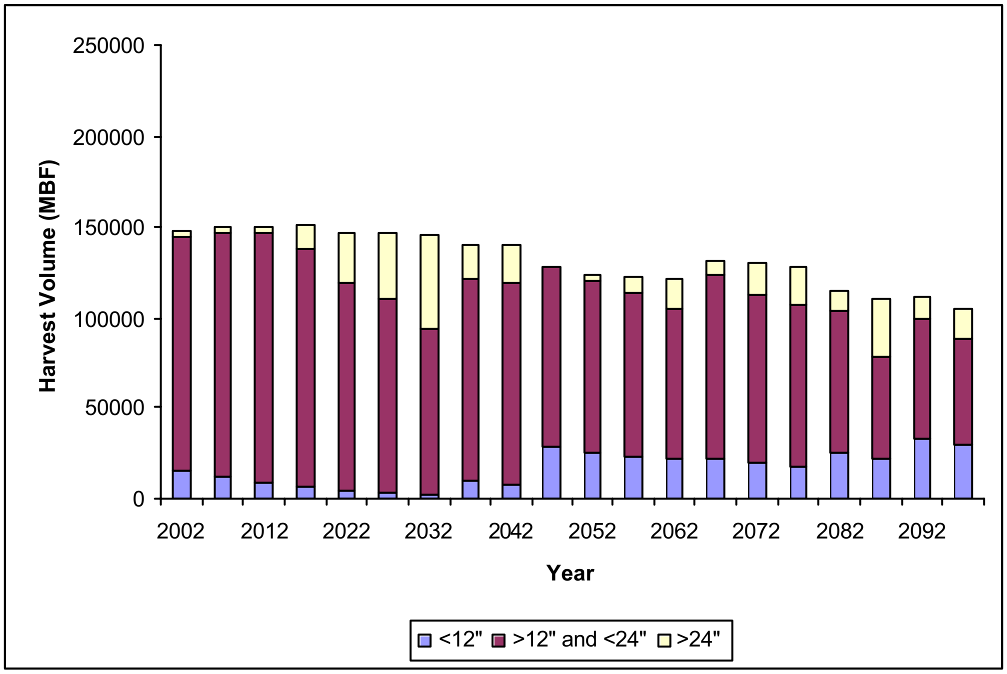


Figure 26. Harvest Volume in three size classes for Private Alternative 2 through time.

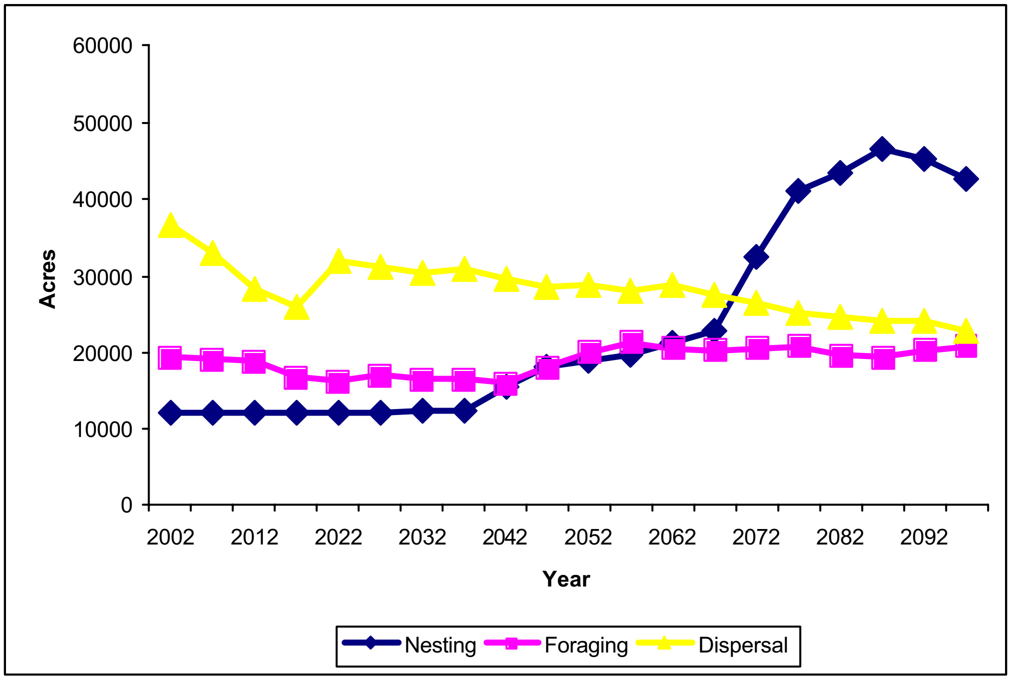


Figure 27. Number of acres in spotted owl habitat for Landscape Alternative 2 through time.

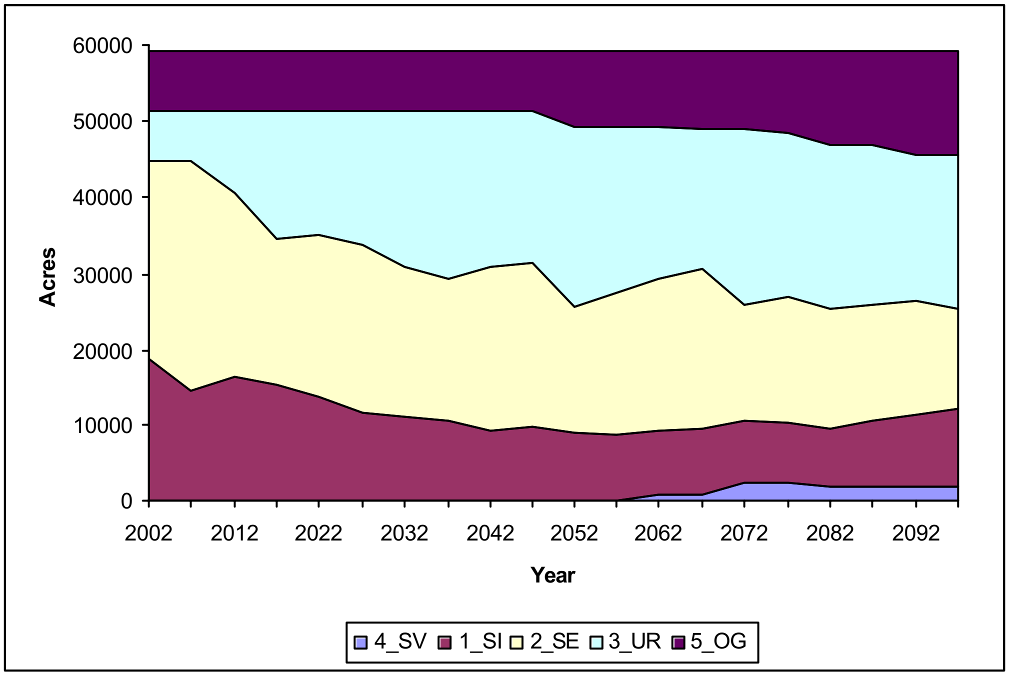


Figure 28. Number of acres in each stand structure for Landscape Alternative 3 over time.

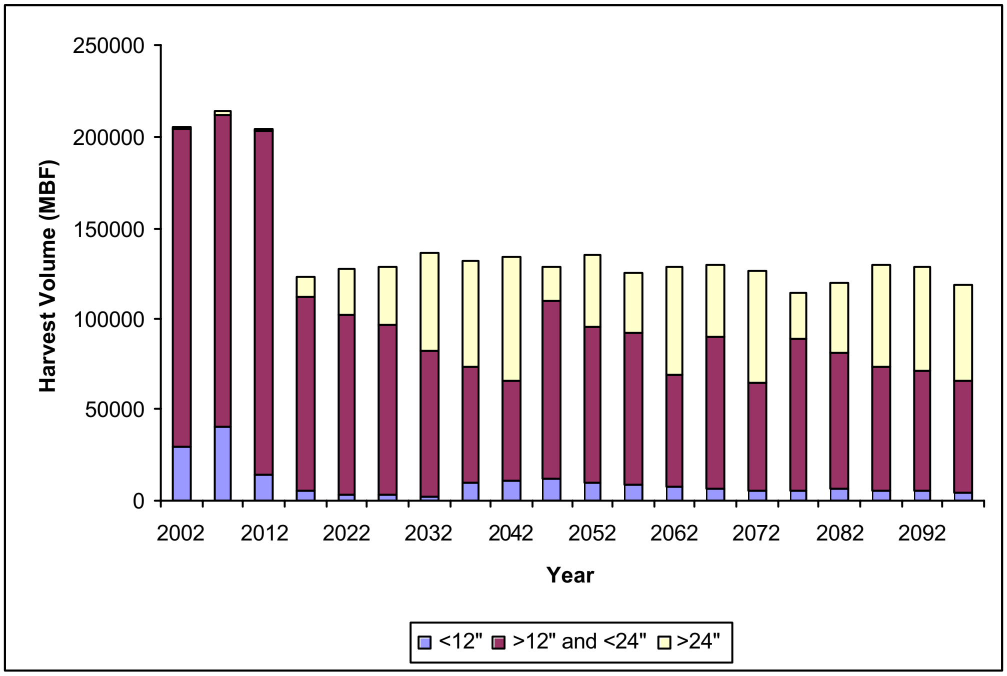


Figure 29. Harvest Volume in three size classes for Landscape Alternative 3 through time.

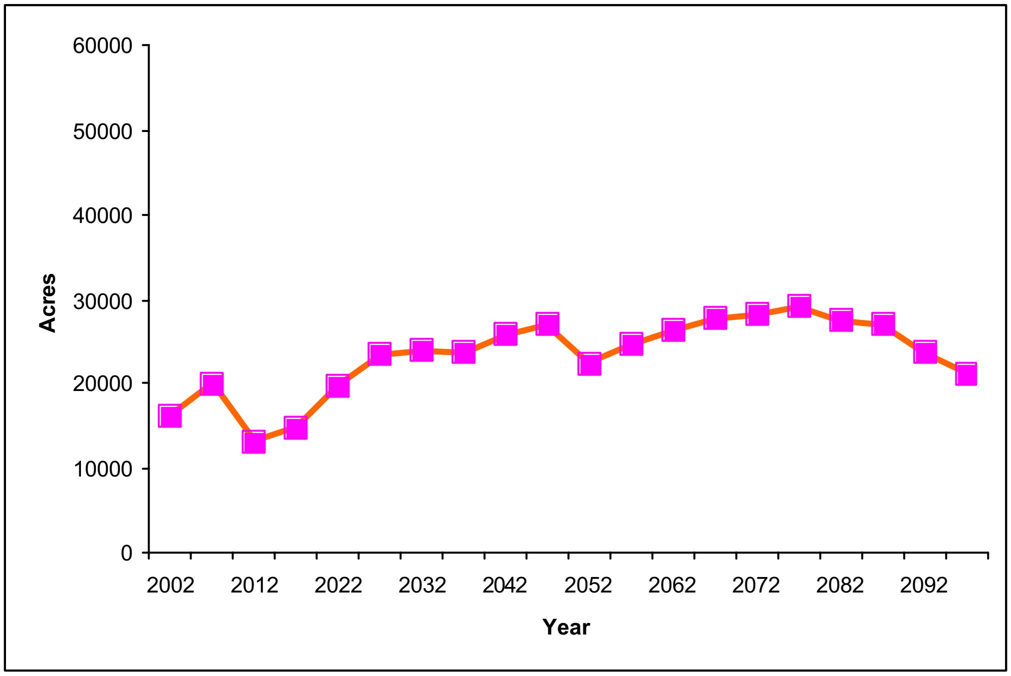


Figure 30. Number of acres within the target density range (Curtis' Relative Density 25-45) for Landscape Alternative 3 through time.

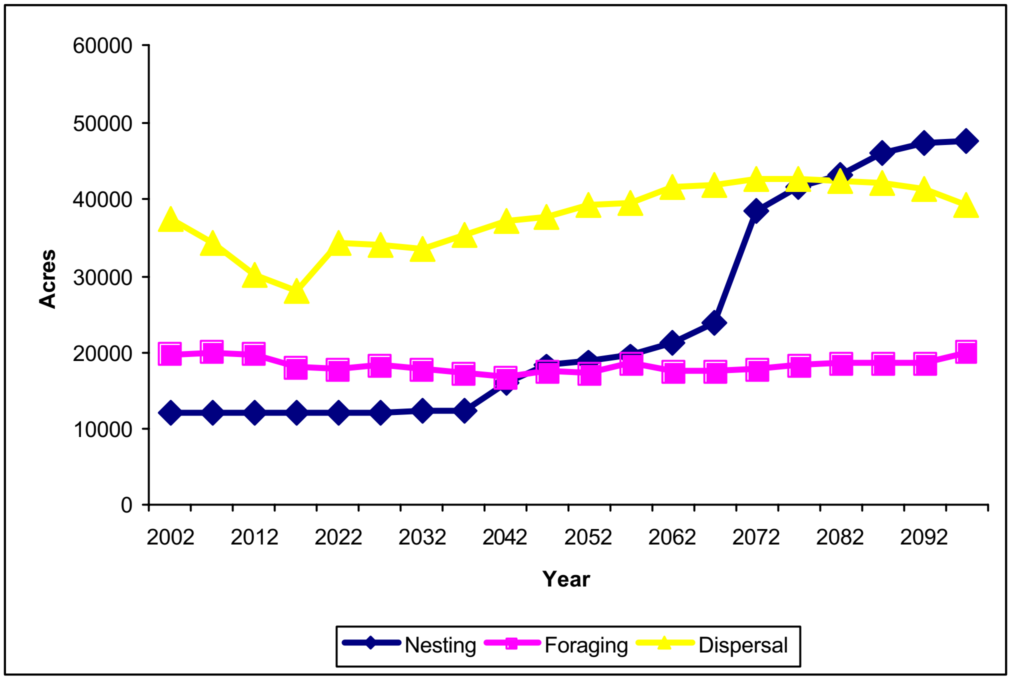


Figure 31. Number of acres in spotted owl habitat for Landscape Alternative 3 through time.

Discussion

Discussion of BLM and Landscape Alternatives

The results demonstrated that each objective could be analyzed at both the individual ownership and cumulative levels, and objectives were responsive as alternatives were adjusted. This analysis approach has several advantages. First, Landscape Alternatives 2 and 3 demonstrated that estimated outputs from the aggregate landscape were very different from each ownership individually. The landscape provided a fairly even mix of four stand structures (open, dense, understory reinitiation, and complex), while each individual ownership was predominantly in only two structures. This information would be very important to manage for broader spatial functions and processes, especially in an area with a "checkerboard" ownership pattern like the study site. Simultaneously, however, each ownership manages for extremely different primary objectives (restoration vs. commodity production), so that individual ownership analysis was critical.

A second advantage of the multiple-level analysis was that it allowed the BLM to include private data of a much coarser resolution into the analysis without affecting the quality of its own data. Although the stand type data was extremely coarse, including the private land in the analysis was important for the reasons stated above. At the same time, because the BLM land was analyzed individually as well, the appropriate degree of confidence for each set of results can be identified.

Specific results illustrated what analyses were possible with the Toggle program. For example, Landscape Alternatives 2 and 3 demonstrated the change in outputs as rotation lengths on the private land were increased from 45 to 85 years. For this landscape, the average amount of open structure decreased by 33%, while the average amount of dense structure increased by 12%, and understory reinitiation structure increased by 22%. This change may be an issue for species dependant on open structure, such as elk or butterflies. The longer rotations also decreased the average amount of harvest volume by 7%, but increased the percentage of harvest volume from larger log sizes. This change could affect mill specifications, potential products, and marketability of logs.

Finally, increasing the rotation length increased the amount of spotted owl dispersal habitat on private lands. It has been identified that a potential role of private land owners is to assist public land management agencies in protecting late successional forest ecosystems where possible, including providing dispersal habitats (Plum Creek, 1996). The analysis with Toggle identified the possible improvement in dispersal habitat on the landscape as well as the cost in harvest volume of longer rotations. This information could then be used to by the company to determine if the benefits are sufficient and the costs are manageable appropriate for this landscape.

Certain results from this analysis also emphasized the necessity to consider the results critically. For example, inconsistencies were apparent when comparing certain objectives between the BLM only alternatives. Based on model outputs, Alternative E was successful in accelerating the development of complex structure on BLM land.

Compared to no action, Alternative E resulted in more average complex structure and more complex structure at the end of the simulation period. The target density objective also supported this result. Very dense stands would typically not be expected to develop or contain complex forest structure. Under no action, the large majority of acres on the landscape were denser than the target range. Alternative E significantly improved this score.

A complementary objective to complex structure was providing spotted owl habitat; however, based on the growth model and measurable criteria, the spotted owl habitat objectives were achieved more successfully under the no action alternative. Because spotted owl habitat generally is associated with complex structures, a discrepancy appeared to exist in the model outputs. Forsman (1980) identified that old growth forest was the preferred habitat for nesting and foraging, likely because of the abundance of large trees with cavities or platforms (nesting); and the availability of desired prey, necessary variability in canopy and ground cover to detect the prey, and protective cover (foraging). Alternative E provided more complex structure then the no action alternative, but less spotted owl nesting, foraging, and dispersal habitat. The lower target density normalized value score for no action also indicated it would not be expected to provide more spotted owl habitat. Possibly, the fairly simplistic measurable criteria for nesting and dispersal habitat failed to define the necessary habitat characteristics sufficiently.

Another potential error was the classification of some acres as savanna structure. The BLM thinnings were designed to develop complex stand structures, including multiple canopy layers. During implementation, leave trees would be spatially arranged to allow understory trees to grow (DeMoss, March 28, 2002). Because the spatial arrangement of leave trees could not be modeled by FVS, the growth model would not grow the understory trees based on a uniform overstory spatial pattern. Wampler (1993) has shown that the number of leave trees in this prescription (40) would very severely suppress the understory. The resultant stands, therefore, were correctly modeled with several large trees and an open understory. This resulted in a savanna structure where the BLM silviculturalist expected complex structure. Monitoring and evaluation would be necessary to determine whether error lies with the growth model or the assumptions of the field foresters.

The errors associated with the measurable criteria and the growth model should be understood and incorporated into the decision-making process. Results are most meaningful when compared between alternatives rather than used as absolute outputs. Comparison partially negates the error since each alternative is similarly biased. A sensitivity analysis may be useful, such as adjusting threshold values slightly and restoring a previously modeled alternative to determine if outputs change significantly. Also, the planning process, including the growth models and measurable criteria, should be conducted in an adaptive management context. Periodically, growth models should be calibrated and measurable criteria improved as more local data is collected and applicable scientific knowledge is available.

Finally, the results indicated potential legal and political questions for both the publicly and privately owned land. Under Landscape Alternatives 2 and 3, the two ownerships approximated landscape management for all stand structures well. However, BLM harvest activities may be limited on "checkerboard" landscapes because of cumulative effects. Because a large amount of the private land was in open and dense structures at all times, the BLM may be forced to provide older forest habitats or simply not create additional open structure due to cumulative effects. In Late Successional Reserves, this is exactly the role the federal lands have been given. On nearby Matrix land, the federal agencies legally can conduct a wider range of silvicultural operations. However, this may not be possible if these lands are forced to mitigate for surrounding private harvest activities. Conversely, the private lands in theses cases would seem to have an unfair advantage if cumulative effects become less of a concern. These are important issues but beyond the scope of this paper.

Additional Planning and Analysis for the BLM

Developing Additional Alternatives

Analysts or decision-makers for the BLM may be interested in developing additional alternatives. These can be developed from scratch, or by making slight modifications to current alternatives. For example, decision-makers may favor some aspects of an alternative, but would like to examine the effects of more or less outputs for certain objectives.

To demonstrate the flexibility of modeling in Toggle, individual pathways will be adjusted in Landscape Alternative 2. This example is for demonstrative purposes only.

If the BLM were interested in seeing how much additional complex structure the private lands could provide, percentages could be adjusted on the private lands alternative. By reducing group 2, pathway 2 (45-year harvest rotation) from 15% to 0%, and increasing pathway 1 (no action) by the same amount, increased complex structure occurs on the landscape after 2067. This is best illustrated in the stand structure graph for the private lands only (Figure 32), although the change occurs for the landscape as well. Harvest volume also decreases during 2002, 2047, and 2092 (Figure 33). Similarly, by reducing group 2, pathway 3 from 13% to 0%, and increasing pathway 1 by the same amount, even more complex structure occurs after 2067 (Figure 34). Harvest volume decreases during 2007, 2052, and 2097 (Figure 35).

Other pathways in other groups can be adjusted in similar ways to complete the new alternative. The harvest volume graphs illustrate that trade-offs for other objectives may be unacceptable, requiring additional analysis. Also, completely new pathways could be added, increasing the flexibility of the analysis for the user.

Performing a Spatial Analysis

Development of a set of alternatives with the Toggle and even selection of a chosen alternative does not necessarily complete the analysis process for the BLM. Because the Toggle analysis is based on representative stands for ecologically similar, non-contiguous groups, most spatial considerations are ignored during the development of alternatives within Toggle. If significant spatial objectives or constraints exist, there is no guarantee that a chosen alternative can be implemented to satisfy the spatial criteria. Planning for multiple ownerships could further complicate this issue.

To perform a spatial analysis, each stand on the landscape must be associated with the most appropriate silvicultural pathway from Toggle. This can be accomplished through discussions with a field forester with on-the-ground knowledge, coordinated queries for selected attributes between GIS and LMS to rank and assign stands, or use of more sophisticated harvest scheduling models such as SNAP. Within a single ownership and between ownerships, types of spatial analyses include maximum harvest unit size, green-up requirements, and landscape fragmentation for selected wildlife or other values. Increased wind risk to stands surrounding recent harvests could influence the location of harvest operations both within and between ownerships. Road easements between owners, especially federal agencies, could also influence the location of harvest units for collaborating ownerships (Sample, 1995). Because the BLM cannot know the location of harvest units on the private land, spatial analysis may be limited to their own land.

Spatial analysis is probably a critical component in the final selection of a chosen alternative. If a solution cannot be identified that meets all spatial requirements, adjustments may need to be made to the alternative in Toggle. The iterative process of developing a chosen alternative must therefore include the allocation of stands to pathways, not end with the selection of an alternative within Toggle. The final chosen alternative should have the most desirable set of trade-offs between objectives, both spatial and non-spatial. Like any objective, achieving all spatial objectives throughout the planning period may be impossible, or possible only with unacceptable trade-offs for other objectives. Performing spatial analysis and incorporating it into the planning process with Toggle is an important issue, but beyond the scope of this paper.

Increasing and Adjusting the Planning Area

The results for the BLM illustrate that outputs for many objectives can be modeled for multiple ownerships and the total landscape simultaneously, and dynamically for changing management scenarios. However, because the planning area encompasses parts of two watersheds, the landscape chosen may not be an ecologically significant unit. The watershed has been suggested as an important building block in ecosystem management by the FEMAT (1993), and the State of Washington Forest Practice Rules (Sessions et al., 1997). Depending on the ultimate objectives of the BLM, a logical future step would be to redesign the study area to analyze the total outputs provided by each watershed as well each individual ownership. The multiple-Toggle modeling approach is flexible enough to allow additional areas of land to be added easily to the analysis.

Implementation, Monitoring, and Adjustment

Planning and analysis with the Landscape Management System and Toggle decision support tool should be done in an adaptive management context. After selection of an alternative, the BLM will need to implement the alternative on the ground. Throughout implementation, monitoring should be done to determine how well the real outputs match the expected results. Periodically, the management plan should be revisited to adjust growth models, objectives and measurable criteria, and to respond to disturbances or other factors that might influence the original management alternative, including changes in laws, societal values, and the management of surrounding ownerships.

Other Applications for the Model

Including Additional Spatial Information in an Analysis

As was discussed, performing a spatial analysis on a chosen alternative may be critical because of the lack of spatial resolution in Toggle. However, analyzing an area using two or more Toggle programs can increase the amount of spatial information contained within the model. Specifically, outputs can be isolated to an individual Toggle program which represents a particular subset of the total analysis area. This approach is similar to the mixed strata-based, area-based approach in FORPLAN, which allowed outputs and constraints to be controlled by spatial zones within the total analysis area. FORPLAN developer K. Norman Johnson (1986) identified:

> When we use decision variables based on the strata defined for an area, we lose the ability, by and large, to track the location of proposed actions within the area… These losses in spatial detail can be reduced by giving the strata more geographic definition…thus narrowing the location of the harvest in a period at least down to the zone.

In the BLM-private ownership example, the clearcut treatments can be isolated to the private lands. For some analyses, this type of information may be useful. Besides treatments, unique outputs or representative stands can be modeled for a particular zone of land as well. Any geographic areas which need to be planned or analyzed in coordination with another but require unique representative stands, silvicultural pathways, or objectives can be modeled effectively within the hierarchy of the multiple-Toggle model.

The multiple ownership example involving the BLM and private industry is only one use of the multiple-Toggle model. Upland and riparian zones within a single ownership is another common example where the multiple-Toggle model may be useful. Riparian zones commonly require unique representative stands, silvicultural pathways, and objectives compared to the upland zone. However, both zones can also provide many of the same objectives for an ownership as well, such as habitat, harvest volume, and wind and fire safe acres. Therefore, tracking objectives at both the single-zone and whole-ownership level is useful. Even more complex models could be designed using many Toggle programs in a nested hierarchy, with results for each objective tracked at several levels. This would further isolate treatments or outputs to a particular zone, increasing spatial resolution, while simultaneously allowing broad spatial scales to be analyzed. Usefulness of this approach would ultimately be limited by model size and complexity.

Examples of situations with a spatial element that can be modeled using a multiple-Toggle approach include:

1) Multiple ownerships within a watershed or landscape,
2) Sub-watersheds within a larger watershed,
3) Landscapes within a National Forest,
4) Riparian zones and upland zones within an ownership,
5) Late successional reserves and matrix land within a National Forest,
6) Land within and outside a viewshed.

Multiple Ownership Collaboration

An extension of the BLM example would be to allow individual owners to control a Toggle program representing their land in a collaborative planning and analysis effort. As an example, each user could have control of a Toggle program on a computer, reporting the results of each objective for his/her land. On a separate computer monitor viewed by all users, the cumulative results of all land in the planning area for each objective could be reported. Users could then evaluate what outputs are being provided, how capable they are of providing additional desired outputs, and the cost to them in terms of all other objectives. Users could respond in real time as other users adjust their management alternatives. Similar collaboration may also be possible on the World Wide Web. A webpage could be created to which users submit modified alternatives. The webpage could then report the cumulative results for all participants.

A potential advantage of this approach would be increased communication between managers of participating ownerships. First, through development of objectives and measurable criteria, each owner would understand what the considerations are for collaboration; and how success will be measured for each objective. The growth model and measurable criteria would ensure a common set of assumptions are used among owners. Second, during the collaborative process to develop a joint management plan, each owner would immediately understand impacts for each objective at both the individual and multiple ownership levels. Study of this application of the Toggle decision support tool would likely require examination of topics such as co-management, policies, assurance that the models have not been modified, conflict resolution, game theory, and others. These issues are beyond the scope of this paper.

Preliminary Evaluation of the Multiple-Toggle Decision Support Tool

The Toggle decision support tool was designed to facilitate completion of certain steps of the rational-iterative decision making process. These steps include developing management alternatives and analyzing and comparing alternatives. The multiple-Toggle model additionally was designed to communicate within and across hierarchical levels, such as within an organization or between ownerships. Within this context, through development of the BLM example, and with consideration of other decision support tools used in forest management, the strengths and weaknesses of Toggle can be evaluated.

Strengths

Strengths of Toggle are that it is relatively easy to use and understand the outputs; objectives are free of subjective preferences while alternatives are developed; it facilitates comparison between alternatives; and it facilitates communication between ownerships or other hierarchical levels. Once Toggle is loaded with input data and adjusted for measurable criteria, threshold values, and maximum values, developing alternatives becomes fairly simple. These advantages are in contrast to a tool such as FORPLAN, the complexity of which made generating alternatives difficult (O'Toole, 1983). Because Toggle is relatively simple to use, many individuals, such as stakeholders, can develop management alternatives. In the rational-iterative decision making process, developing alternatives has been identified by many as a creative step that should include as many individuals as possible to avoid "groupthink" (Oliver and Twery, 1999).

Toggle also facilitates comparison of alternatives and selection of a chosen alternative in several ways. Simplicity in the model makes it easy for decision makers to understand outputs. Specifically, how outputs were generated can be easily explained by examining percentages in pathways, measurable criteria, and growth model projections. Additionally, determining tradeoffs between objectives is assisted by reporting outputs in three ways: 1) a matrix with normalized values; 2) a matrix with summary values; and 3) graphs. Finally, objectives are given equal importance in Toggle until the decision maker selects an alternative. This feature is important because frequently there is not agreement in the relative importance of objectives in ecosystem management (Oliver and Twery, 1999).

Although more research is required, Toggle also appeared to improve communication across hierarchical levels. First, the use of growth models and measurable criteria for objectives ensures a common set of assumptions between users. Second, reporting results at multiple levels simultaneously improves understanding of impacts important to individual levels as well as cumulative effects.

Weaknesses

Two major weaknesses were identified with the Toggle decision support tool. These are that Toggle cannot perform an optimization for a particular objective, and that alternatives lack spatial definition, ignoring a potentially critical component in ecosystem management. Models using optimization that have been developed and applied to forest management include FORPLAN (Johnson et al., 1986). Although the rational, non-iterative decision-making process is not considered appropriate for ecosystem management, an optimization option could be useful in developing alternatives that improve understanding of potential trade-offs (Oliver and Twery, 1999). Weights could be assigned to generate alternatives optimizing a particular objective with given constraints, then adjusted to perform different optimizations with different constraints. Each alternative then simply becomes part of the decision matrix reporting outputs for each objective without subjective weights.

The other major weakness of Toggle is the lack of spatial definition in alternatives. As has been discussed, if spatial objectives or constraints exist, there is no guarantee alternatives generated in Toggle can be implemented successfully to achieve the spatial considerations. Other tools, such as GIS-based harvest scheduling programs including SNAP, can conduct these spatial analyses and schedule according to spatial objectives or constraints. Closer integration between Toggle, LMS, GIS, and possibly SNAP may be a partial solution to this problem, as well as understanding that the iterative process of developing and analyzing alternatives must also include spatial analysis.

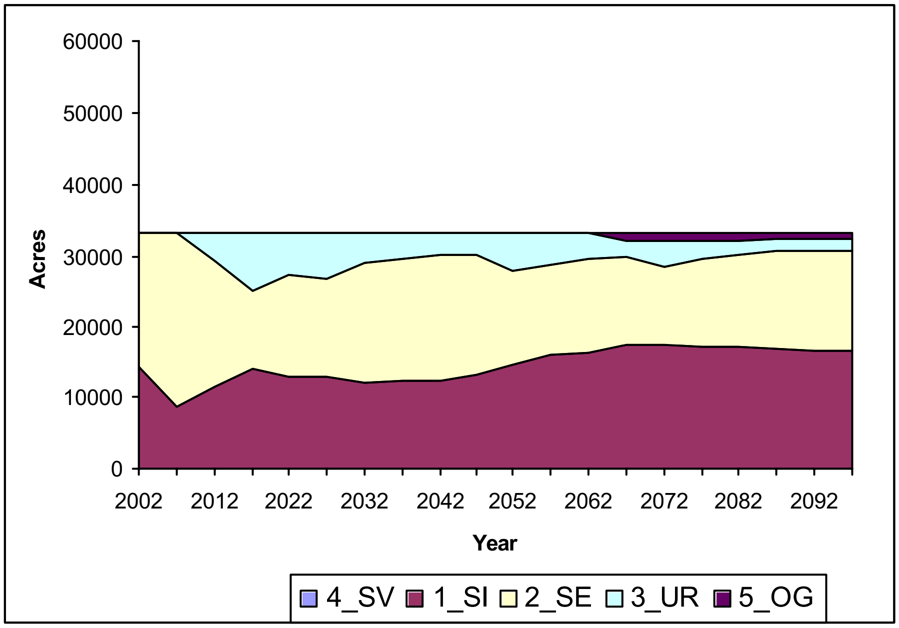


Figure 32. Stand structure graph for private lands after first change to Private Alternative 2. By adjusting private lands group 2 area percentages from pathway 2 (45-year harvest rotation) to pathway 1 (no action), complex structure increased after 2067. The original stand structure graph for Private Alternative 2 can be examined in Figure 25.

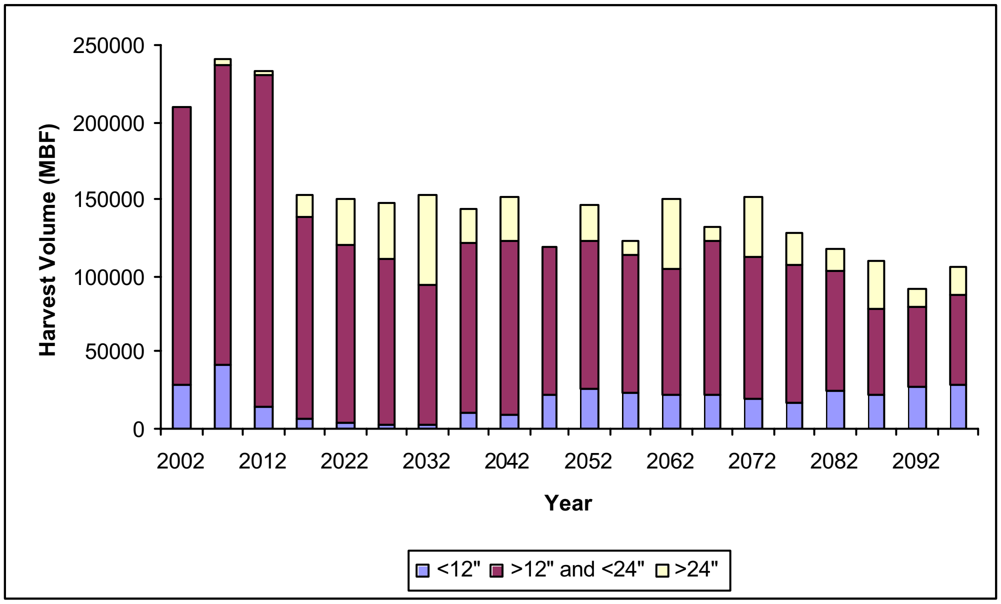


Figure 33. Harvest Volume by Size graph for the landscape after first change to Private Alternative 2. By adjusting private lands group 2 area percentages from pathway 2 (45-year harvest rotation) to pathway 1 (no action), harvest volume decreased during 2002, 2047, and 2092. The original Harvest Volume graph for Landscape Alternative 2 can be examined in Appendix A.

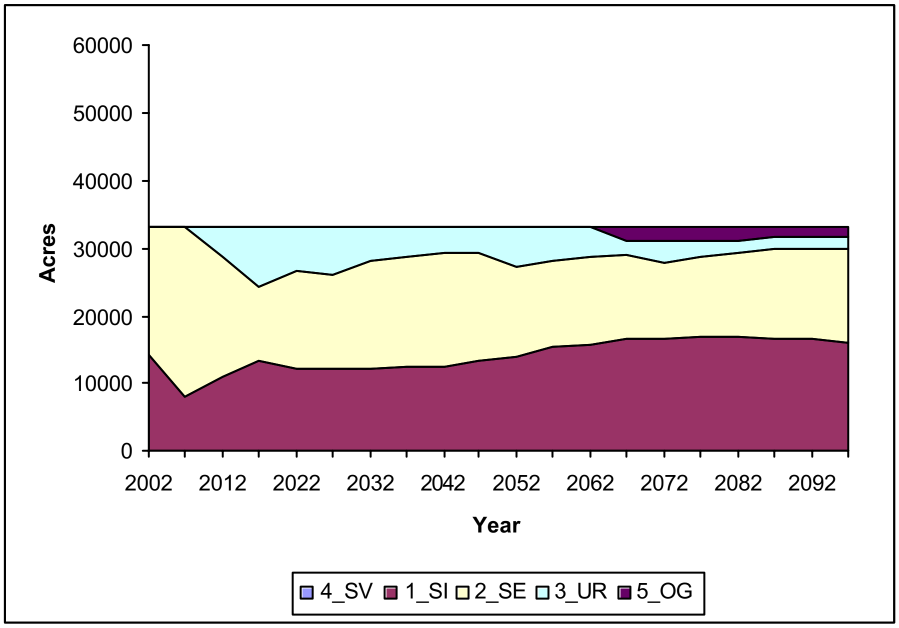


Figure 34. Stand structure graph for private lands after second change to Private Alternative 2. By adjusting private lands group 2 area percentages from pathway 2 (45-year harvest rotation) to pathway 1 (no action), complex structure increased after 2067. The original stand structure graph for Private Alternative 2 can be examined in Figure 25.

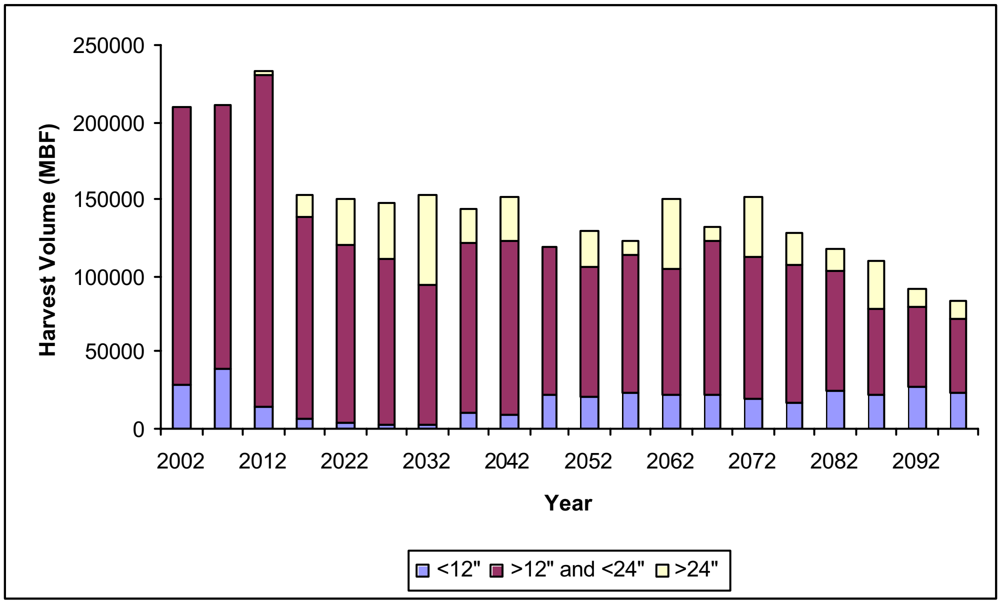


Figure 35. Harvest Volume by Size graph for the landscape after second change to Private Alternative 2. By adjusting private lands group 2 area percentages from pathway 2 (45-year harvest rotation) to pathway 1 (no action), harvest volume decreased during 2002, 2047, and 2092. The original Harvest Volume graph for Landscape Alternative 2 can be examined in Appendix A.

Conclusions

Ecosystem management on a single ownership is a complex task requiring an understanding of ecological functions at several scales. Many technical tools are emerging to assist land managers in the complicated temporal and spatial analyses now required. On public lands, decision-makers must select management alternatives that balance many desired objectives with unclear societal preferences. Decision support systems which integrate technical tools into the rational iterative decision-making process are emerging to resolve this difficulty. On both public and private lands, an understanding of guiding laws and their consequences, both intended and unintended, is critical for effective land management.

Ecosystem management across multiple ownerships complicates the task further. Applicable laws increase when there are interactions between both public and private owners. Uncertainty and risk can increase with dependence on neighboring owners. Simultaneously, management flexibility can decrease as ownerships become accountable to their neighbors; however, many objectives valued by society can best be achieved through collaboration, and some ecological functions and processes can only be considered at broad spatial scales.

This study examined the application of emerging technical tools to analyze cumulative effects to a multiple ownership landscape using a hierarchical modeling structure. Although collaboration between managers was not examined, the results indicated both estimated neighboring management scenarios and direct collaboration may be possible and useful. Other potential uses and necessary functionalities missing from Toggle have also been identified.

A more difficult task than expanding and developing the Toggle program will be identifying and remedying other deficient aspects of multiple ownership ecosystem management. More significant hurdles to both ecosystem management and comanagement include state and federal laws inconsistent with general natural resources policy; inconsistent societal values concerning natural resource management; extensive gaps in scientific knowledge; and inadequate technical skills for current land managers. Development and successful application of useful computer models can potentially influence changes in these areas at the intersection between policy and technology. Toggle, with GIS and LMS, may represent a prototype for one of these models.

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Appendix A: Figures not provided in the text for objectives for all BLM, Private, and Landscape Alternatives.

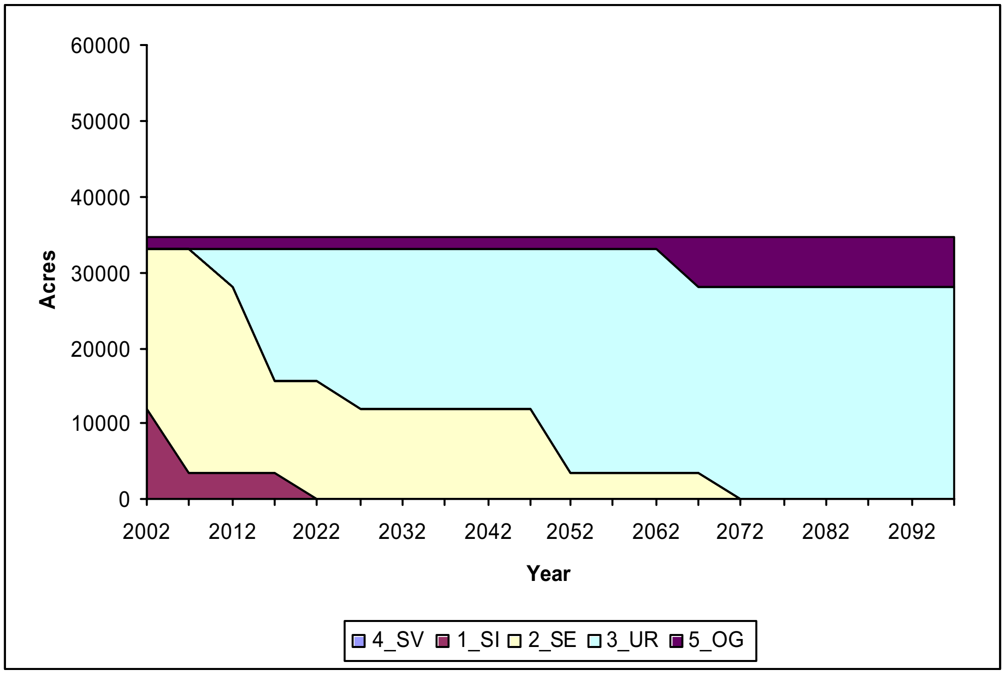

Figure A1. Number of acres in each stand structure for Private No Action alternative over time.

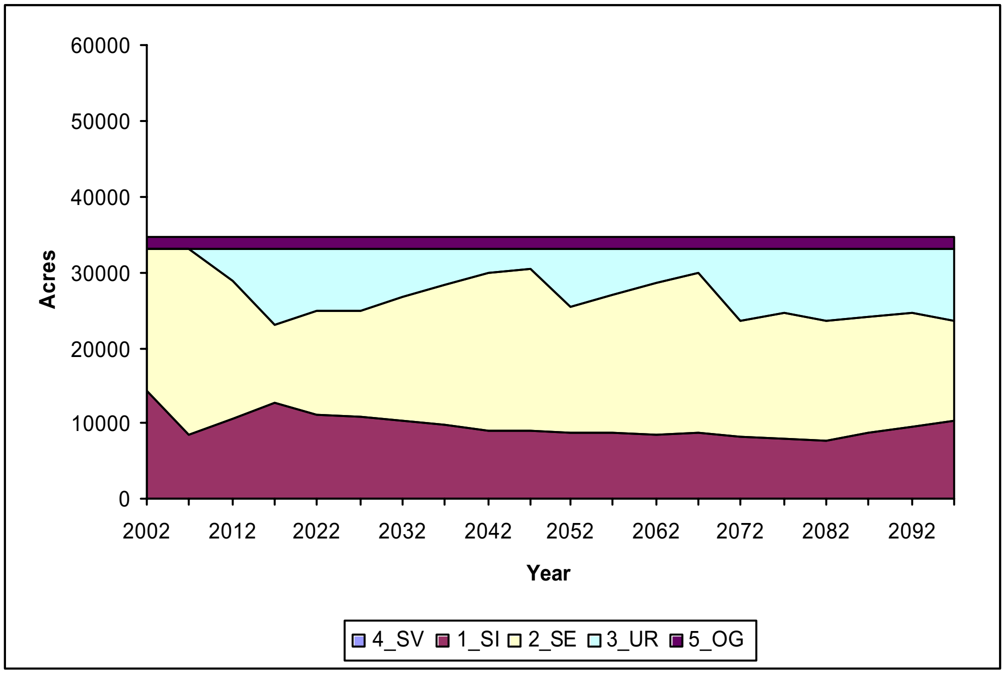

Figure A2. Number of acres in each stand structure for Private Alternative 3 over time.

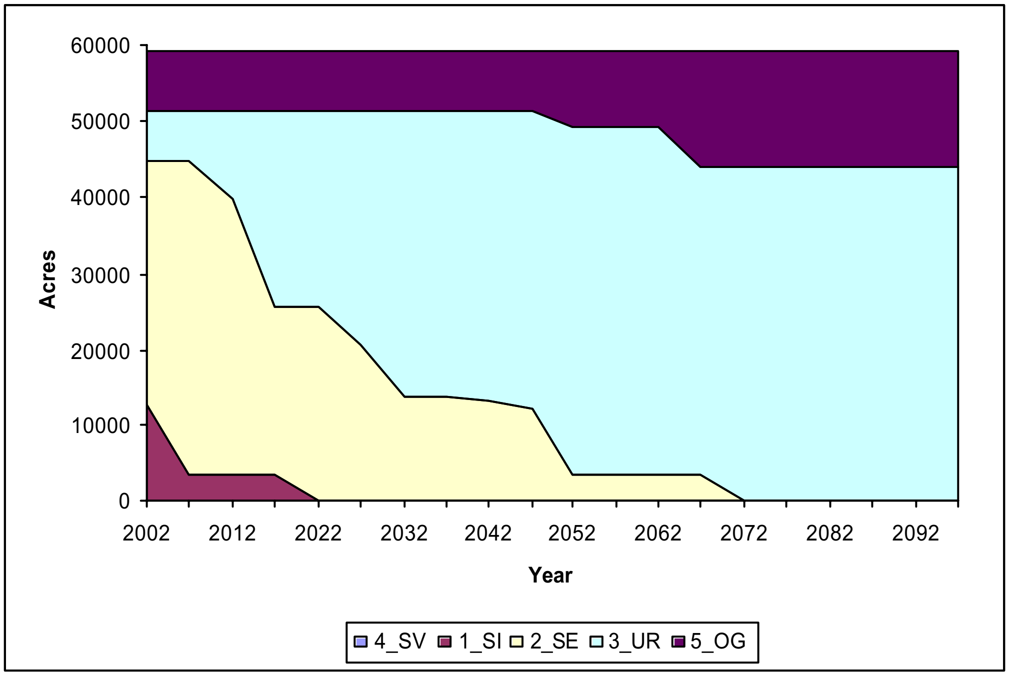

Figure A3. Number of acres in each stand structure for Landscape No Action alternative over time.

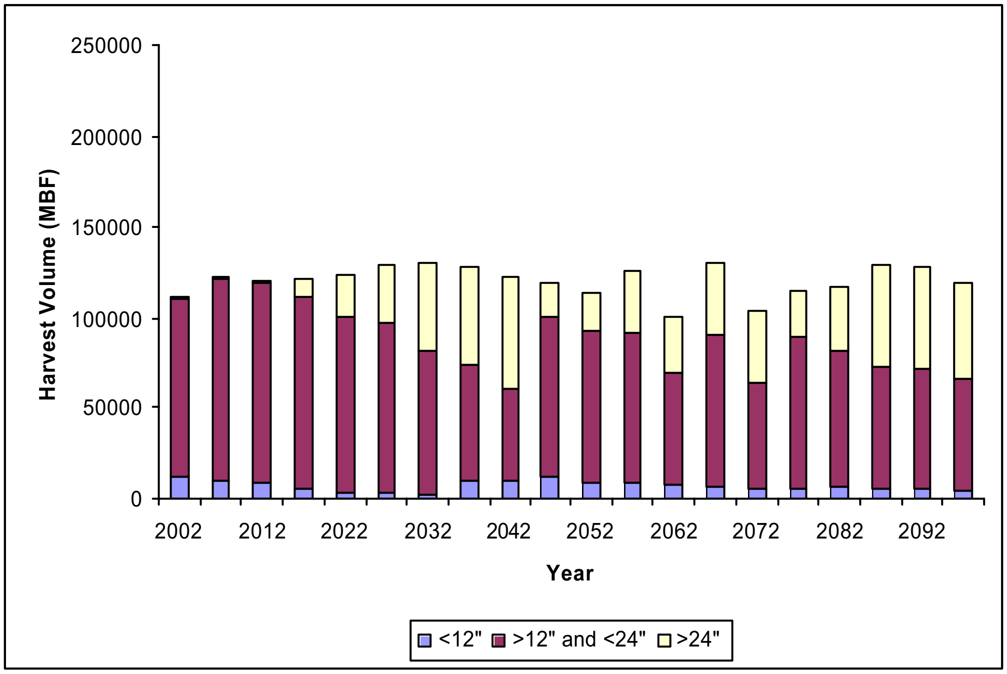

Figure A4. Harvest volume in three size classes for Private Alternative 3 through time.

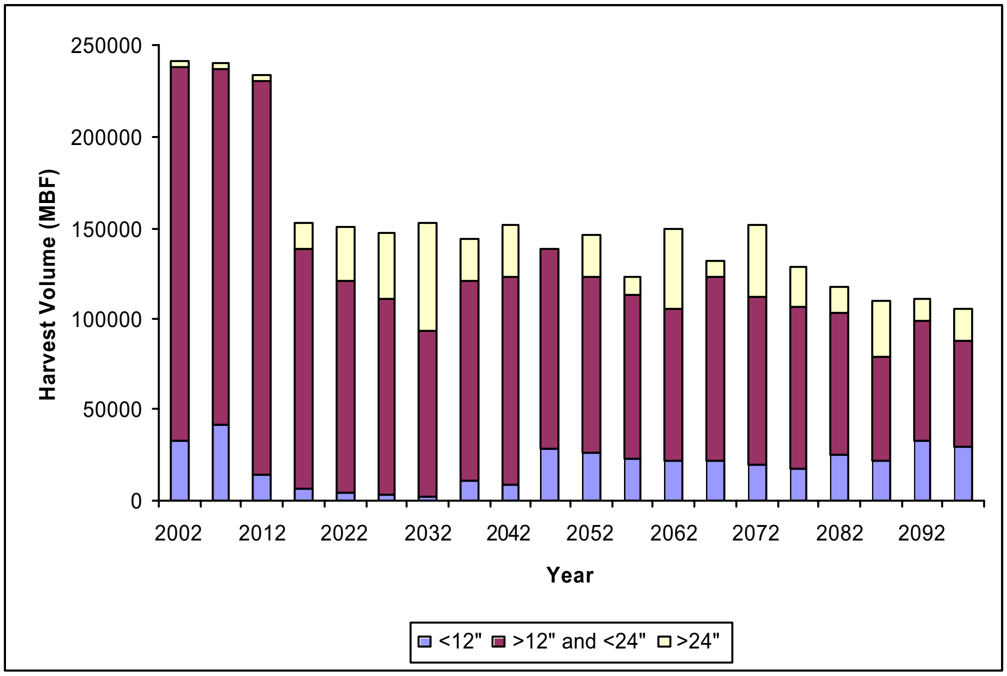

Figure A5. Harvest volume in three size classes for Landscape Alternative 2 through time.

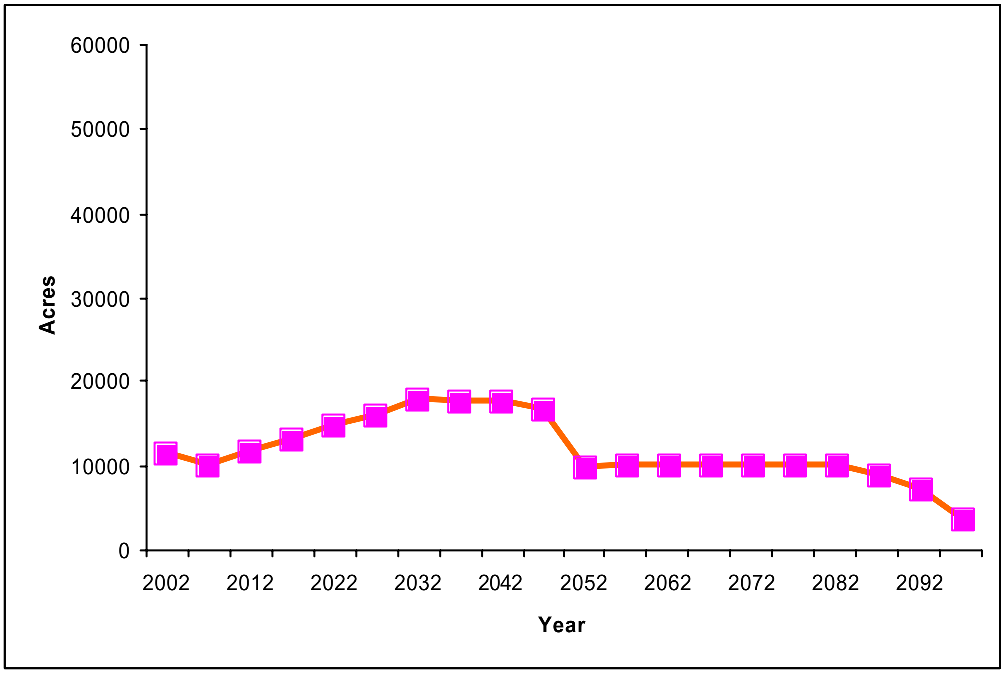

Figure A6. Number of acres within the target density range (Curtis' Relative Density 25-45) for BLM Alternative E through time.

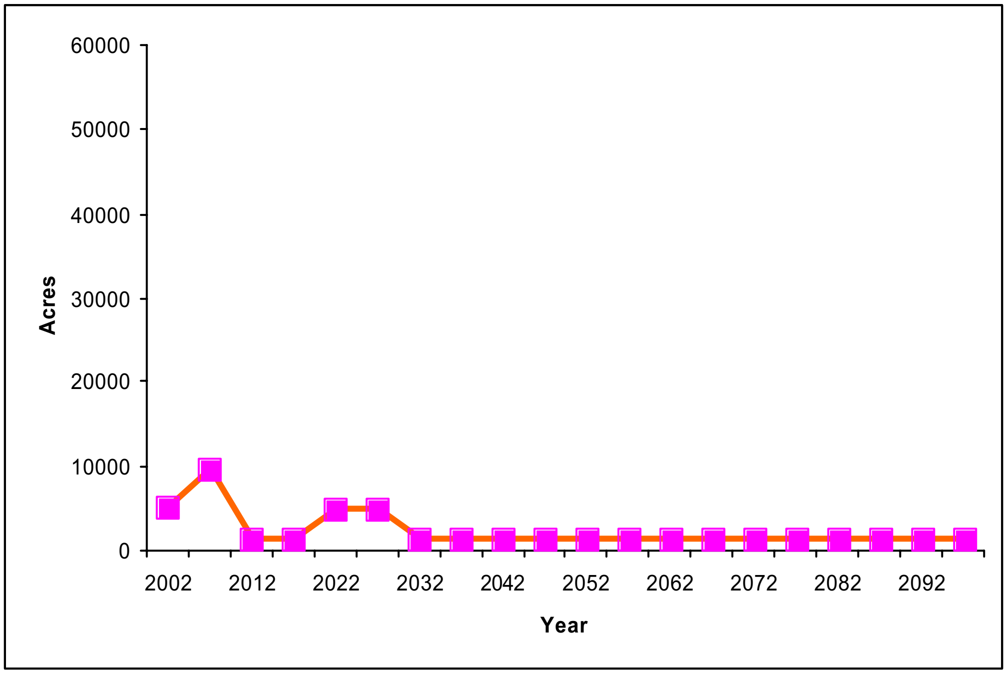

Figure A7. Number of acres within the target density range (Curtis' Relative Density 25-45) for Private No Action alternative through time.

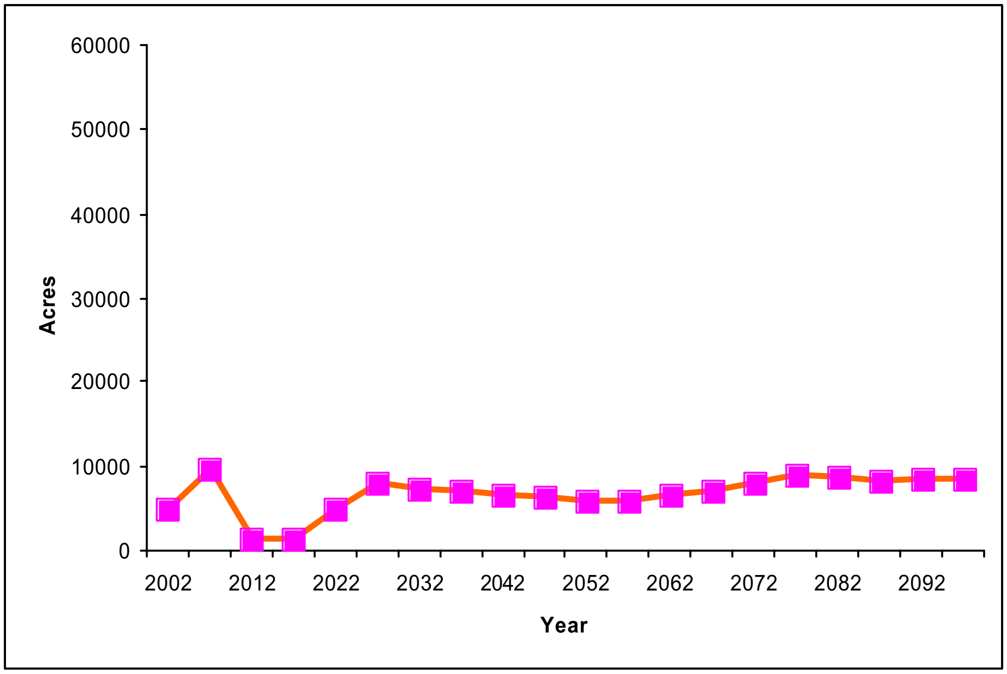

Figure A8. Number of acres within the target density range (Curtis' Relative Density 25-45) for Private Alternative 2 through time.

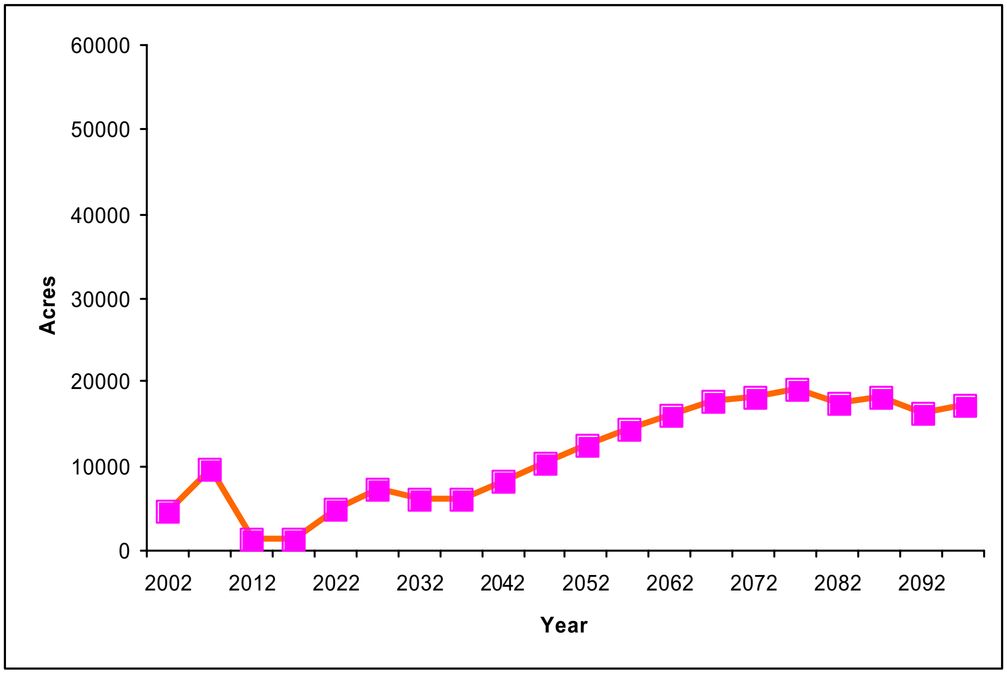

Figure A9. Number of acres within the target density range (Curtis' Relative Density 25-45) for Private Alternative 3 through time.

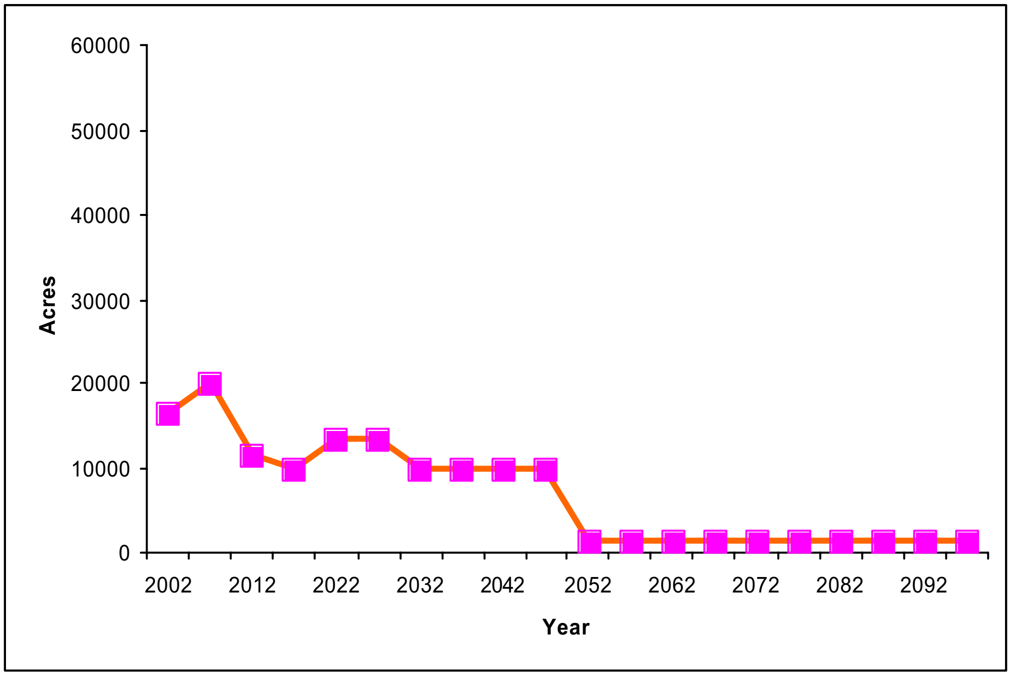

Figure A10. Number of acres within the target density range (Curtis' Relative Density 25-45) for Landscape No Action alternative through time.

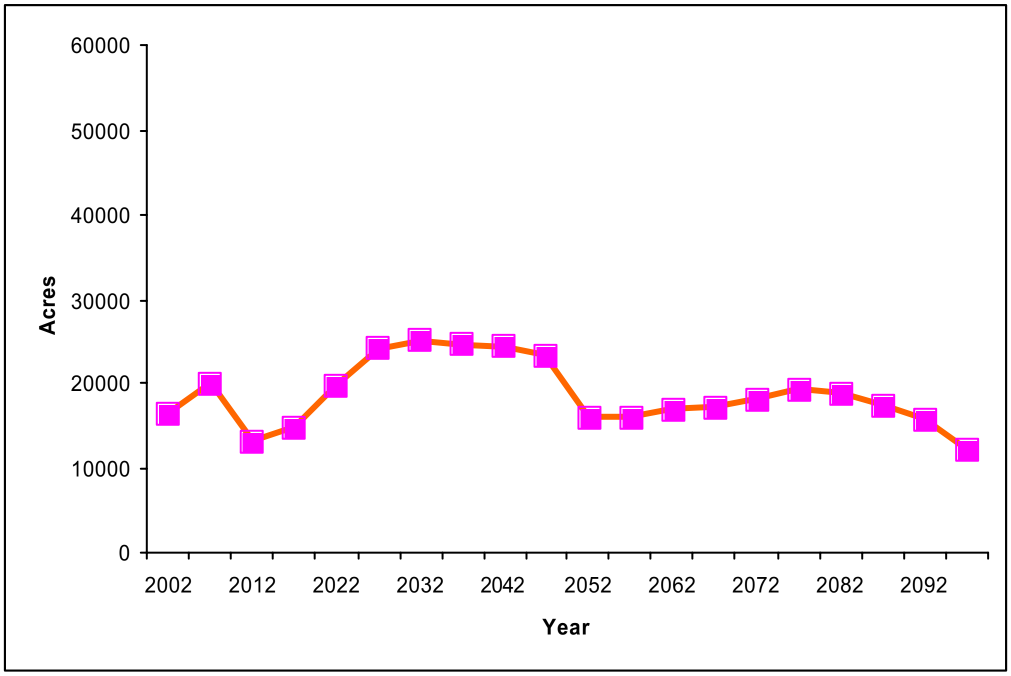

Figure A11. Number of acres within the target density range (Curtis' Relative Density 25-45) for Landscape Alternative 2 through time.

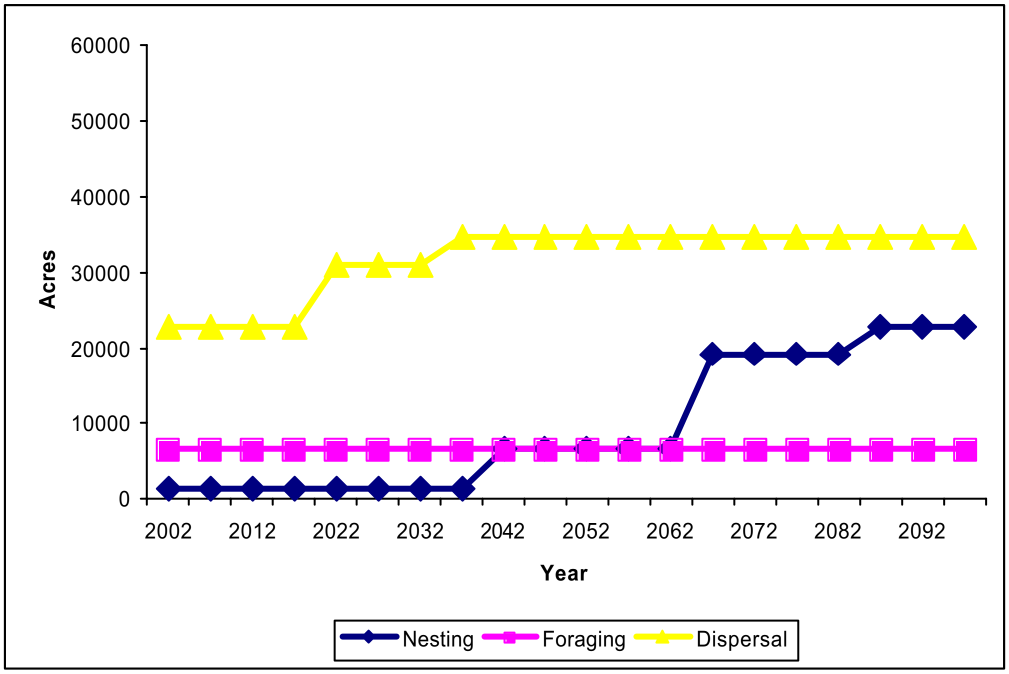

Figure A12. Number of acres in spotted owl habitat for Private No Action alternative through time.

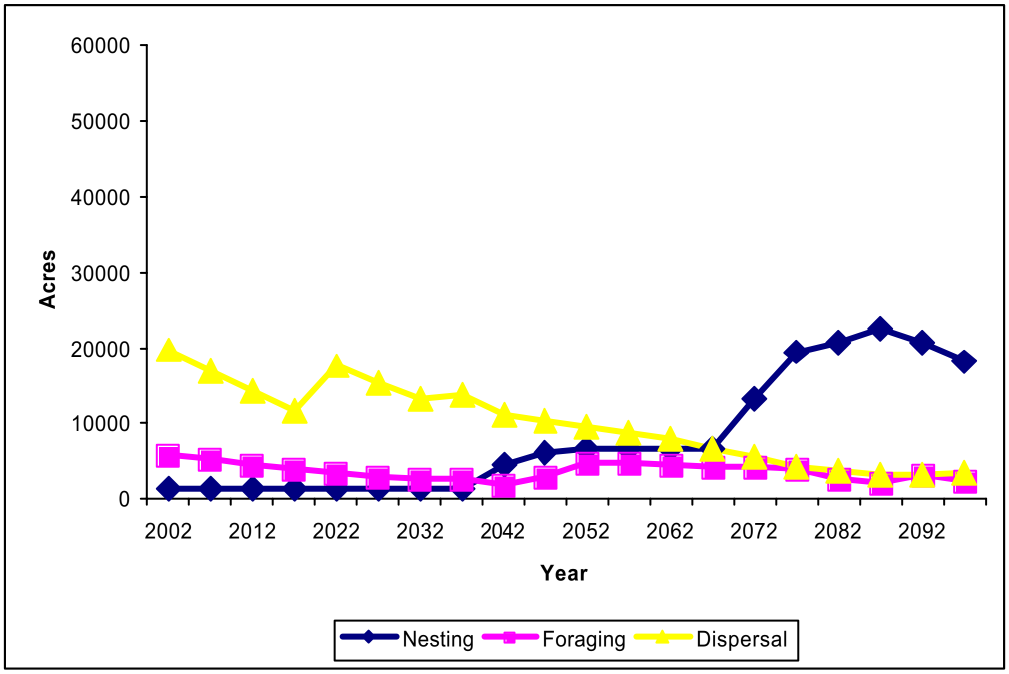

Figure A13. Number of acres in spotted owl habitat for Private Alternative 2 through time.

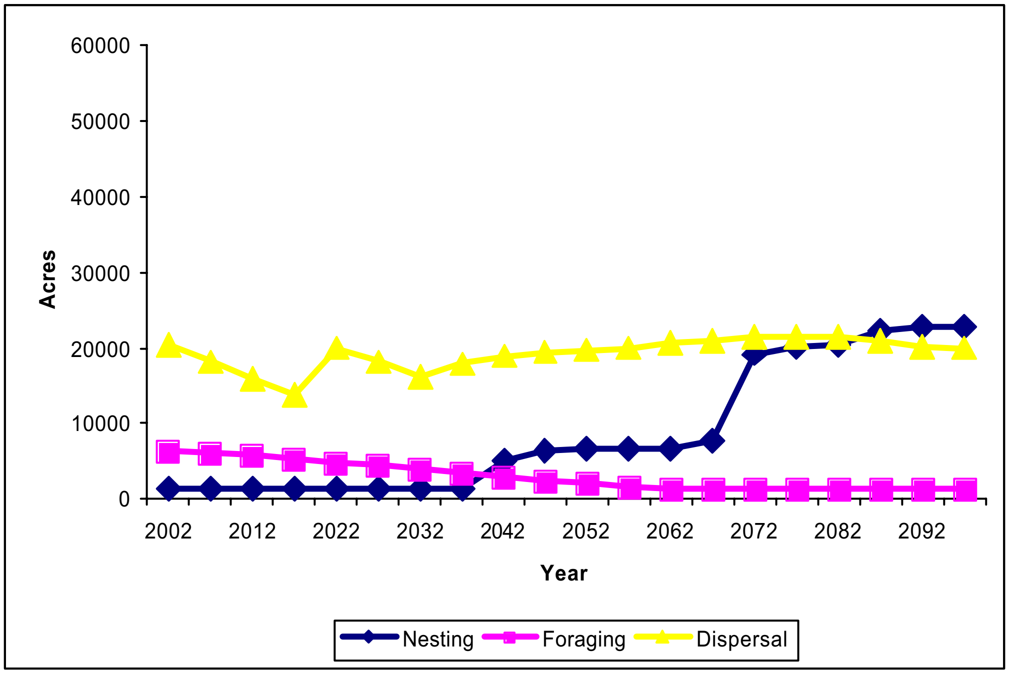

Figure A14. Number of acres in spotted owl habitat for Private Alternative 3 through time.

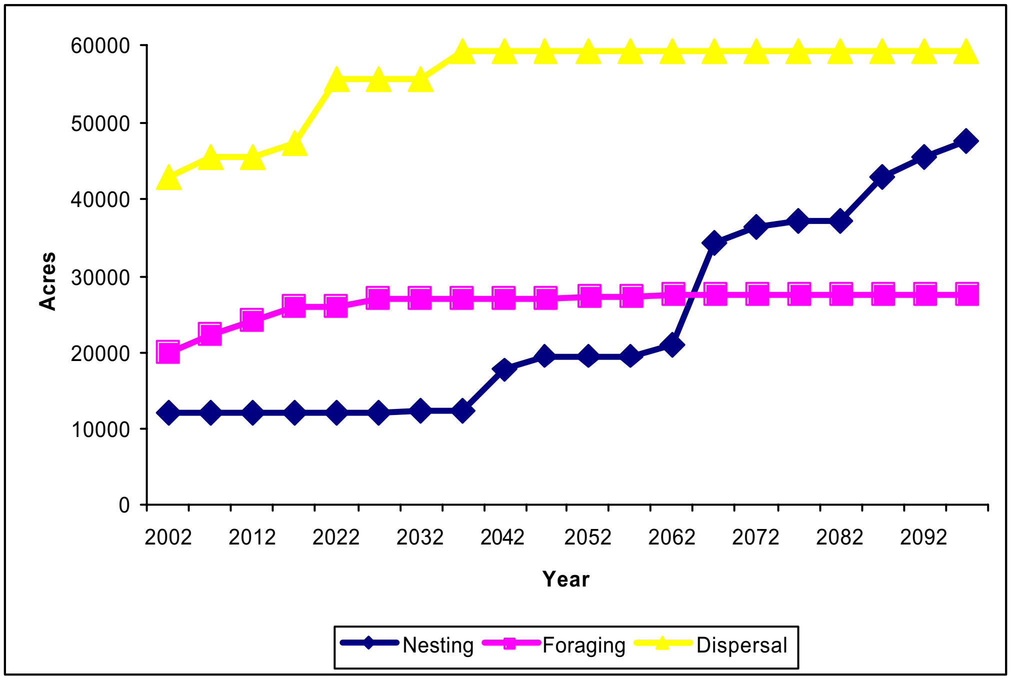

Figure A15. Number of acres in spotted owl habitat for Landscape No Action alternative through time.

Appendix B: Information and Files Concerning Modeling of BLM, Private, and Landscape Alternatives in LMS and Toggle

FVS keyword calibration file

```
COMMENT
KEYWORD   111111111 222222222 333333333 444444444 555555555 666666666 777777777
NUMCYCLE       10
VOLUME                    6.0      4.5      1.0
MCDEFECT                   0.25     0.20     0.20     0.15     0.15
END
SDIMAX            800
SDIMAX       DF      600
SDIMAX       WH       800
SDIMAX       RC      600
SDIMAX             RA      600
BAMAX                  350
COMMENT
BFDEFECT                  0.25     0.55     0.45
BFDEFECT            RA     0.25     0.55     0.45
BAIMULT                  0.75
MORTMULT                   1.6            20
END
```

Number of acres in each group for the BLM lands:

Group	Acres
DF10	191
DF15NoPCT	1074
DF15PCT	704
DF20	887
DF25	1760
DF30	2042
DF35	2303
DF40PCT	419
DF40NoPCT	740
DF45	1542
DF55	1687
DF65	377
DF75	169
DF95	1837
DF135	322
DF150	8462

Number of acres in each group for the private lands:

Group	Acres
Broadleaf	3665
Mixed	5175
OpenForest	3510
SmallConifer	8258
MediumConifer	12650
LargeConifer	1433

BLM Alternative E scenario file

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Private Lands Alternative 2 scenario file

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2087, mixed7_8_9_10_9, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
;MediumConifer
2002, mediumconifer12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2002, mediumconifer12, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, mediumconifer12, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2092, mediumconifer12, Quick, T:2 P:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, mediu mconifer12_2, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, mediumconifer12_2, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, mediumconifer12_2, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2097, mediumconifer12_2, Quick, T:2 P:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, mediumconifer12_3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, mediumconifer12_3, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, mediumconifer12_3, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, mediumconifer12_4, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, mediumconifer12_4, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, mediumconifer12_4, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2022, mediumconifer12_5, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2022, mediumconifer12_5, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2067, mediumconifer12_5, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2027, mediumconifer12_6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2027, mediumconifer12_6, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2072, mediumconifer12_6, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2032, mediumconifer12_7, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2032, mediumconifer12_7, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, mediumconifer12_7, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2037, mediumconifer12_8, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2037, mediumconifer12_8, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, mediumconifer12_8, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, mediumconifer12_9, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, mediumconifer12_9, Quick, T:0 P:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, mediumconifer12_9, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA

Private Lands Alternative 3 scenario file

#EndYear=2097
;mediumconifer
2002, mediumconifer12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2002, mediumconifer12, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2037, mediumconifer12, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA

2087, mediumconifer12, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, mediumconifer12_2, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, mediumconifer12_2, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2042, mediumconifer12_2, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, mediumconifer12_2, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, mediumconifer12_3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, mediumconifer12_3, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, mediumconifer12_3, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, mediumconifer12_3, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, mediumconifer12_4, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, mediumconifer12_4, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, mediumconifer12_4, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2022, mediumconifer12_5, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2022, mediumconifer12_5, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, mediumconifer12_5, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2027, mediumconifer12_6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2027, mediumconifer12_6, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, mediumconifer12_6, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2032, mediumconifer12_7, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2032, mediumconifer12_7, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2067, mediumconifer12_7, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2037, mediumconifer12_8, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2037, mediumconifer12_8, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2072, mediumconifer12_8, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2042, mediumconifer12_9, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, mediumconifer12_9, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, mediumconifer12_9, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, mediumconifer12_10, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2047, mediumconifer12_10, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, mediumconifer12_10, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2002, mediumconifer12_11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, mediumconifer12_11, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2052, mediumconifer12_11, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, mediumconifer12_11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2007, mediumconifer12_11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, mediumconifer12_12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2057, mediumconifer12_12, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA

2092, mediumconifer12_12, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2012, mediumconifer12_11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, mediumconifer12_13, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2062, mediumconifer12_13, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, mediumconifer12_13, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
;mixed7_8_9__10
2002, mixed7_8_9_10, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2002, mixed7_8_9_10, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2037, mixed7_8_9_10, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, mixed7_8_9_10, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, mixed7_8_9_10_2, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, mixed7_8_9_10_2, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2042, mixed7_8_9_10_2, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, mixed7_8_9_10_2, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, mixed7_8_9_10_3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, mixed7_8_9_10_3, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, mixed7_8_9_10_3, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, mixed7_8_9_10_3, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, mixed7_8_9_10_4, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, mixed7_8_9_10_4, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, mixed7_8_9_10_4, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2022, mixed7_8_9_10_5, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2022, mixed7_8_9_10_5, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, mixed7_8_9_10_5, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2027, mixed7_8_9_10_6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2027, mixed7_8_9_10_6, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, mixed7_8_9_10_6, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2032, mixed7_8_9_10_7, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2032, mixed7_8_9_10_7, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2067, mixed7_8_9_10_7, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2037, mixed7_8_9_10_8, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2037, mixed7_8_9_10_8, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2072, mixed7_8_9_10_8, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2042, mixed7_8_9_10_9, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, mixed7_8_9_10_9, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, mixed7_8_9_10_9, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, mixed7_8_9_10_10, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2047, mixed7_8_9_10_10, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, mixed7_8_9_10_10, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA

2052, mixed7_8_9_10_11, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2052, mixed7_8_9_10_11, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, mixed7_8_9_10_11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, mixed7_8_9_10_12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2057, mixed7_8_9_10_12, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, mixed7_8_9_10_12, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, mixed7_8_9_10_13, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2062, mixed7_8_9_10_13, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, mixed7_8_9_10_13, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
;openforest
2042, openforest3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, openforest3, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, openforest3, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, openforest3_2, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2047, openforest3_2, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, openforest3_2, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, openforest3_3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2052, openforest3_3, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, openforest3_3, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, openforest3_4, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2057, openforest3_4, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, openforest3_4, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, openforest3_5, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2062, openforest3_5, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, openforest3_5, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2067, openforest3_6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2067, openforest3_6, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2072, openforest3_7, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2072, openforest3_7, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, openforest3_8, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2077, openforest3_8, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, openforest3_9, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2082, openforest3_9, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, openforest3_10, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2087, openforest3_10, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, openforest3_11, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2092, openforest3_11, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, openforest3_12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2097, openforest3_12, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
;smallconifer
2042, smallconifer11, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, smallconifer11, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, smallconifer11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, smallconifer11_2, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2047, smallconifer11_2, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, smallconifer11_2, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, smallconifer11_3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2052, smallconifer11_3, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, smallconifer11_3, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, smallconifer11_4, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA

2057, smallconifer11_4, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, smallconifer11_4, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, smallconifer11_5, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2062, smallconifer11_5, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, smallconifer11_5, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2067, smallconifer11_6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2067, smallconifer11_6, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2072, smallconifer11_7, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2072, smallconifer11_7, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, smallconifer11_8, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2077, smallconifer11_8, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, smallconifer11_9, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2082, smallconifer11_9, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, smallconifer11_10, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2087, smallconifer11_10, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, smallconifer11_11, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2092, smallconifer11_11, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, smallconifer11_12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2097, smallconifer11_12, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
;broadleaf
2002, broadleaf6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2002, broadleaf6, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2037, broadleaf6, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, broadleaf6, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, broadleaf6_2, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2007, broadleaf6_2, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2042, broadleaf6_2, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, broadleaf6_2, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, broadleaf6_3, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2012, broadleaf6_3, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, broadleaf6_3, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, broadleaf6_3, Quick, T:2 W:D, ZZ_NA, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, broadleaf6_4, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2017, broadleaf6_4, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2052, broadleaf6_4, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2022, broadleaf6_5, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2022, broadleaf6_5, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, broadleaf6_5, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2027, broadleaf6_6, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2027, broadleaf6_6, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, broadleaf6_6, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2032, broadleaf6_7, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2032, broadleaf6_7, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2067, broadleaf6_7, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2037, broadleaf6_8, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2037, broadleaf6_8, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2072, broadleaf6_8, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2042, broadleaf6_9, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2042, broadleaf6_9, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2077, broadleaf6_9, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2047, broadleaf6_10, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2047, broadleaf6_10, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2082, broadleaf6_10, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA

2052, broadleaf6_11, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2052, broadleaf6_11, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2087, broadleaf6_11, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2057, broadleaf6_12, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2057, broadleaf6_12, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2092, broadleaf6_12, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2062, broadleaf6_13, Quick, T:2 W:D, DF, ZZ_NA, ZZ_NA, DF350.rgn, ZZ_NA, ZZ_NA, ZZ_NA
2062, broadleaf6_13, Quick, T:0 W:D, ZZ_NA, DF, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA
2097, broadleaf6_13, Quick, T:100 W:D, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA, ZZ_NA

Regeneration files

DF33WH33RC33:

DF, 0.40, 3.96, 0.88, 3.30, 0.00
DF, 0.45, 4.51, 0.89, 3.30, 0.00
DF, 0.52, 5.15, 0.90, 3.30, 0.00
DF, 0.52, 5.17, 0.90, 3.30, 0.00
DF, 0.52, 5.24, 0.90, 3.30, 0.00
DF, 0.55, 5.47, 0.91, 3.30, 0.00
DF, 0.67, 6.75, 0.93, 3.30, 0.00
DF, 0.68, 6.76, 0.94, 3.30, 0.00
DF, 0.71, 7.07, 0.94, 3.30, 0.00
DF, 0.71, 7.12, 0.94, 3.30, 0.00
RC, 0.40, 3.96, 0.88, 3.30, 0.00
RC, 0.45, 4.51, 0.89, 3.30, 0.00
RC, 0.52, 5.15, 0.90, 3.30, 0.00
RC, 0.52, 5.17, 0.90, 3.30, 0.00
RC, 0.52, 5.24, 0.90, 3.30, 0.00
RC, 0.55, 5.47, 0.91, 3.30, 0.00
RC, 0.67, 6.75, 0.93, 3.30, 0.00
RC, 0.68, 6.76, 0.94, 3.30, 0.00
RC, 0.71, 7.07, 0.94, 3.30, 0.00
RC, 0.71, 7.12, 0.94, 3.30, 0.00
WH, 0.40, 3.96, 0.88, 3.30, 0.00
WH, 0.45, 4.51, 0.89, 3.30, 0.00
WH, 0.52, 5.15, 0.90, 3.30, 0.00
WH, 0.52, 5.17, 0.90, 3.30, 0.00
WH, 0.52, 5.24, 0.90, 3.30, 0.00
WH, 0.55, 5.47, 0.91, 3.30, 0.00
WH, 0.67, 6.75, 0.93, 3.30, 0.00
WH, 0.68, 6.76, 0.94, 3.30, 0.00
WH, 0.71, 7.07, 0.94, 3.30, 0.00
WH, 0.71, 7.12, 0.94, 3.30, 0.00

WH25RC25:

RC, 0.40, 3.96, 0.88, 2.50, 0.00
RC, 0.45, 4.51, 0.89, 2.50, 0.00
RC, 0.52, 5.15, 0.90, 2.50, 0.00
RC, 0.52, 5.17, 0.90, 2.50, 0.00
RC, 0.52, 5.24, 0.90, 2.50, 0.00
RC, 0.55, 5.47, 0.91, 2.50, 0.00
RC, 0.67, 6.75, 0.93, 2.50, 0.00
RC, 0.68, 6.76, 0.94, 2.50, 0.00

RC, 0.71, 7.07, 0.94, 2.50, 0.00
RC, 0.71, 7.12, 0.94, 2.50, 0.00
WH, 0.45, 4.51, 0.89, 5.00, 0.00
WH, 0.52, 5.17, 0.90, 5.00, 0.00
WH, 0.55, 5.47, 0.91, 5.00, 0.00
WH, 0.68, 6.76, 0.94, 5.00, 0.00
WH, 0.71, 7.12, 0.94, 5.00, 0.00

WH50RC50:
RC, 0.40, 3.96, 0.88, 5.00, 0.00
RC, 0.45, 4.51, 0.89, 5.00, 0.00
RC, 0.52, 5.15, 0.90, 5.00, 0.00
RC, 0.52, 5.17, 0.90, 5.00, 0.00
RC, 0.52, 5.24, 0.90, 5.00, 0.00
RC, 0.55, 5.47, 0.91, 5.00, 0.00
RC, 0.67, 6.75, 0.93, 5.00, 0.00
RC, 0.68, 6.76, 0.94, 5.00, 0.00
RC, 0.71, 7.07, 0.94, 5.00, 0.00
RC, 0.71, 7.12, 0.94, 5.00, 0.00
WH, 0.40, 3.96, 0.88, 5.00, 0.00
WH, 0.45, 4.51, 0.89, 5.00, 0.00
WH, 0.52, 5.15, 0.90, 5.00, 0.00
WH, 0.52, 5.17, 0.90, 5.00, 0.00
WH, 0.52, 5.24, 0.90, 5.00, 0.00
WH, 0.55, 5.47, 0.91, 5.00, 0.00
WH, 0.67, 6.75, 0.93, 5.00, 0.00
WH, 0.68, 6.76, 0.94, 5.00, 0.00
WH, 0.71, 7.07, 0.94, 5.00, 0.00
WH, 0.71, 7.12, 0.94, 5.00, 0.00

DF350:
DF, 0.27, 1.33, 0.83, 7.00, 0.00
DF, 0.51, 2.54, 0.85, 7.00, 0.00
DF, 0.61, 3.07, 0.86, 7.00, 0.00
DF, 0.61, 3.07, 0.86, 7.00, 0.00
DF, 0.63, 3.14, 0.86, 7.00, 0.00
DF, 0.68, 3.39, 0.87, 7.00, 0.00
DF, 0.68, 3.40, 0.87, 7.00, 0.00
DF, 0.69, 3.45, 0.87, 7.00, 0.00
DF, 0.74, 3.71, 0.87, 7.00, 0.00
DF, 0.75, 3.76, 0.88, 7.00, 0.00
DF, 0.79, 3.96, 0.88, 7.00, 0.00
DF, 0.82, 4.08, 0.88, 7.00, 0.00
DF, 0.83, 4.13, 0.88, 7.00, 0.00

DF,	0.87,	4.35,	0.89,	7.00,	0.00
DF,	0.90,	4.49,	0.89,	7.00,	0.00
DF,	0.90,	4.51,	0.89,	7.00,	0.00
DF,	0.92,	4.62,	0.89,	7.00,	0.00
DF,	0.94,	4.69,	0.89,	7.00,	0.00
DF,	0.94,	4.72,	0.89,	7.00,	0.00
DF,	0.98,	4.89,	0.90,	7.00,	0.00
DF,	0.99,	4.97,	0.90,	7.00,	0.00
DF,	1.03,	5.15,	0.90,	7.00,	0.00
DF,	1.03,	5.17,	0.90,	7.00,	0.00
DF,	1.04,	5.18,	0.90,	7.00,	0.00
DF,	1.04,	5.19,	0.90,	7.00,	0.00
DF,	1.04,	5.21,	0.90,	7.00,	0.00
DF,	1.04,	5.21,	0.90,	7.00,	0.00
DF,	1.05,	5.24,	0.90,	7.00,	0.00
DF,	1.06,	5.32,	0.91,	7.00,	0.00
DF,	1.09,	5.45,	0.91,	7.00,	0.00
DF,	1.09,	5.47,	0.91,	7.00,	0.00
DF,	1.11,	5.57,	0.91,	7.00,	0.00
DF,	1.12,	5.61,	0.91,	7.00,	0.00
DF,	1.15,	5.75,	0.91,	7.00,	0.00
DF,	1.17,	5.86,	0.92,	7.00,	0.00
DF,	1.27,	6.34,	0.93,	7.00,	0.00
DF,	1.33,	6.63,	0.93,	7.00,	0.00
DF,	1.33,	6.67,	0.93,	7.00,	0.00
DF,	1.35,	6.75,	0.93,	7.00,	0.00
DF,	1.35,	6.76,	0.94,	7.00,	0.00
DF,	1.37,	6.85,	0.94,	7.00,	0.00
DF,	1.39,	6.94,	0.94,	7.00,	0.00
DF,	1.41,	7.04,	0.94,	7.00,	0.00
DF,	1.41,	7.04,	0.94,	7.00,	0.00
DF,	1.41,	7.07,	0.94,	7.00,	0.00
DF,	1.42,	7.12,	0.94,	7.00,	0.00
DF,	1.53,	7.64,	0.95,	7.00,	0.00
DF,	1.57,	7.84,	0.96,	7.00,	0.00
DF,	1.85,	9.27,	0.99,	7.00,	0.00
DF,	1.91,	9.55,	0.99,	7.00,	0.00

Pathway percentages for BLM and Private alternatives.

BLM Alternative E:

Pathway	G1	G2	G3	G4	G5
1	10	10	10	10	25
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	90	0	0
8	0	0	0	0	75
9	0	0	0	0	0
10	90	90	0	0	0
11	0	0	0	0	0
12	0	0	0	90	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

Pathway	G6	G7	G8	G9	G10
1	25	25	26	25	25
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	39	0
7	0	0	0	36	0
8	75	0	0	0	75
9	0	75	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	16	0	0
13	0	0	58	0	0
14	0	0	0	0	0
15	0	0	0	0	0

Pathway	G11	G12	G13	G14	G15
1	50	50	50	100	100
2	0	0	0	0	0
3	0	18	50	0	0
4	0	32	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	26	0	0	0	0
8	24	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

Pathway	G16				
1	100				
2	0				
3	0				
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				

Pathway	G21	G22	G23	G24	G25
1	10	10	10	10	25
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	75
6	0	0	0	0	0
7	0	0	90	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	90	90	0	0	0
11	0	0	0	0	0
12	0	0	0	90	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

Pathway	G26	G27	G28	G29	G30
1	25	25	26	25	25
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	75	0	0	0	75
6	0	75	0	46	0
7	0	0	0	29	0
8	0	0	22	0	0
9	0	0	52	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

Pathway	G31	G32	G33	G34	G35
1	50	50	52	100	100
2	0	0	0	0	0
3	0	18	48	0	0
4	0	32	0	0	0
5	23	0	0	0	0
6	27	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

Pathway	G36				
1	100				
2	0				
3	0				
4	0				
5	0				
6	0				
7	0				
8	0				
9	0				
10	0				
11	0				
12	0				
13	0				
14	0				
15	0				

Private Alternative 2:

Pathway	G1	G2	G3	G4	G5	G6
1	50	0	0	0	0	100
2	5	15	0	29	17	0
3	5	13	0	25	16	0
4	5	12	0	10	15	0
5	5	12	0	10	14	0
6	5	10	0	10	13	0
7	5	8	30	10	13	0
8	5	8	28	2	12	0
9	7	6	27	2	0	0
10	8	6	15	2	0	0
11	0	10	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0

Private Alternative 3:

Pathway	G1	G2	G3	G4	G5	G6
1	50	0	0	0	0	100
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	0	0	0	0	0	0
18	0	0	0	0	0	0
19	0	0	0	0	0	0
20	0	0	0	0	0	0
21	0	0	0	0	0	0
22	0	0	0	17	0	0
23	0	0	0	17	0	0
24	10	0	0	17	14	0
25	10	5	0	15	14	0
26	10	5	0	19	12	0
27	5	7	0	15	11	0
28	5	10	0	0	11	0
29	5	8	5	0	11	0
30	5	8	3	0	10	0
31	0	9	47	0	9	0
32	0	10	45	0	8	0
33	0	10	0	0	0	0
34	0	10	0	0	0	0
35	0	7	0	0	0	0
36	0	8	0	0	0	0
37	0	3	0	0	0	0
38	0	0	0	0	0	0
39	0	0	0	0	0	0
40	0	0	0	0	0	0