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Nantahala and Pisgah National Forests



Draft Environmental Impact Statement for the Proposed Land Management Plan

Appendix D: Vegetation Modeling Methods



Forest
Service

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Region

National Forests
in North Carolina

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Proposed Land Management Plan**

Appendix D: Vegetation Modeling Methods

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Model Contents and Structure

Spectrum is a linear programming model that has been the Forest Service standard for land management planning. It is used to estimate outcomes of applying passive or active management practices to forested stands and modeling changed conditions under multiple scenarios. In this analysis, Spectrum modelling software was used to construct a model of the forest lands, the potential management actions applied to them and the resultant activities, outputs and conditions that result from the management and natural processes. Spectrum creates a linear programming matrix, similar to a spreadsheet, where a column represents a management action applied to a specific class of land for 200 years, and a row represents some management objective for a specific 10-year period of that planning horizon. The coefficient at the intersection of a row and column is the per-acre amount that the management action on the specific class of land contributes to the management objective in that period. Most management objectives have some target value that we seek to equal, exceed or stay below. Hence, each row becomes a summation equation: the target is the right-hand-side of the equation; each column is a variable in that equation; and the value in the cell at the row-column intersection is the coefficient for that variable. The entire matrix is huge set of simultaneous equations that we ask a linear programming software solver to “solve”. We are asking the solver, “for each land class, how many acres should be allocated to the different management actions available to it in order to meet all of our management objectives?”

In this section, we will describe the different components that make up the model and some of the processes used to create those components.

Land Classification

All lands on the forest were classified by six different attributes. Each analysis unit created was a unique combination of the six attributes. Like combinations of the attributes were bulked into analysis units (AU) and their acres tabulated. Therefore, most analysis units are comprised of 4-5 non-contiguous locations, each with the same set of land attributes. See the equation below:

$$\text{AU (acres)} = \text{Step 1 Timber Suitability} * \text{Forest Type Group} * \text{Geographic Area} * \text{Step 2 Timber Suitability} * \text{Management Area}$$

Each of the land attributes is discussed below.

Forest Type Groups

The many forest types found on the Nantahala-Pisgah were aggregated into 12 type classes (Table 1a). This classification was used to assign appropriate harvest and burning treatments, and was used to determine production functions for volume and seral state classification and changes. These forest type groups carried forth the convention identified during the FVS modeling effort which build the yield tables utilized within the Spectrum analysis. In essence they are a homogenization of the FSVeg forest type, FIA forest type and the ecozones. They also contain forest type groups that represent current conditions not identified in the ecozones such as white pine dominated forests. Refer to the white paper, FVS Modeling for the National Forests of North Carolina Land and Resource Management Plan (Keyser and Rodrigue 2015) for more information about the determination of forest type group.

Because the original intent of the Spectrum model land stratification scheme was to include the modeled ecozones (it was decided that adding the ecozones would produce too many analysis units for the model to function properly) the outputs produced by the model will need to be cross walked to ecozones for the analysis in the EIS. Refer to Table 1b for a suggested crosswalk.

Table 1a. Forest Types

Name	Description
01WP	01 - White Pine
02SF	02 - Spruce fir
03SLP	03 - Shortleaf pine
04PP	04 - Pitch/Virginia pine
05WpHw	05 - White pine/hardwood
06SlpH	06 - Shortleaf pine/hardwood
07PVH	07 - Pitch/Virginia pine/hardwood
08Doak	08 - Dry oak
09loak	09 - Intermediate oak
10CvHw	10 - Moist oak/Cove hardwood
11MxHw	11 - Mixed hardwood
12NoHw	12 - Northern hardwood
Other	Other FT, Shrub, or Non-forest
99	99 - Brush

Table 1b. Suggested Ecozone, Forest Type, and Forest Type Group Cross Walk

Ecozones	Forest Type - FSVeg Code	SPECTRUM FTG Code
Spruce-Fir	6, 7, 10, 17	02SF
Northern Hardwood	70, 81	12NoHw
High Elevation Red Oak	55	09loak
Acidic Cove	4, 5, 8, 9, 41, 50, 56, 83	10CvHw
Rich Cove	9, 41, 50, 56, 82, 83	10CvHw
Mesic Oak	10, 42, 48, 53, 54	10CvHw
Dry-Mesic Oak	3, 42, 48, 52, 53, 54	09loak
Dry Oak	42, 51, 52, 54, 57, 59, 60	08Doak
Pine-Oak/Heath	15, 16, 20, 25, 33, 38, 49	04PP, 07PVH
Shortleaf Pine-Oak	3, 12, 13, 14, 16, 21, 25, 31, 32, 33, 44, 49	03SLP, 06SlpH
Alluvial	72, 82	11MxHw
White Pine/White Pine HWD (Existing Condition)	3, 4, 9, 10,41,42	01WP, 05WpHw

Age Class

Forested lands were classified by their age class at the beginning of the planning horizon. Ten-year age class increments were used (Table 2). This classification allowed the model to track stands as they age and apply treatments at the appropriate time. The age class calculations are based off of the year 2018. Initial discussions included using multiple – age class structures that suited individual community types and their seral development. Adding multiple age class structures that suited individual community groups would add to many records and make the database unmanageable. This would also necessitate the ecozone layers to be added to the model that also compounds the multiplication of records. The age classes in this model were grouped past the latest onset of old growth conditions (140 years) according to the local NRV model.

Table 2. Spectrum Age Classes

Existing Age	End-point
0-10	10
11-20	20
21-30	30
31-40	40
41-50	50
51-60	60
61-70	70
71-80	80
81-90	90
91-100	100
101-110	110
111-120	120
121-130	130
131-140	140
141+	150+

Geographic Area

Twelve distinct, geographically contiguous areas were identified on the forest (see Proposed Forest Plan, Geographic Areas Chapter). These delineations were created using a combination of natural features and land ownership patterns.

Table 3. Geographic Areas

Name	Description
BM	Bald Mountains
BK	Black Mountains
EE	Eastern Escarpment
FL	Fontana Lake
NM	Nantahala Mountains
GB	Great Balsam
HD	Highland Domes

Name	Description
HI	Hiwassee
NG	Nantahala Gorge
PL	Pisgah Ledge
NS	North Slope
UM	Unicoi Mountains

Management Area

Management Area is an administrative delineation that designates a general management focus for lands assigned to each Management Area class (See Proposed Forest Plan, Management Area chapter). For Alternative A, the no action alternative, the management areas from the existing plan were used (1994). These management areas are listed in Table 4. For Alternatives B, C and D, a new management area classification was developed, shown in Table 5. See the discussion of the alternatives for details on management areas.

Table 4. Alternative A, Current Forest Plan, Management Areas

Management Area Number	Management Emphasis
1b	Emphasize sustained yield timber management
2a	Emphasize visually pleasing scenery, habitat of mature forest
2c	Emphasize visually pleasing scenery, habitat of older forests
3b	Emphasize sustained yield timber management
4a	Emphasize visually pleasing scenery
4c	Emphasize visually pleasing scenery
4d	Emphasize high quality wildlife habitat, particularly for black bear
5	Emphasize a semi-primitive recreational setting
6	Wilderness Study Areas
7	Wilderness
8	Experimental Forest
9	Roan Mountain
10	Research Natural Areas
11	Cradle of Forestry
12	Developed recreation areas
13	Special Interest Areas
14	Appalachian trail and corridor
15	Wild and scenic river and corridor
16	Administrative facilities

Management Area Number	Management Emphasis
17	Balds
18	Riparian areas
U	Unassigned
U-New	New Acquisitions

Table 5. Management Areas, Action Alternatives B, C, and D

Management Area Number	Management Emphasis
1	Matrix
2	Interface
3	Backcountry
4a	AT
4b	Scenic Byways
4c	Heritage Corridors
4d	Wild and Scenic Rivers
5a	Special Interest Areas
5b	Ecological Interest Areas
5R	RNA
6	WSA
6R	Rec Wilderness
7	Wilderness
8	Experimental Forest
9	Roan Mountain
11	Cradle of Forestry

Timber Suitability

Identification of lands as not suitable and suitable for timber production is required by the National Forest Management Act of 1976. The process is detailed in Forest Service handbook 1909.12 § 61 via a two-step approach. The results from both steps of timber suitability process were used within the Spectrum model as attributes to classify analysis units. The results of step one were incorporated into the dataset to aid in calculation of the sustained yield limit, which is determined based on the lands potentially suitable for timber production. Refer to the Determination of Sustained Yield Limit section below for more details. The results of step 2 of the timber suitability process identified the final allocation of lands suitable for timber production after each alternatives desired conditions, objectives, and management area allocations were considered. The use of the step 2 timber suitability results were important for adequately representing the planned actions on the Nantahala and Pisgah landscape over the modeled period highlighting management area allocation differences between alternatives. Refer to Forest Plan Appendix B or the EIS Timber section for detailed information regarding the determination of lands suitable for timber production.

The inclusion of the results from the step 2 of the timber suitability process were originally not included in early model development of the EIS alternatives. This was because the EIS alternative data sets were developed sequentially using the sustained yield limit dataset. Step 2 was included after the action alternatives were under development and ultimately retrofitted to Alternative A to ensure that comparisons could be made across alternatives during the analysis in the EIS. Review of the model built for Alternative A indicated that step 2 could be added to the dataset while already in the model for several reasons: (1) Alternative A was not modeling a lot of harvest activities in the unsuitable land base currently. This reflects the current reality of management on the forest with the exception of burning. (2) The constraints that were already built into the model for Alternative A were implicitly describing the management area suitability decisions.

Management Actions

A range of land management actions that would be used to manipulate vegetation on the forest were represented in the model. One of the management actions is “no action”, a prescription that only represents the changes to the land from natural processes. For any analysis unit created from the land stratification process, a range of management prescriptions that are appropriate for the unique combination of criteria listed above are made available. The model chooses how many acres of each analysis unit will be assigned to each of the available management prescriptions. When some portion of an analysis unit is assigned to a management action, that assignment is assumed to continue through the entire planning horizon. Table 6 shows the management actions represented and their general description. Refer to the white paper, FVS Modeling for the National Forests of North Carolina Land and Resource Management Plan (Keyser and Rodrigue 2015) for more information about the management prescriptions included in this analysis.

The prescriptions listed in Table 6 are derived from the Keyser and Rodrigue 2015 paper but modified to meet the coarser requirements of the Spectrum model. For example, burning actions had to be bulked to the decade rather than occurring more often.

Table 6. Management Actions Used to Manipulate Forest Vegetation

Management Action	Description
Burn1	Continuous stand management through burning. Timing options of burning every 10 years or every 20 years are available.

Management Action	Description
Burning for Young Forest Creation	Regular prescribed burns every 10 years with the objective of creating some openings that will regenerate.
Clearcut with High Retention	A clearcut that maintains 20 to 30 basal area per acre for wildlife or future stand structure objectives.
Clearcut with Regular Retention	A clearcut that maintains 10 to 20 basal area per acre for wildlife, structure or visual objectives.
Group Selection	An area assigned to group selection will have small patches of the stand (roughly 0.25 acres) harvested. Every 15 to 30 years the area will be entered to harvest another set of small patches.
Individual Tree Selection	Partial harvest of roughly 25 percent of the stand to meet volume and stand composition objectives.
Loftis Shelterwood	A 3-step shelterwood initiated with a Loftis prep-cut, followed by a harvests 20-30 years and 40-50 years later, depending on forest type.
Minimum Level	No management, only natural processes occur.
Sanitation Thinning	Removal of part of the stand with the primary objective of improving stand health.
Shelterwood 2-Step with Loftis Cut	A shelterwood harvest with the initial, Loftis cut aimed at adjusting stand structure and composition, and the final cut happening 10 – 30 years later, depending on forest type.
Shelterwood with Conversion 2 Period	A 2-step shelterwood harvest followed by a final harvest 20 years later.
Shelterwood with Conversion 5 Period	A 2-step shelterwood harvest with an initial harvest followed by a final harvest 50 years later.
Spruce Fir Group Selection	Similar to group selection above.

Assignment of Permissible Management Actions to Land Areas

Allowable management actions were assigned for each management area in the plan alternatives, as shown in Tables 11 and 13 at the end of this section. For Alternative A, allowable management actions were set to reflect the management area emphases of the current plan. For Alternatives B, C and D, the same rules were used to construct management action options for analysis units. Assignment of management action options varied primarily by management area. Silvicultural and burning management action options also varied by the forest type attribute of analysis units. Once a permissible set of management actions was built into the model for an alternative, management objectives such as targets and limits were built into the model, and controlled the final optimal solution for the alternative.

Activities, Outputs, Conditions

To represent the results of applying management actions to analysis units, a set of activities, outputs and conditions were constructed in the model. For each management action, a sequence of management activities and the resultant outputs and condition changes was specified. Table 7a shows the activities, outputs and states that are tracked in the model.

Table 7a. Activities, Outputs, and States

Activity Name	Description	Units
ThinAcre	Acres thinned	Acre
OthrHarvAcre	Individual tree selection and group selection	Acre
OthrSheltAcr	Acres of prep or overwood removals for shelterwoods	Acre
RegenAcre	Acres receiving regeneration cuts	Acre
Burning	Prescribed burning	Acre
PCT	Pre commercial thinning	Acre

Condition Name	Description	Units
LateSerlClos	Late Seral State, closed canopy	Acre
Young Forest	Young Forest, created with management	Acre
MidAgeOpen	Middle Age Seral State, open canopy	Acre
LateSerlOpen	Late Seral State, open canopy	Acre
YoungGaps	Small areas of young forest created by natural disturbance	Acre
OldSerlOpen	Old Seral State, open canopy	Acre
OldSerlClose	Old Seral State, closed canopy	Acre
Burned	Not used	Acre
MixedAge	Mixed age state	Acre
MidAgeClosed	Middle age seral state, closed canopy	Acre

Output Name	Description	Units
LTSY	Long Term Sustained Yield – Predefined	MCF
AllHarvAcre	Acres harvested, any method	Acre
Volume	Volume harvested	MCF

The seral conditions displayed as part of the Spectrum outputs were defined using the NRV model description of the ecozone communities (approximated from silvics manuals for white pine) with adjustment made to age class breaks that fit within model parameters (10-year increments and the class number being at the end of the class increment) (Table 7b). These were linked to the forest type group developed in the classification structure above. Initially all analysis units were assumed to be in a closed condition but the open seral condition was included to test open condition objectives in the plan. The seral class outputs were derived for the Alternatives but not included in the sustained yield limit calculations.

Table 7b. Spectrum Seral Class Structure

Forest Type Group	Successional Class			
	Young	Mid	Late	Old
01WP (W. Pine)	0-20	30-90	100-130	140+
02SF (Spruce/Fir)	0-30	40-70	80-120	130+
03SLP (Shortleaf)	0-20	30-70	80-100	110+
04PP (Pitch)	0-20	30-70	80-130	140+
05WpHw (W. Pine/Hwd)	0-20	30-90	100-130	140+
06SlpH (Shortleaf/Hwd)	0-20	30-70	80-100	110+
07PVH (Pitch/Hwd)	0-20	30-70	80-130	140+
08Doak (Dry oak)	0-20	30-70	80-100	110+
09loak (Intermediate oak)	0-20	30-80	90-130	140+
10CvHw (Cove Hwd)	0-10	20-100	110-140	150+
11MxHw (Mixed Hwd)	0-10	20-100	110-140	150+
12NoHw (N. Hardwood)	0-20	30-80	90-130	140+

Production Functions for Activities and Outputs

For each analysis unit, the combination of land attributes was translated into a beginning seral condition. For each seral condition, a rule set known was created to control when an acre changed from one condition to another as a result of management, natural disturbances or the aging of the forest. This rule set is known as a production function. Within the production function, management activities were uniquely scheduled by management action. For harvests, the resultant volumes produced were determined by yield tables constructed from yield simulations run in the FVS simulation model.

Expression of Management Objectives in the Spectrum Model

Management objectives for the Spectrum model by alternative are displayed in Tables 12, 14, and 15 at the end of this appendix. The most direct expression of management objectives in the Spectrum model are those taken from forest plan objectives for activities or desired outcomes. Examples of these are “prescribe burn 65,000 acres in each 10-year period” and “create 11,000 acres of young forest in the first two 10-year periods.”

Another type of management objective are ones that limit or prohibit activities forest-wide or on subunits of the forest. Examples of these are “no burning for young forest creation in Management Area 8” and “total acres harvested cannot be more than 30,000 acres in any 10-year period.”

Other types of constraints are used to keep the mix of management actions chosen to be “implementable,” to ensure the model behaves as we would as managers. Flow constraints that control periodic changes in activities or outputs prevent dramatic changes through time. A flow constraint example is “the number of acres receiving regeneration cuts must not increase or decrease more than 15 percent between periods.” Proportional constraints help distribute activities geographically, or balance activities among management areas. An example of this constraint is “of all acres allocated to clearcut with high retention in Management Areas 1 and 3, no more than 40 percent can be in the Highland Domes geographic area.”

Ultimately, we ask the model “what is the best mix of management actions to apply to each of the analysis units in order to meet all of our objectives?” After all objectives have been met, what decides the “best” is an *objective function*: some output or condition that we want to maximize. There may be many ways to meet all of the objectives, but we ask the model to find the “solution” that will meet all of the objectives, and give us the highest value for the chosen objective function. For example, in Alternative A we asked the model to emphasize our harvest in areas that have been previously treated. For Alternatives B, C and D we asked the model to emphasize the amount of young forest maintained through time (while still meeting all other objectives).

Interpretation of Objective and Constraint Tables for Alternatives

In the tables that list the objectives used in the model for the different alternatives, there is a column showing what constraints are limiting, and in what periods they are limiting. Objectives that describe what we want, such as “at least 65,000 acres per decade should be burned for the first two decades”, might show a lower limit (LL) in period 1 or 2. If only 65,000 acres are burned (the objective is at lower limit), this indicates that the model has no incentive to burn more acres to achieve a higher objective function value. Objectives that describe what we don’t want, such as “no more than 8 percent of all management can happen outside of Management Area 1”, might show an upper limit (UL) in period 1. If exactly 8 percent of all management happens outside of Management Area 1 (the objective is at upper limit) this indicates that allowing more to happen outside of Management Area 1 would increase the value of the objective function.

Determination of Sustained Yield Limit (SYL)

Determination of the SYL was guided by the requirement in chapter 60 of the 2012 planning Rule. Based on the handbook guidance, timber harvest prescriptions were made available for all lands that were identified as ‘may be suitable for timber production’. For all forest type groups, the prescriptions made available were ones that are silviculturally appropriate for the long term production of timber. For any harvest regime, that regime (e.g., clearcut with standard retention, or group selection in spruce fir) was modelled to repeat in perpetuity. For each regime modeled on a forest type, the per-acre Long Term Sustained Yield (LTSY) coefficient for that regime was internally calculated. The LTSY coefficient for an acre is the sum of volume harvested over future rotations divided by the rotation age.

Data Validation

Data validation was completed to ensure that the per-acre volume production shown in the model was consistent with historical harvest data. In order to do this, a dataset of past timber sales was developed from Timber Information management (TIM) data. This dataset contained timber sale data from 2002 to 2017. This data was checked for errors in the number of acres treated, sales without acre data were removed, sales of Rights of Way were removed, settlement and Wildlife opening clearcuts were also removed.

Forest Activity Tracking System (FACTS) data was joined with Field Sampled Vegetation (FSVeg) data and summarized by ecozone, forest type and sale using GIS for only timber harvest activity records and exported to Excel. This data estimated timber sale harvest units from standard timber sales, salvage units, and some southern pine beetle suppression units. The data was paired with the historical sales data from TIM (see the document “Historical_Sale-Data_for_Validation.xlsx” located in the project record.) and where the sales were present on both datasets the acres in each forest type were matched up, converted to Spectrum FTG and the percentage of the sale in each Forest Type Group (Table 1a) calculated. This could be multiplied by each sales total volume and proportional volume per forest type estimated which was divided by the acres in the FTG for the sale to estimate volume per acre. These were averaged across the forest type groups for comparison to the SPECTRUM yields per FTG. Results from this analysis generated estimates of volume per acre for the Forest Type Groups listed in Table 8.

Table 8. Comparison of TIM/FACTS Database Estimates of CCF/Acre for the SYL Runs (CCF/Acres¹)

Forest Type Group	01	02	03	04	05	06	07	08	09	10	11	12
TIM/FACTS	26	NA	28	28	30	22	26	28	29	31	25	25
SPECTRUM (R-1)	35.5	13.1	41.6	25.6	30.2	23.9	21.6	19.3	26.4	32.5	31.6	NA

Model Adjustments

Based on the results from the first SYL run and comparison to the data validation measures described above, the Spectrum model was adjusted in the following ways:

1. Put in missing harvest options for Forest Type 12
2. Removed option for Spruce Fir harvest on Unsited lands
3. The yields for Clearcut with Standard Retention were adjusted to more accurately reflect the simulations for that prescription. Initially, yields for this prescription came from FVS natural growth simulations (Keyser and Rodrigue 2015) and showed per-acre yields of 100 percent of the volume present at the age of harvest. This technique was used to allow the model to generate many timing choices for a prescription. Most of these yields were higher than historical harvest levels. To make the model yields closer to historical yields, adjustment proportions were developed for each forest type based on the FVS harvest simulations. These proportions ranged from 0.65 - 0.84.

After making these adjustments, the results of “SYL – Run 2” are shown below in Table 9.

¹ Limitations to this validation analysis include: (1) The acres between FACTS/FSVeg/TIM data not equating; (2) Volume per acre estimates are inflated because of the inability to remove non-forest conversions like wildlife acres from TIM data; (3) The three tracking systems used may not have all relevant harvest information present especially early in the 2002 to 2017 period.

Table 9. Comparison of TIM/FACTS Database Estimates of CCF/Acre for SYL Run 2

Forest Type Group	01	02	03	04	05	06	07	08	09	10	11	12
CCF/Acre – TIM/FACTS	26	NA	28	28	30	22	26	28	29	31	25	25
CCF/Acre – SPECTRUM (Run 2)	30.1	13.1	30.8	11.4	25.5	18.7	15.3	13.5	22.1	27.8	23.8	18.1

Sustained Yield Limit Results

To determine the Sustained Yield Limit, the model was run to maximize the sum of the LTSY coefficients for all acres allocated to timber harvest. The LTSY coefficient for an acre is the sum of volume harvested over future rotations divided by the rotation age. The model was run with departure (no constraint limiting the harvest in any period). This run brought 700,000+ acres into solution (Table 10) closely aligning with the number of potentially suitable acres identified during Step 1 of the timber suitability analysis.

Table 10. Annual Sustained Yield

SPECTRUM Run	Acres	Annual SYL – MMCF (MMBF)
N&P SYL – W/ Departure	700,993	45 (225)

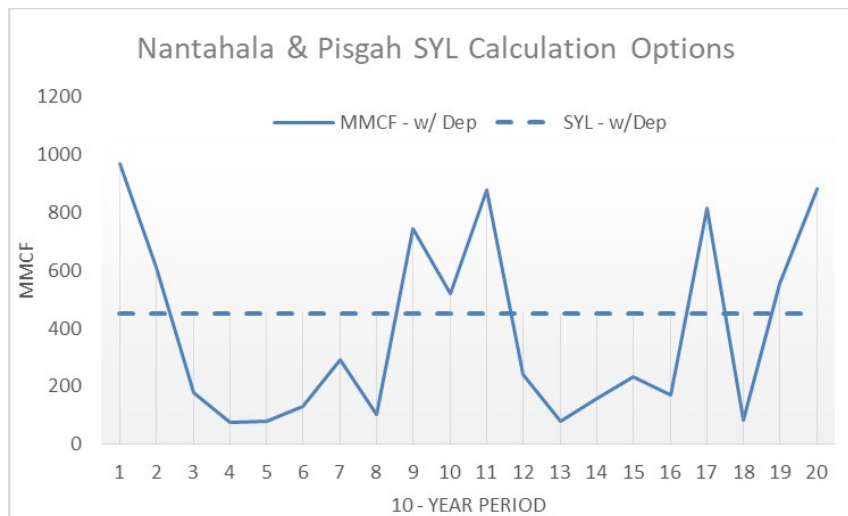


Figure 1. Nantahala and Pisgah Sustained Yield Limit Calculation

Alternative A, The “No Action” Alternative

Management Areas and Permissible Management Actions

The following table describes the management areas assigned under the current plan, the harvest suitability and the range of management prescriptions allowed in those areas. Management action options built for analysis units in the Spectrum model were limited to those listed here.

Table 11. Alternative A Management Areas and Their Characteristics

Mgmt. Area	Description	Admin. Suitability Design	Harvest Treatments Permitted
1b	Timber Production, Regulated, Motorized Rec	Suited – Timber Production (TP)	All Table 6 treatments– standard basal area retention (BAR)
2a	Scenery, Mature Forest, Roaded access	Suited – TP	All T6 Trts - high BAR
2c	Scenery, Mature Forest, Roaded access	Unsuited – TP	All T6 Trts - high BAR
3b	Timber Production, Regulated, Non-motor Rec	Suited – TP	All T6 Trts - st. BAR
4a	Scenery, Mature Forest, Non-motor Rec	Suited – TP	All T6 Trts - high BAR
4c	Scenery, Mature Forest, Non-motor Rec	Unsuited – TP	Just Burning
4d	Mature Forest, Scenery, Non-motor Rec	Suited – TP	All T6 Trts - st. BAR with 25 acre max limit
5	Backcountry, Mature, Non-motor Rec	Unsuited – TP	Just Burning
6	Wilderness Study Areas	Unsuited – TP	-----
7	Wilderness	Unsuited – TP	-----
8	Experimental Forests	Unsuited – TP	All Treatments
9	Roan Mountain	Unsuited – TP	-----
10	Research Natural Areas	Unsuited – TP	-----
11	Cradle of Forestry in America	Unsuited – TP	All Treatments
12	Developed Recreation Sites	Unsuited – TP	-----
13	Special Interest Areas	Unsuited – TP	-----
14	Appalachian Trail Corridor	Unsuited – TP	-----
15	Wild and Scenic River Corridors	Unsuited – TP	-----
16	Admin Sites	Unsuited – TP	-----
17	Balds	Unsuited – TP	-----
18	Riparian Areas	Unsuited – TP	Embedded in other MAs
U	Old acquisitions unassigned MA	Unsuited – TP	-----
U-New	New acquisitions unassigned MA*	Unsuited – TP	-----

* Several small areas of the forest were acquired under the existing forest plan but were not assigned a management area. These areas were not assigned a management area in this analysis and were analyzed as unassigned.

Objectives for Alternative A

The planning team determined that the no-action/current condition for Alternative A is work that has happened in the last five years. To generate the objectives for Spectrum, historical data was compiled for activity types including harvest and prescribed fire. Forestwide targets for activity levels were determined from these data and applied as targets to attain in the model. A subset of the management area and geographic area distribution data, expressed as percentages, was translated into Spectrum constraints in order to distribute the target activity levels in a manner similar to the past (Tables 12 a - f).

Table 12a. Historic Distribution of Harvest Types within the Nantahala & Pisgah Management Areas*

Alt. A MA	EA Regen	Salvage	Thinning	UEA Regen	% of Total Harvest
5 - 18	--	--	--	--	0.8
% in MA 1b	73	7	20	--	4.4
% in MA 2a	43	18	36	3	10.5
% in MA 2c	80	11	9	--	2.1
% in MA 3b	67	24	8	1	48.2
% in MA 4a	56	26	4	15	7.9
% in MA 4c	46	52	--	2	3.2
% in MA 4d	74	4	14	8	22.4
% in New Aq	76	14	10	--	0.5

*Based on Forest Activity Tracking System (FACTS) and Timber Information Management (TIM).

Table 12b. Historic Distribution of Harvest Types within the Nantahala and Pisgah Geographic Areas*

Geographic Area	EA Regen %	Salvage %	Thinning %	UEA Regen %	GA Harvest %
Nantahala Mtns	75	8	16	--	22.1
Unicoi Mtns	85	4	3	8	17.5
Fontana Lake	15	53	32	--	14.9
Eastern Escarpment	63	37	--	--	12.3
Pisgah Ledge	51	--	34	15	8.0
Highland Domes	83	--	1	17	7.8
Great Balsam	95	--	5	--	7.4
Hiwassee	35	65	--	--	4.6
Nantahala Gorge	69	8	23	--	3.1
Black Mtns	91	9	--	--	2.1
Bald Mtns	100	--	--	--	0.1

*Based on Forest Activity Tracking System (FACTS) and Timber Information Management (TIM).

Table 12c. Timber Harvest Over the Last Five Years on the Nantahala and Pisgah

Fiscal Year	(Vol Cut/acres trt)
2017	16,311 CCF/ 767 acres
2016	26,818 CCF/ 1,271 acres
2015	19,793 CCF/ 756 acres
2014	12,136 CCF/ 649 acres
2013	17,043CCF/ 633 acres

Table 12d. Acres and Percent Prescribed Fire by Geographic Area

Geographic Area	Acres	%
Eastern Escarpment	13,629	21
Hiwassee	13,391	20
Nantahala Mtns	13,154	20
Black Mtns	6,771	10
Pisgah Ledge	6,030	9
Fontana Lake	3,567	5
Great Balsam	2,821	4
Nantahala Gorge	2,207	3
Unicoi Mtns	1,688	3
Bald Mtns	1,608	2
Highland Domes	741	1
North Slope	56	0
Total	65,663	100

Table 132e. Acres and Percent Prescribed Fire by Alternative A Management Area

MA	Acres	%
6	3	0
16	47	0
7	54	0
8	73	0
13	104	0
12	297	0
14	412	1
17	566	1

MA	Acres	%
11	1,145	2
2c	2,311	4
2a	2,468	4
U-New	3,198	5
1b	4,603	7
4a	6,246	10
4c	7,652	12
4d	9,686	15
5	10,672	16
3b	16,125	25
Total	65,663	100

Table 12f. Nantahala and Pisgah Burn Accomplishments CY 14 to 17

Calendar Year	Acres
2017	3,300
2016	11,673
2015	4,384
2014	9,257
4-Year Average	7,154

Two other objectives for Alternative A were based on data that was not present in the model, and therefore could not be modelled directly. The first was to have no harvest in riparian areas, and the second was to allow no harvesting in existing old growth patches. To make sure that these two objectives could be met, the solution harvest acres by management area were compared to the number of acres in each management area that were not in riparian and old growth patches. In no case did the harvest level exceed what was available, indicating that these objectives could be met.

The harvest of previously treated stands before additional second growth stands was decided to be an overall criteria to guide Alternative A. To model this, the objective function chosen to drive the model was to maximize the acres harvested in the first 100 years from stands that are currently 60 years old or younger, subject to meeting the other targets, limits, and constraints in the model.

Table 12g shows the full list of Spectrum constraints used to create Alternative A. See the explanation in “Interpretation of Objective and Constraint Tables for Alternatives,” above, for interpretation of this table. Constraints were adjusted iteratively as the model was refined. Additional explanation of certain constraints is available in the project record.

Table 12g. Spectrum Constraints on Alternative A

Target/Constraint (Category)	Periods of upper (UL) or lower (LL) limits
Acres burned forest-wide (BG1) cannot be more than 80000 in periods 1 to 10	UL 3
Acres burned forest-wide (BG1) must be at least 70000 in periods 1 to 10	LL 1-2
Acres receiving regeneration cuts (HV3) cannot be more than 7000 in periods 1 to 10	UL 1-10
Acres thinned (HV4) must be at least 1500 in periods 1 to 10	LL 2-4
Acres receiving regeneration cuts (HV3) must be at least 6500 in periods 1 to 10	

Target/Constraint (Geographic Area Controls)	Periods of upper (UL) or lower (LL) limits
Acres harvested in MA 2a (Hm2) in periods 1 to 5 must be at least 10.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 5	LL 2-5
Acres harvested in MA 3b (Hm3) in periods 1 to 5 must be at least 48.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 5	LL 4-5
Acres harvested in MA 4d (Hm4) in periods 1 to 5 must be at least 22.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 5	LL 1-4
Young forest acres in MA 1b (YM1) in periods 1 to 10 must be at least 5.00 percent of Total acres in MA 1b (AM1) in periods 1 to 10	LL 7
Acres BURNED in MA 4c (BM2) in periods 1 to 10 must be at least 12.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	
Acres BURNED in MA 4d (BM3) in periods 1 to 10 must be at least 15.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	
Acres BURNED in MA 5 (BM4) in periods 1 to 10 must be at least 16.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	
Acres BURNED in MA 3b (BM5) in periods 1 to 10 must be at least 25.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	
Young forest acres in MA 1b (YM1) in periods 1 to 10 cannot be more than 10.00 percent of Total acres in MA 1b (AM1) in periods 1 to 10	UL 1,3

Target/Constraint (Management Area Controls)	Periods of upper (UL) or lower (LL) limits
Acres harvested in Eastern Escarpment GA (HG4) in periods 1 to 7 cannot be more than 14.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	UL 2-5
Acres harvested in Nantahala Mtns (HG1) in periods 1 to 7 must be at least 19.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	LL 1-6

Target/Constraint (Management Area Controls)	Periods of upper (UL) or lower (LL) limits
Acres harvested in Nantahala Mtns (HG1) in periods 1 to 7 cannot be more than 23.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	UL 7
Acres harvested in Unicoi Mtns (HG2) in periods 1 to 7 must be at least 16.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	LL 1-6
Acres harvested in Unicoi Mtns (HG2) in periods 1 to 7 cannot be more than 20.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	
Acres harvested in Fontana Lake GA (HG3) in periods 1 to 7 must be at least 13.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	LL 1-7
Uneven age acres harvested in Unicoi Mtns. (Hg2) in periods 1 to 5 must be at least 8.00 percent of Acres harvested in Unicoi Mtns (HG2) in periods 1 to 5	LL 1-5
Acres harvested in Eastern Escarpment GA (HG4) in periods 1 to 7 must be at least 10.00 percent of Acres harvested forestwide (Hv1) in periods 1 to 7	LL 7
Uneven age acres harvested in Highland Domes (Hg5) in periods 1 to 5 must be at least 15.00 percent of Acres harvested in Highland Domes (HG5) in periods 1 to 5	LL 1-3
Uneven age harvest acres in Pisgah ledge (Hg6) in periods 1 to 5 must be at least 17.00 percent of Acres harvested in Pisgah Ledge (HG6) in periods 1 to 5	LL 1-5

Alternatives B, C, D, the Action Alternatives

The action alternatives are differentiated primarily by the number of acres assigned to the different management areas. For each alternative, the relevant management area map for that alternative was overlaid on the other land attribute layers to construct a unique analysis unit set for that Alternative as well as the addition of step 2 of the timber suitability analysis. As mentioned above, the starting point for the development of each dataset was the sustained yield limit dataset.

Management Areas and Permissible Management Actions

Assumptions cover related to management actions were synthesized based on forest plan ID team discussions. These assumptions were incorporated into the model for each action alternative and described Table 13a. Along with the actions permissible within each management area, assumptions addressing the intensity of harvest across the management areas for both Tier 1 and Tier 2 were development using the terrestrial ID team subset. These proportional assumptions are included in Table 13b. The management area assumptions represented in Tables 13a & b represent the primary inputs to the Spectrum models used for Alternatives B, C, and D. Secondary inputs related to GA and forest type group were developed but were not used as broadly. They were used where model actions could not easily be guided by the management area level assumptions. The geographic area assumptions are located in the project record.

Table 13a. Alternative B, C, and D Management Areas and Their Permissible Management Actions

Forest Plan Management Area Direction	
Management Area and Code	Permissible Management Actions
Interface (2)	Use high BA retention treatments
Matrix (1)	Standard BA retention
	Regeneration treatments more even-aged
Backcountry (3)	Higher amount of group selection and woodland habitat creation
	Use High BA retention when regenerating using even-aged treatments
	Increased use of fire in comparison to Matrix
EIA/SIA (4a, 4b)	Use Fire and Thinning primarily
	In cove forest type (10CVHw) use Group Selection and thinning only
	In WP Types (01WP, 05WpHw) use regeneration only treatments
AT (4a)	Use Fire and Thinning primarily
	In cove forest type (10CVHw) use Group Selection and thinning only
	WP Types (01WP, 05WpHw) use regeneration only treatments (High BA)
Byways (4b)	Use Fire and Thinning primarily
	In cove forest type (10CVHw) use Group Selection and thinning only
	WP Types (01WP, 05WpHw) use regeneration only treatments (High BA)
	Don't use CC management options
Heritage Corridors (4c)	Use Fire and Thinning primarily
	In cove forest type (10CVHw) use Group Selection and thinning only
	WP Types (01WP, 05WpHw) use regeneration only treatments (High BA)
	Don't use CC management options
Wild and Scenic Rivers (4d)	Wild – Fire Only
	Scenic – Fire and Thinning
	Recreational – All types but with high BA retention on regeneration
RNA (5R)	No Management
Wilderness/ WSA (7, 6)	No Management
Experimental Forests (8)	Open to all management (low intensity 1% of harvest)
Roan Mtn (9)	Individual tree and group selection in 02SF and 12NoHw
Cradle of Forestry (11)	Open to all management (low intensity 1% of harvest)

Table 13b. Alternative B, C, and D Management Areas and Their Estimated Relative Proportion of Activity

Management Area	Tier 1 MA Activity Distribution (%)	Tier 2^ MA Activity Distribution (%)
Matrix	92%	60%
Interface	3%	5%
EIAs*	3%	10%
Backcountry % other MAs	2%	25%

*Where the MA is present in Alternatives C and D. Within Alternative B the proportion of activity distribution was within the appropriate management are assignment that the EIA would have derived from.

^This is the allocation of the extra acres from Tier 2, NOT the total acres. Tier 1 related activities would still use the tier one activity distribution.

Management Objectives

For all the action alternatives, two sets of objectives, represented in the model as constraints, were developed: Tier 1 and Tier 2 objectives. For each tier, constraint levels were the same for all the alternatives. These were developed based on the draft forest plan objectives published in the consolidated terrestrial objectives section. They were transformed to represent a decagonal number as needed.

Table 14 shows the full list of Spectrum constraints used to create Tier 1 for Alternatives B, C, and D. See the explanation in “Interpretation of Objective and Constraint Tables for Alternatives,” above, for interpretation of this table. Additional explanation of certain constraints is available in the project record.

Table 14. Tier 1 Objectives and Constraints for Alternatives B, C, and D

Tier 1 Target/Constraint (Targets)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres harvested (all treatments) forest wide (HA2) cannot be more than 30000 in periods 1 to 20	UL 1-6,11,15-17,19	UL 1-6,15-17,19	UL 1-6,15-17,19
Acres burned forest-wide (BG1) must be at least 65000 in periods 1 to 2	LL 1	LL 1	LL 1
Acres burned forest-wide (BG1) cannot be more than 100000 in periods 1 to 10	UL 3,7,8	UL 3,7,8	UL 3,7,8
Acres receiving regeneration cuts (HV3) cannot be more than 12000 in periods 1 to 20	UL 2-20	UL 1-20	UL 2-20
YOUNG FOREST acres created by all mgmt (yng) must be at least 11000 in periods 1 to 2			
Regen Acre harvest in MA 2 (Hm6) must be at least 500 in periods 1 to 1	LL 1	LL 1	LL 1

Tier 1 Target/Constraint (Prohibitions)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres Allocated to Management in MA 5R, RNA (AMe) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Management in MAs 6, 7 (AMd) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Burn for Young Forest Creation in MA 8 (AMh) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1

Tier 1 Target/Constraint (Open Forest)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
YOUNG FOREST on Types 08,09,10,11,12 produced with regen cuts (YT1) in periods 1 to 4 must be at least 50.00 percent of YOUNG FOREST acres created by regen cuts (YP1) in periods 1 to 4	LL 1	LL 1	LL 1
OPEN FOREST condition acres on Types 03,04,06,07,08,09,11 (OT1) in periods 2 to 10 must be at least 90.00 percent of OPEN FOREST condition acres forestwide (OF1) in periods 2 to 10	LL 2,3		LL 2,3
OPEN FOREST condition acres forest-wide (OF1) must be at least 4000 in periods 2 to 10	LL 2	LL 2	LL 2

Tier 1 Target/Constraint (Management Controls)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres of For Type 10 allocated to GrpSel or MinLvl on MAs 4a-5b (AT3) in periods 1 to 1 must be equal to Acres of Forest Type 10 in MAs 4a,4b,4c,5a,5b (AT2) in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Group Selection on Admin. Unsuit lands (SM6) in periods 1 to 1 cannot be more than 10.00 percent of All acres Allocated to Group Selection (SM5) in periods 1 to 1			
Acres Allocated to Thin&Burn or Sanit. Thin on Admin Unsuit land (SM4) in periods 1 to 1 cannot be more than 10.00 percent of All acres Allocated to Thin and Burn or Sanitation Thinning (SM3) in periods 1 to 1	UL 1	UL 1	UL 1

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Tier 1 Target/Constraint (Management Controls)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres allocated to Regeneration Rxs on Admin Unsuit lands (SM2) in periods 1 to 1 cannot be more than 10.00 percent of Acres Allocated to Regeneration Rxs forestwide (SM1) in periods 1 to 1	UL 1	UL 1	UL 1
Acres allocated to Group Selection in Forest Types 10, 12 (GS2) in periods 1 to 1 must be at least 25.00 percent of Acres allocated to active management on Forest Types 10 & 12 (AT4) in periods 1 to 1	LL 1	LL 1	LL 1

Tier 1 Target/Constraint (Management Area Control)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres Allocated to Thin and Burn in MA 1 (BM6) in periods 1 to 1 cannot be more than 50.00 percent of Acres Allocated to Thin and Burn forestwide (BA1) in periods 1 to 1	UL 1	UL 1	UL 1
Acres Allocated to Prescribed Burn and Thin and Burn in MA 5a (BM9) in periods 1 to 1 must be at least 80.00 percent of Acres allocated to active management in MA 5a (AMj) in periods 1 to 1			
Acres Allocated to CC w High Retention in MAs 1&3 (AMg) in periods 1 to 1 cannot be more than 5.00 percent of Acres Allocated to Management, MAs 1&3 (AMf) in periods 1 to 1	UL 1	UL 1	UL 1
Acres Burned in MA 5a (BMA) must be at least 5000 in periods 1 to 20	LL 1-4, 11,17	LL 1-6,8-15,17-19	LL 1-20
Acres Allocated to CCRR or CCRH in MAs 3,5b,4a-d,8 (Hm5) in periods 1 to 1 must be at least 5.00 percent of Acres Allocated to CC HiRet or CC StdRet Forestwide (HV5) in periods 1 to 1	LL 1	LL 1	LL 1
Acres Allocated to Management in MA 2, Interface (AMa) in periods 1 to 1 cannot be more than 3.00 percent of Acres Allocated to Management (AA2) in periods 1 to 1			
Acres Allocated to Burn for Young Forest in MA 1 (BA4) in periods 1 to 1 cannot be more than 90.00 percent of Acres allocated to Burning for Young forest (BA2) in periods 1 to 1			

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Tier 1 Target/Constraint (Management Area Control)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres Allocated to Management in MA 1, Matrix (AMb) in periods 1 to 1 must be equal to 92.00 percent of Acres Allocated to Management (AA2) in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Burn for Young Forest in MAs 3,5b,4a-d,8 (BM8) in periods 1 to 1 must be at least 25.00 percent of Acres allocated to Burning for Young forest (BA2) in periods 1 to 1	LL 1	LL 1	LL 1
Acres Alloc to Thin&Burn, Prescribed burn, Sanit.Thin in MA 5a (BMa) in periods 1 to 1 must be equal to Acres allocated to active management in MA 5a (AMj) in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Clearcut Hi Retention in GeoArea HD, MAs 1&3 (AMi) in periods 1 to 1 cannot be more than 40.00 percent of Acres Allocated to CC w High Retention in MAs 1&3 (AMg) in periods 1 to 1			
Acres allocated to Thin and Burn in GeoArea HI, MA 1 (BG5) in periods 1 to 1 cannot be more than 40.00 percent of Acres Allocated to Thin and Burn in MA 1 (BM6) in periods 1 to 1			

Tier 1 Target/Constraint (Flow Control)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres receiving regeneration cuts (HV3) must not increase more than 17.65 percent. in periods 2 to 21			
Acres receiving regeneration cuts (HV3) must not decrease more than 15.00 percent. in periods 1 to 20			
Young Forest + Young Gaps (YNG) must not increase more than 15.00 percent. in periods 6 to 20	LL 8,9,10,16-18	LL 8,9,10,14-18	LL 8,9,10,14,16-18
Young Forest + Young Gaps (YNG) must not decrease more than 15.00 percent. in periods 6 to 20	LL 6,12,13	LL 6,12,13	LL 6,12,13
Acres harvested from Group Selection (GS1) must not increase more than 17.65 percent. in periods 2 to 21	LL 1,3,5,7,9,11,19	LL 3,5,7,9,11,13,19	LL 1,3,5,7,11,19

Tier 1 Target/Constraint (Burning)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
BURNING acres on Types 04,07,08 (BT5) in periods 1 to 10 must be at least 5.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10			
Acres Allocated to Thin and Burn forestwide (BA1) in periods 1 to 1 must be at least 8.00 percent of Acres allocated to burning Rx's forestwide (BA5) in periods 1 to 1	LL 1	LL 1	LL 1
BURNING acres on Forest Type 09 (BT4) in periods 1 to 10 must be at least 13.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	LL 1-7,9	LL 3-7,9	LL 1,3,4,6,7,9
Acres Allocated to Burn1 (prescribed burning) (BA3) in periods 1 to 1 must be at least 60.00 percent of Acres allocated to Burning for Young forest (BA2) in periods 1 to 1			
Acres burned forest-wide (BG1) must be at least 60000 in periods 3 to 10			
Acres Burned on ForTypes 03,04,06,07,08,09 (BT9) in periods 1 to 10 cannot be more than 75.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	UL 2,5,7-9	UL 1,2,7	UL 2,3,5,7,9
BURNING acres on Types 03,06 (BT3) in periods 1 to 10 must be at least 16.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	LL 1-5,7,9,10	1,2,4-10	LL 1-7,9,10
Acres allocated to Burning on For Type 02 (BT6) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1
Burning on ForTypes 04,07 (BT7) in periods 1 to 10 must be at least 15.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10			
Burning of Forest Type 08 (BT8) in periods 1 to 10 must be at least 6.00 percent of Acres burned forest-wide (BG1) in periods 1 to 10	LL 1,5,9,10	LL 1,5,6,8,9	LL 1,5,6,8-10

Table 15: shows the full list of Spectrum constraints used to create Tier 2 for Alternatives B, C, and D. See the explanation in "Interpretation of Objective and Constraint Tables for Alternatives," above, for interpretation of this table.

Table 15. Tier 2 Objectives for Alternatives B, C, and D

Tier 2 Target/Constraint (Target)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres receiving regeneration cuts (HV3) cannot be more than 35000 in periods 1 to 20	UL 1	UL 1	UL 1
Young Forest + Young Gaps (YNG) must be at least 60000 in periods 2 to 20			
Young Forest + Young Gaps (YNG) must be at least 57000 in periods 1 to 1			
Regen Acre harvest in MA 2 (Hm6) cannot be more than 500 in periods 1 to 10	UL 3-10	UL 1-10	UL 2-10
Young Forest + Young Gaps (YNG) cannot be more than 90000 in periods 1 to 20	UL 2-20	UL 3-20	UL 3-20
All Harvest acres forestwide (HA2) cannot be more than 65000 in periods 1 to 20	UL 1,2,5,6,14	UL 1	UL 1,2,5,6
Acres receiving regeneration cuts (HV3) must be at least 31000 in periods 1 to 20	LL 2-20	LL 2-20	LL 2-14, 16-20
Regen Acre harvest in MA 2 (Hm6) must be at least 300 in periods 1 to 10	LL 1-2		LL 1

Tier 2 Target/Constraint (Target)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
YOUNG FOREST on Types 08,09,10,11,12 produced with regen cuts (YT1) in periods 1 to 4 must be at least 50.00 percent of YOUNG FOREST acres created by regen cuts (YP1) in periods 1 to 4			

Tier 2 Target/Constraint (Proportional Controls)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Of the acres managed in Tier 2 in excess of the Tier 1 managed acres, 60 percent of those should be in MA 1	EQ 1	EQ 1	EQ 1
Of the acres managed in Tier 2 in excess of the Tier 1 managed acres, 25 percent of those should be allocated to Burning prescriptions	Had to do 60%	Had to do 48%	Had to do 60%
Of the acres managed in Tier 2 in excess of the Tier 1 managed acres, 75 percent of those should be allocated to regeneration harvest prescriptions	Could only reach 34%	Could only reach 45%	Could only reach 35%

Tier 2 Target/Constraint (Prohibitions)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres Allocated to Management in MA 5R, RNA (AMe) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Management in MAs 6.7 (AMd) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres allocated to Burning on For Type 02 (BT6) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1

Tier 2 Target/Constraint (Open Forest)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
OPEN FOREST condition acres forest-wide (OF1) must be at least 33000 in periods 4 to 10			
OPEN FOREST condition acres on Types 03,04,06,07,08,09,11 (OT1) in periods 2 to 10 must be at least 90.00 percent of OPEN FOREST condition acres forestwide (OF1) in periods 2 to 10	LL 5,6,10	LL 4-7, 10	LL 4-6, 9,10
OPEN FOREST condition acres forest-wide (OF1) must be at least 20000 in periods 3 to 3		LL 3	LL 3
OPEN FOREST condition acres forest-wide (OF1) must be at least 15000 in periods 2 to 2	LL 2	LL 2	LL 2

Tier 2 Target/Constraint (Management Controls)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres Allocated to Group Selection on Admin. Unsuit lands (SM6) in periods 1 to 1 cannot be more than 10.00 percent of All acres Allocated to Group Selection (SM5) in periods 1 to 1	UL 1	UL 1	
Acres Allocated to Thin&Burn or Sanit. Thin on Admin Unsuit land (SM4) in periods 1 to 1 cannot be more than 10.00 percent of All acres Allocated to Thin and Burn or Sanitation Thinning (SM3) in periods 1 to 1	UL 1	UL 1	UL 1
Acres allocated to Regeneration Rx's on Admin Unsuit lands (SM2) in periods 1 to 1 cannot be more than 10.00 percent of Acres Allocated to	UL 1	UL 1	UL 1

Tier 2 Target/Constraint (Management Controls)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Regeneration Rxs forestwide (SM1) in periods 1 to 1			
Acres allocated to Group Selection in Forest Types 10, 12 (GS2) in periods 1 to 1 must be at least 25.00 percent of Acres allocated to active management on Forest Types 10 & 12 (AT4) in periods 1 to 1	LL 1	LL 1	LL 1
Acres allocated to GROUP SELECTION (AMs) in periods 1 to 1 cannot be more than 15.00 percent of Acres Allocated to Management (AA2) in periods 1 to 1			
Acres of For Type 10 allocated to GrpSel or MinLvl on Mas 4a-5b (AT3) in periods 1 to 1 must be equal to Acres of Forest Type 10 in MAs 4a,4b,4c,5a,5b (AT2) in periods 1 to 1	EQ 1	EQ 1	EQ 1

Tier 2 Target/Constraint (MA Controls)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres Alloc to Thin&Burn, Prescribed burn, Sanit.Thin in MA 5a (BMa) in periods 1 to 1 must be equal to Acres allocated to active management in MA 5a (AMj) in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to Prescribed Burn and Thin and Burn in MA 5a (BM9) in periods 1 to 1 must be at least 80.00 percent of Acres allocated to active management in MA 5a (AMj) in periods 1 to 1			
Acres Allocated to CCRR or CCRH in MAs 3,5b,4a-d,8 (Hm5) in periods 1 to 1 must be at least 5.00 percent of Acres Allocated to CC HiRet or CC StdRet Forestwide (HV5) in periods 1 to 1	LL 1		LL 1
Acres Allocated to Thin and Burn in MA 1 (BM6) in periods 1 to 1 cannot be more than 78.00 percent of Acres Allocated to Thin and Burn forestwide (BA1) in periods 1 to 1	UL 1		UL 1
Acres allocated to Burn for Young Forest creation in MA 8 (AMh) must be equal to 0 in periods 1 to 1	EQ 1	EQ 1	EQ 1
Acres Allocated to CC w High Retention in MAs 1&2 (AMg) in periods 1 to 1 cannot be more than 8.00 percent of Acres Allocated to Management, MAs 1&2 (AMf) in periods 1 to 1	UL 1	UL 1	UL 1

Tier 2 Target/Constraint (GA Control)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres allocated to Thin and Burn in GeoArea HI, MA 1 (BG5) in periods 1 to 1 cannot be more than 40.00 percent of Acres Allocated to Thin and Burn in MA 1 (BM6) in periods 1 to 1			
Acres Allocated to Clearcut Hi Retention in GeoArea HD, MAs 1&3 (AMi) in periods 1 to 1 cannot be more than 40.00 percent of Acres Allocated to CC w High Retention in MAs 1&2 (AMg) in periods 1 to 1			

Tier 2 Target/Constraint (Flow Control)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Young Forest + Young Gaps (YNG) must not decrease more than 13.04 percent. in periods 2 to 21			
Acres harvested from Group Selection (GS1) must not increase more that 17.65 percent. in periods 2 to 21	LL 2-11,13,19		
Young Forest + Young Gaps (YNG) must not increase more that 33.33 percent. in periods 2 to 21	LL 2	LL 2	LL 2

Tier 2 Target/Constraint (Burning)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
Acres burned forest-wide (BG1) must be at least 95000 in periods 3 to 10			
Acres Allocated to Burn1 (prescribed burning) (BA3) in periods 1 to 1 must be at least 60.00 percent of Acres Allocated to Burning for Young Forest forestwide (BA2) in periods 1 to 1			
Acres Allocated to Burn for Young Forest in MA 1 (BA4) in periods 1 to 1 cannot be more than 90.00 percent of Acres Allocated to Burning for Young Forest forestwide (BA2) in periods 1 to 1			
Acres Burned in MA 5a (BMA) must be at least 5000 in periods 1 to 20		LL 1,2,4,6,8,10,	

Tier 2 Target/Constraint (Burning)	Alt B, Periods of Upper (UL) or Lower (LL) Limits	Alt C, Periods of Upper (UL) or Lower (LL) Limits	Alt D, Periods of Upper (UL) or Lower (LL) Limits
		12,14,16,18, 20	
Acres Allocated to Thin and Burn forestwide (BA1) in periods 1 to 1 must be at least 8.00 percent of acres allocated to burning Rxs forestwide (BA5) in periods 1 to 1	LL 1	LL 1	LL 1
Acres Allocated to Burn for Young Forest in MAs 3,5b,4a-d,8 (BM8) in periods 1 to 1 must be at least 25.00 percent of Acres Allocated to Burning for Young Forest forestwide (BA2) in periods 1 to 1	LL 1	LL 1	LL 1
Acres burned forest-wide (BG1) must be at least 85000 in periods 1 to 2			
BURNING acres on Forest Type 09 (BT4) in periods 1 to 10 must be at least 13.00 percent of acres burned forestwide (BG1) in periods 1 to 10			
Acres burned forestwide (BG1) must be at least 200000 in periods 1 to 10	LL 1-2	LL 1-2	LL 1-2
BURNING acres on Types 03,06 (BT3) in periods 1 to 10 must be at least 16.00 percent of acres burned forestwide (BG1) in periods 1 to 10		LL 1,3,4,7	LL 3,4
Burning of Forest Type 08 (BT8) in periods 1 to 10 must be at least 6.00 percent of acres burned forestwide (BG1) in periods 1 to 10	LL 1,4,8		LL 1,5,9
Burning on Forest Types 04,07 (BT7) in periods 1 to 10 must be at least 15.00 percent of acres burned forest-wide (BG1) in periods 1 to 10	LL 2,10		
Acres Burned on Forest Types 03,04,06,07,08,09 (BT9) in periods 1 to 10 cannot be more than 80.00 percent of acres burned forestwide (BG1) in periods 1 to 10	UL 1,3,4,7	UL 1,4,7	UL 1,3,4