FORESTED VEGETATION

Introduction

Ecosystem Management is the basis for analysis during the Forest Plan Revision effort. Modeling effects on Forested Vegetation was accomplished using the SPECTRUM Model.

SPECTRUM (Version 2.6) is modeling software developed by the USDA Forest Service to help provide decision support for forest plan revision. Utilizing mathematical programming techniques such as linear programming and goal programming, models can be built to explore allocation of resources, like budget, and scheduling of management actions, including no action, to achieve resource management objectives. RELMdss (Version 2.0a) software also uses mathematical programming techniques and is designed to evaluate the feasibility of strategic or non-spatial modeling results via disaggregation to more site-specific sub-units of a Forest, such as watersheds.

SPECTRUM and RELM models were constructed for each Forest by alternative to address three main questions. These are: first, what set of management actions, if any, need to be placed on the landscape to achieve the objectives of a particular alternative? Objectives were generally defined as a mix of forested vegetative desired future conditions over time. Secondly, what level of timber harvest is sustainable for this alternative? And third, can the scheduled levels of management activities derived in answer to questions 1 and 2 be disaggregated across 4th level hydrologic units in such a way that site-specific resource management standards and guidelines are not generally violated. This third question is intended to test the feasibility of implementing model-derived solutions for each alternative and to anticipate potential conflicts or risks. While lending assurance and increasing confidence that an alternative is implementable, it is, however, not a guarantee.

Using SPECTRUM software, models covering 16 decades were formulated for each National Forest, by alternative, with analysis units that represented approximately 120 vegetation conditions, described by Potential Vegetation Group (PVG) and by growth stage, moving through time down normal and managed pathways. The normal pathway primarily followed successional processes and was the default unless either a natural disturbance event occurred or a management action was scheduled. Natural disturbance was defined as stand-replacing (lethal) fire occurring at historical levels each decade. Management actions, such as resetting stand density with prescribed fire and/or mechanical treatment, resulted in managed pathways that reflected the outcome from such treatment. Desired future conditions (DFC) for each alternative were represented as goals for the number of acres to be maintained in specific growth stages, by PVG. SPECTRUM modeling sought to achieve the DFC of each alternative. Separate models were built for existing Wilderness Areas on the Payette and Sawtooth National Forests.

The model was also used to track additional information including fire hazard ratings; insect hazard ratings; estimated commercial harvest (in board feet and cubic feet) associated with mechanical treatment; acres of created openings, large trees, RELM information (equivalent replacement treatments); and budgetary costs. As a result, model solutions could be derived using a number of different objectives or perspectives on problem analysis.

Analysis Units

Analysis units are made up of forested land with distinctly different characteristics that can be estimated, modeled, combined, and then projected through time to analyze change. The Forest Plan Revision effort combined a variety of characteristics to develop analysis units that would focus on ecosystem processes and functioning while meeting the intent of the National Forest Management Act. The two major vegetation characteristics or components that were combined were growth stage (size class and canopy closure) and Potential Vegetation Groups (PVG). These groupings were then overlaid with rule sets or GIS coverages such as Management Prescription Categories (MPC) to finalize the analysis units and develop the analysis unit acreages for the SPECTRUM model. An analysis unit is the acres of a growth stage/PVG combination within a MPC.

Size Class

The Ecosystem Diversity Matrix (Haufler et al. 1996) was used as the basis for determining the breakdown of size classes to use in the SPECTRUM modeling effort. We simplified from 10 vegetative stages to 5 size classes by eliminating the breakdown by types of fire regimes (understory fire or stand-replacing fire). We did assign single or multi-storied designations to the growth stages (size class, canopy closure, PVG combinations) in the growth matrices (see below). Size class information was determined for all areas except the southern portion of the Sawtooth National Forest from Satellite Imagery (Landsat) processed for the Southwest Idaho Ecogroup by the University of Montana (Redmond et al. 1997). Current cover types, size, and canopy closure were determined from satellite imagery taken in 1991 to 1995. The two primary scenes for the Southwest Idaho Ecogroup, P41/R29 and P41/R30 were 1995 satellite scenes taken in mid-July to early August. Accuracy for size class on the two primary scenes was 44 percent (perfect) 83 percent (acceptable) for P41/R29, and 65 percent (perfect) 87 percent (acceptable) for scene P41/ R30. The southern portion of the Sawtooth used stand exam data (in the RMIS database) to determine proportionalities that were then applied to the forested acres within the Minidoka Ranger District of the Sawtooth National Forest.

Additional analysis of the satellite imagery and GIS information related to Burned Area Emergency Rehabilitation was completed after the fire season of 2000. This analysis provided a new coverage that was used for size class in areas affected by the large wildfires of 2000.

Size Classes are:

- **Grass Forbs/Shrub Seedling** (combined Grass Forbs and shrub seedling) – sizes from 0.0 to 0.9" Diameter Breast Height (DBH) are included in this category.
- **Sapling** – sizes 1.0 to 4.9" DBH are included in this category.
- **Small Tree** – sizes 5.0 to 12.0" DBH are included in this category.
- **Medium Tree** – sizes 12.1 to 20" DBH are included in this category.
- **Large Tree** – sizes 20.1 and larger DBH are included in this category.

Canopy Closure

The density of the vegetation was categorized into four canopy closure categories. They are used to determine the potential risks from insects or wildfire, and to estimate species composition. The higher the stand density, the less light reaches the forest floor, which favors climax species and increases the risk to insects and lethal fire. Some Potential Vegetation Groups, due to the harsh sites, do not reach a high-density condition, but only progress to moderate canopy closure. The Montana Satellite Imagery (Landsat) was also used for canopy closure. Accuracy for canopy closure on the two primary scenes were 53 percent (perfect), 96 percent (acceptable) for P41/R29, and 74 percent (perfect), 100 percent (acceptable) for scene P41/R30.

Additional analysis of the satellite imagery and GIS information related to Burned Area Emergency Rehabilitation was completed after the fire season of 2000. This analysis provided a new coverage that was used for canopy closure in areas affected by the large wildfires of 2000.

Canopy Closures are:

- **Open**– 0 to 9 percent canopy closure (when viewed from above).
- **Low** – 10 to 40 percent canopy closure.
- **Moderate** – 41 to 70 percent canopy closure.
- **High** – 71 percent and greater canopy closure.

Potential Vegetation Groups

Vegetation composition is influenced by environmental (site) characteristics. Using habitat types to classify the landscape provides a logical framework for studying succession, or vegetational changes over time. Habitat types were grouped into Potential Vegetation Groups (PVGs) based on the Ecosystem Diversity Matrix (Haufler et al. 1996). The PVGs were mapped using a variety of techniques for the Ecogroup. The Sawtooth National Forest classification used cover types, slope, aspect, elevation, Montana Landsat cover types and local knowledge to develop a Potential Vegetation map. The Boise National Forest used land types, slope, aspect, elevation, and a few selected Montana Landsat cover types to develop the Potential Vegetation map. The Payette National Forest used the 1995 inventory strata (with updates) to model PVGs along with aspect, slope, and elevation.

PVGs were then used to group size class and canopy closure into ecological units that would have similar responses to disturbances and have similar pathways through the successional stages. These groupings became the basis for the Growth Matrix (see below) and understanding the ecological process and function of the vegetation.

Potential Vegetation Groups are:

1. Dry Ponderosa Pine, Xeric Douglas-Fir
2. Warm Dry Douglas-Fir, Moist Ponderosa Pine
3. Cool Moist Douglas-Fir
4. Cool Dry Douglas-Fir
5. Dry Grand Fir
6. Cool Moist Grand Fir
7. Warm Dry Subalpine Fir
8. Warm Moist Subalpine Fir
9. Hydric Subalpine Fir
10. Persistent Lodgepole
11. High Elevation Subalpine Fir

Tentatively Suited Timberland Acres

Tentatively suited timberlands have been reassessed as part of Forest Plan Revision for the three Ecogroup National Forests. Reassessment of tentatively suited timberlands has been completed in accordance with the National Forest Management Act, as contained in Forest Plan regulations 36 CFR § 219.14 and Forest Service Handbook FSH 2409.13, Chapter 20. The National Forest Management Act requires that, as a minimum, lands previously identified as not suited be reassessed at least every 10 years. Since current efforts to revise the Forest Plans coincide with the need to reassess timberlands not suited, a complete reassessment of suited timberlands is being performed. This allows for a comprehensive examination of the status of timberlands on each National Forest that will take into account changes since the previous assessment of timberlands. Some of these changes include changes in land ownership, increased knowledge and experience with reforestation efforts, large wildfire events, and increased knowledge and experience regarding timber management effects on soils and water quality.

Assessment of tentatively suited timberlands was accomplished using Geographic Information Systems (GIS). Use of GIS results in consistent identification of each of the following data elements:

- Net National Forest land area administered by each Forest.
- National Forest lands that are not forested.
- National Forest lands that have been withdrawn from timber production.
- Areas that are physically unsuited for timber production due to the inability to assure adequate restocking, or irreversible damage to soils or watersheds.

Table B-1. Steps and Data Sources for Assessing Tentatively Suited Lands

Steps for Assessing Tentatively Suited Lands	Data Sources
1). Determine net National Forest system land area for each National Forest.	Lands data in GIS
2). Identify non-forested lands. These lands include: • Non-forested vegetation determined as part of the modeling of Potential Vegetation Groups • Roads. • Streams. • Lakes, ponds and reservoirs $\geq$ 1 acre is size. • State and county roads on National Forest system lands	From PVG modeling efforts using Landsat imagery and non-forested cover types. The remaining items identified here should be available from a several data layers in GIS.
3). Identify and subtract National Forest system lands that have been withdrawn from timber production including: • Designated wilderness areas. • Research Natural Areas. • Wild segments of wild and scenic rivers (outside of wilderness areas). • Experimental Forests • Other withdrawn areas * Utility right-of-way corridors. * Electronic sites. * Administrative sites (unless previously identified in step 2 as areas withdrawn from timber production). * Developed campgrounds. The products resulting from completion of steps 1, 2 and 3 will be: Identification of available forested lands, identification of unavailable withdrawn lands, and non-forested lands.	Each of the identified items should be available from data layers in GIS .
4). Identification of physically unsuited lands. These lands will include all forested lands in PVGs 1 and 11.	Potential Vegetation Group maps (described above).

Management Prescription Categories (MPCs)

The array of MPC assignments to the alternatives were modeled in SPECTRUM. Alternatives vary primarily by the different MPCs that are applied to subwatersheds or sixth-field hydrologic units (or groups or parts of 6th HUCs). See Chapter 2 in this EIS, and Chapter III in the Forest Plans for a complete description of MPCs.

MPCs that preclude mechanical treatments, or where management direction focuses on restoration without providing for a sustainable level of outputs, were labeled as unsuited. MPCs that have mechanical treatments and provide for a sustainable level of outputs were labeled as suited. Mechanical treatments within unsuited MPCs will accrue volume (based on outcome of meeting Desired Future Conditions) toward the Total Sale Program Quantity (TSPQ). Mechanical treatments within suited MPCs will accrue volume (based on outcome of meeting DFCs) toward the Allowable Sale Quantity.

Assumptions used to determine unsuited vs. suited for MPCs:

MPC - 1.1 Existing Wilderness
Not tentatively suited as described above.

MPC - 1.2 Recommended Wilderness
Unsuited - all areas given this MPC were labeled unsuited, as management direction precludes mechanical treatments.

MPC - 2.1 Wild Rivers
Not tentatively suited as described above.

MPC - 2.1 Scenic and Recreational Rivers
These MPCs are not being used during the modeling process. Standards and guidelines are in the Forest Plans to address management in these areas.

MPC - 2.2 Research Natural Areas
Not tentatively suited as described above.

MPC - 2.3 Boise Basin Experimental Forest
The Experimental Forest was not separated out during modeling for attaining DFCs, but was removed from the tentatively suited base before modeling of the Forested Vegetation in SPECTRUM.

MPC - 3.1 Passive Restoration and Maintenance of Aquatic, Terrestrial, and Hydrologic Resources
Unsuited - all areas given this MPC are unsuited because mechanical treatments generally do not meet the intent of this MPC.

MPC - 3.2 Active Restoration and Maintenance of Aquatic, Terrestrial, and Hydrologic Resources
These areas are unsuited for timber management, as the MPC standards are linked to restoration of ecological conditions for aquatic and terrestrial habitat, not linked to producing a sustainable level of timber goods and services. Management Actions with mechanical treatments were used only to estimate Total Sale Program Quantity.

MPC - 4.1 Undeveloped Recreation Emphasis
This MPC is unsuited for timber management because the MPC standards are linked to sustaining the Recreation Opportunity SPECTRUM class of semi-primitive recreation, and is not compatible with providing sustainable levels of timber goods and services. Management Actions with mechanical treatments will be used only to estimate Total Sale Program Quantity. This MPC was further broken into three subcategories (4.1a does not allow mechanical treatments, 4.1b allows salvage of dead on a limited basis, and 4.1c allows limited mechanical restoration treatments).

MPC - 4.2 Roaded Recreation Emphasis

With a wide variety of activities allowed, including objectives for production of timber products, this MPC is suited for timber management. Generally outcomes from Management Actions that produce a timber product accrue volume to the ASQ.

MPC - 4.3 Concentrated Recreation Emphasis
With a focus on concentrated recreation, this emphasis is not compatible with providing sustainable levels of timber goods and services. Management Actions with mechanical treatments will be used only to estimate Total Sale Program Quantity.

MPC - 5.1 Restoration and Maintenance within Forested Landscapes
With a wide variety of activities allowed, including objectives for production of timber products, this MPC is suited for timber management. Adjustments to estimated yields did occur to ensure meeting goals for the Management Areas related to restoration and maintenance objectives. Outcomes from Management Actions that produce a timber product accrue volume to the ASQ, but emphasis will be on meeting goals and objectives related to restoration and maintenance.

MPC - 5.2 Commodity Production Emphasis within Forested Landscapes
This MPC is suited for timber management. Goals and objectives focus on production of a sustainable level of timber goods and services while providing for ecological values. Outcomes from Management Actions that produce a timber product will accrue volume to the ASQ.

MPC - 6.1 Restoration and Maintenance within Shrubland and Grassland Landscapes
With a wide variety of activities allowed, including objectives for production of timber products, this MPC is suited for timber management. Adjustments to estimated yields would occur to ensure meeting goals for the Management Areas related to restoration and maintenance objectives. Generally outcomes from Management Actions that produce a timber product accrue volume to the ASQ, but emphasis will be on meeting goals and objectives related to restoration and maintenance. Since less than 50 percent of the area within this MPC are forested, it is likely the forested areas are on the northern facing slopes in stringers intermingled with grass, shrubs, and other non-forested types.

MPC - 6.2 Commodity Production Emphasis within Shrubland and Grassland Landscapes
This MPC is suited for timber management. Outcomes from Management Actions that produce a timber product accrue volume to the ASQ. Since less than 50 percent of the area within this MPC are forested, it's likely the forested areas are on the northern facing slopes in stringers intermingled with grass, shrubs, and other non-forested types.

The individual MPCs were combined into MPC groups to simplify the modeling process and reduce the number of analysis units. For each Alternative, the acres of Growth Stage/PVG combinations (with suited or unsuited label) within each MPC group are the final analysis units that were modeled in SPECTRUM.

- MPC 1.1 was not combined with other MPCs.

- MPC 2.1 (2.1 is Wild River segments; Scenic River segments are handled through goals, objectives and standard and guidelines) and combined with 1.2, 2.0, 2.2, 4.1a, and 4.1b. Similar management direction generally precludes timber management activities (best fit).

- MPC 2.4 was combined with MPC 4.1c; Management direction and goals within Management areas would be similar to those assigned to MPC 4.1c. The acres in MPC 2.4 are relatively small (0.1 percent of the Ecogroup area).

- MPC 3.1 was not combined with other MPCs.

- MPC 3.2 was combined with 4.3 and 8.0 to assure they were not part of the suited base. Acres of 4.3 and 8.0 are very small and only occur is a few of the alternatives.

- MPC 4.2, 5.1 and 6.1 were combined into one group, because similar management actions will be applied and all are in the suited base.

- MPC 5.2, and 6.2 were combined into one group, because similar management actions will be applied and all are in the suited base.

Seven MPC groups were developed:
- Group 1 - MPCs 1.2, 2.1(wild), 2.0, 2.2, 4.1a, and 4.1b
- Group 2 - MPCs 4.1c, 2.4 (Boise Experimental Forest)
- Group 3 - MPC 3.1
- Group 4 - MPC 3.2, 4.3 and 8.0
- Group 5 - MPCs 4.2, 5.1, and 6.1
- Group 6 - MPCs 5.2, and 6.2
- Group 7 - MPCs 1.1 existing wilderness

Riparian Conservation Areas (RCAs)

These sensitive areas were determined from the GIS stream layer with streams buffered to a width of 300 feet on either side of perennial streams and 150 feet on either side of intermittent streams (Thornton, in the planning record, and meta data for the RCA layer). A Riparian Conservation Area layer was developed for use in Forest Plan revision.

Table B-2. Adjustments to MPC Assignments to Reflect RCA Management by Alternative

Current MPC	MPC Group	Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
1.1	7	NC	NC	NC	NC	NC	NC	NC
1.2, 2.1, 2.2, 4.1a, 4.1b	1	NC	NC	NC	NC	NC	NC	NC
4.1c, 2.4	2	NC	NC	NC	3.1	NC	3.1	3.1
3.1	3	NC	NC	NC	NC	NC	NC	NC
3.2, 4.3, 8.0	4	NC	NC	NC	3.1	NC	3.1	3.1
4.2, 5.1, 6.1	5	3.1	3.2	3.2	3.1	NC	3.1	3.2
5.2, 6.2	6	3.1	3.2	3.2	3.1	5.1	3.1	3.2

NC = No Change.

The analysis units by MPC were adjusted to reflect a different level of management for many of the RCAs. Table B-2 shows how the analysis units within RCAs in many of the MPCs were shifted to other MPCs to reflect a different level of management that linked to the intent of the alternative. For example, in Alternative 2, analysis units that are within RCAs in MPC 3.1 will be managed similar to other land in MPC Group 3 (no change). But analysis units that are within RCAs in MPC Group 5 will be managed similar to areas that would fall into MPC Group 4. This is intended to reflect the more restrictive management direction for RCAs within Alternative 2 than Alternative 5.

Landslide-prone (LSP) Areas

These sensitive areas were determined using the SINMAP (Stability Index MAPping) model (Pack et al. 1997). A landslide-prone layer was developed for use in Forest Plan Revision. The layer had four categories of risk: High, Moderate, Low, and Stable. The analysis units by MPC were adjusted to reflect a different level of management for many of the landslide-prone risk categories. Tables B-3 through B-5 show how the analysis units within various landslide-prone risk categories in many of the MPCs were shifted to other MPCs to reflect a different level of management linked to the intent of the alternative. Stable areas were not adjusted. For example, in Alternative 2, analysis units that are within LSP High Risk in MPC 3.1 will be managed similar to other land in MPC Group 3 (no change). But analysis units that are within LSP High Risk in MPC Group 5 will be managed similar to areas that would fall into MPC Group 3. This is intended to reflect a more restrictive management direction for LSP High Risk within Alternative 2 than Alternative 5.

Table B-3. Alternatives with Modified MPC Assignments for LSP Areas – High Risk

Current MPC	MPC Group	Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
1.1	7	NC	NC	NC	NC	NC	NC	NC
1.2, 2.1, 2.2, 4.1a, 4.1b	1	NC	NC	NC	NC	NC	NC	NC
4.1c, 2.4	2	NC	NC	NC	3.1	NC	NC	3.1
3.1	3	NC	NC	NC	NC	NC	NC	NC
3.2, 4.3, 8.0	4	NC	NC	NC	3.1	NC	NC	3.1
4.2, 5.1, 6.1	5	3.1	NC	3.2	3.1	NC	NC	3.2
5.2, 6.2	6	3.1	5.1	3.2	3.1	5.1	5.1	3.2

NC = No Change

Table B-4. Alternatives with Modified MPC Assignments for LSP – Moderate Risk

Current MPC	MPC Group	Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
1.1	7	NC	NC	NC	NC	NC	NC	NC
1.2, 2.1, 2.2, 4.1a, 4.1b	1	NC	NC	NC	NC	NC	NC	NC
2.3, 4.1c	2	NC	NC	NC	3.1	NC	NC	NC
3.1	3	NC	NC	NC	NC	NC	NC	NC
3.2, 4.3, 8.0	4	NC	NC	NC	3.1	NC	NC	NC
4.2, 5.1, 6.1	5	NC	NC	NC	3.1	NC	NC	NC
5.2, 6.2	6	5.1	NC	5.1	3.1	NC	NC	5.1

NC = No Change

Table B-5. Alternatives with Modified MPC Assignments for LSP – Low Risk

Current MPC	MPC Group	Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
1.1,	7	NC	NC	NC	NC	NC	NC	NC
1.2, 2.1, 2.2, 4.1a, 4.1b	1	NC	NC	NC	NC	NC	NC	NC
2.3, 4.1c	2	NC	NC	NC	NC	NC	NC	NC
3.1	3	NC	NC	NC	NC	NC	NC	NC
3.2, 4.3, 8.0	4	NC	NC	NC	NC	NC	NC	NC
4.2, 5.1, 6.1	5	NC	NC	NC	3.2	NC	NC	NC
5.2, 6.2	6	NC	NC	5.1	3.2	NC	NC	NC

NC = No Change

SPECTRUM Acres

Acres by growth stage and PVG for sixth-field Hydrologic Unit or smaller units (poly-id in GIS Management Area layer) were input into an Oracle database. MPCs were generally assigned by Inventory Roadless Areas (IRA) or non-IRA areas within sixth-field Hydrologic Units (poly-id) and input into an Oracle database. The acres of growth stage and PVG within RCAs and Landslide-Prone Hazard Categories were input into an Oracle database. Queries to the Oracle databases were used to generate the analysis unit label (including suited/unsuited) and the associated acres. Using this process generated accurate acreages for the SPECTRUM model, but their spatial relationships were not maintained. Analysis units that were less than 50 acres in size were generally lumped into closely matching analysis units to limit model size. An analysis unit could contain acres from the southern portion of a Forest, the middle of the Forest, and the northern end, if they were the same Growth Stage/PVG combination within the same MPC. The number of analysis units varied by Alternative, but the Boise NF had about 550 analysis units, the Payette about 600 analysis units, and the Sawtooth about 350 analysis units.

Modeling Forested Ecosystem Process And Function

The modeling effort focused very strongly on the ecological process and function of the forested landscape and the inter-relationships between successional pathways (how vegetation changes over time) and disturbance processes (both natural and human induced). Coordination between Silviculturists and Fire Management specialists within the Ecogroup provided the professional knowledge to refine the scientific information related to ecological process and function (Steele et al. 1981, Steele and Geier-Hayes 1987, 1989, Crane and Fisher 1986).

<u>**Growth Matrix**</u>
Successional Pathways were determined for each Potential Vegetation Group. There were two pathways defined; one for vegetation succession without disturbance (referred to as the normal pathway), the other for vegetation succession with disturbance processes (referred to as the managed pathway). These pathways, called Growth Matrices (Nass et al. 1998, in the planning record) were developed in tabular format with the density (canopy closure) as the columns and size class as the rows (see Table B-6). The length of time analysis unit acres would remain in a particular cell of the matrix was assigned and the movement toward other cells was indicated. Each cell was defined using trees per acre by size and basal areas, this assisted in assigning a structure (single or multi-storied condition) to each cell. These Growth Matrices were reviewed, discussed and adjusted numerous times by the Silviculturists and Fire Management specialists within the Ecogroup. Each Potential Vegetation Group has its own set of pathways, often with different ages, structure, and length of time within cells and different path movement between cells.

Table B-6. Schematic Design of Growth Matrix

Growth Matrix Design Without Disturbance	Open Canopy Closure 0 – 9%	Low Canopy Closure 10 – 40%	Moderate Canopy Closure 41 – 70%	High Canopy Closure Greater than 71%
Grass Forbs / Shrub Seedling 0 to 0.9" DBH	0 - 20 years Single story			
Sapling 1.0 to 4.9" DBH		20- 30 years Single story	30 to 50 years Single Story	
Small tree 5.0 to 12.0" DBH				60 to 90 years Multiple story
Medium tree 12.1 to 20" DBH				90-140 years Multiple story
Large tree 20.1 and larger DBH				140 + years Multiple story

These matrices by PVG became a major component of the SPECTRUM model and were used to determine future forested landscape conditions from the various levels of management prescribed by the alternatives to achieve Desired Future Conditions.

Wildfire Hazard - Each cell in the Growth Matrix was assigned a wildfire hazard index (0, 0.5, 1.0, 1.5, 2.0, 2.5 or 3.0) related to the size class, canopy closure of the individual cell and based on the Potential Vegetation Group (PVG). The 11 PVGs were combined into fire regimes (non-lethal, mixed 1, mixed 2, and lethal) (Geier-Hayes et al. in the planning record, Crane and Fisher 1986). The fire regime assigned to the PVG helped determine the hazard of an uncharacteristic fire occurring in that cell.

Insect Hazard - Each cell in the Growth Matrix was assigned an insect hazard index (0, 1.0, 2.0, or 3.0) related to the size class, canopy closure, and structure characteristics of the individual cell and based on the Potential Vegetation Group (Nass et al., in the planning record). The value assigned to each cell was determined by using the stand hazard rating developed by Steele et al. 1996 and habitat type groups on the Ecosystem Diversity Matrix (Mehl et al. 1998) with local knowledge from Ecogroup silviculturists.

Wildfire Index - Wildfires occur frequently in the Ecogroup (average of over 350 fire starts per year). With the current fire suppression tactics, the fires generally burn between 5,000 and 10,000 acres per year across the Ecogroup (50,000 to 100,000 per decade) as small 0.5 acre to 100-acre fires. This background fire disturbance was included in the modeling process as "natural disturbance". The historical range of variability (HRV) information developed regarding lethal fire frequency for the Southern Idaho Batholith (Morgan and Parsons 1998) was used to determine the percent of Wild Stand Replacing Fire that would be expected, by size class and PVG (by cell). This percentage from the HRV modeling effort was adjusted based on the fire hazard value for each cell. If there was a high hazard value (e.g., 3.0) and the HRV information indicated that a wild stand replacing fire was expected to occur once every 250 years (0.4 percent) for that size class and PVG; then the wildfire index was calculated using the formula of: .4 + .4(3) = 1.6 percent rounded to the nearest whole number (2.0) as the model could only use whole numbers. The model would take 2 percent of the acres in that growth matrix cell and assume that these acres were part of the natural disturbance and shift them back to the grass/forbs-shrub/seedling stage in the growth matrix. By using the estimated percent of lethal fire by PVG from the HRV model (Morgan and Parsons 1998), the natural variation for lethal fire within fire regimes would be considered, but the wildfire index would be adjusted for current conditions that could be more hazardous (the fire hazard value).

Management Actions

Disturbance processes affect forest vegetation succession processes. Management actions were developed to reflect human induced disturbance processes into the modeling effort. The management actions vary by MPC and by PVGs. For example, prescribed fire is viable in PVGs with non-lethal fire regimes, but is not as viable in lethal fire regime vegetation groups in MPC 5.1. For each PVG and for each MPC, the most viable Management Actions were selected for modeling in SPECTRUM (Geier-Hayes et al., in the planning record, Morelan et al., in the planning record). Management actions are a combination of initial and future actions. For example, the initial action may be to replace the stand with mechanical activities (R2) because the current species mix is climax vegetation (grand fir), the future action may be to maintain the area in large tree low density to favor seral species using a mixture of fire and mechanical (M4). Table B-7 displays an example of the most viable management actions for MPC Group 4 (MPC 3.2) in the Moist Grand Fir PVG.

Twelve Management Actions were developed to reflect different intensities of human-induced disturbance processes and no management. They are grouped into four divisions.

Replace (R) – This action replaces the existing vegetation and shifts the area back to the grass/forbs/shrub/seedling stage.

- R1 – indicates that fire use would be the tool that replaces the existing growth matrix cell and shifts the acres to the grass/forbs-shrub/seedling cell.
- R2 – indicates that mechanical treatments would be the tool that replaces the existing growth matrix cell and shifts the acres to the grass/forbs-shrub/seedling cell.
- R3 – combines the use of fire as a tool along with mechanical treatments. This is applied to initial actions only.
- R4 – combines in an alternating pattern the use of fire and mechanical treatments. The final replacement would use mechanical treatments. This management action would only be used for future actions.

Reset (Re) – This action manipulates the vegetation by shifting the crown closure within the same size class. If this management action occurred in a high-density crown closure growth cell, those acres would be shifted back to moderate density, without a change in size class. This is applied to initial actions only as future thinnings are addressed in R2, R4, M2, and M4.

- Re1 – indicates that fire use would be the tool to change the crown closure and move acres into another cell.
- Re2 – indicates that mechanical treatment would be the tool to change the crown closure and move acres into another cell.
- Re3 – indicates that a mixture of fire use and mechanical treatments would be the tools to change the crown closure and move acres into another cell.

Maintain (M) – This action manipulates the vegetation so it stays within the same cell. If this management action occurred in a moderate density, large tree growth cell, management tools would maintain the vegetation in that cell.

- M1 – indicates that fire use would be the tool to maintain the vegetation in a growth cell.
- M2 – indicates that mechanical treatments would be used to maintain the vegetation in a growth cell.
- M3 – indicates that a combination of fire use and mechanical would be used to maintain the vegetation in a growth cell. This is used for initial treatments only.
- M4 – indicates that a mixture of fire use and mechanical would be used to maintain the vegetation in a growth cell. For example: use fire to maintain large tree moderate density and then 30 or 40 years later use mechanical treatments to maintain the desired condition, then 30 or 40 years later use fire again. This management action would only be used for future actions.

No action (N) – this would indicate continuing to move the acres along the natural pathways. Once a replace, reset, or maintain management action is selected by the model; the pathways on the managed pathways are used and N is not longer an option.

Table B-7. Viable Management Actions for PVG 6 in MPC Group 4

Potential Vegetation Group 6 (COOL MOIST GRAND FIR)					**MPC Group 4 (MPC 3.2, 4.3 and 8.0)**			
Initial \ Future	**R1**	**R2**	**R4**	**M1**	**M2**	**M4**	**N**	Rows reflect initial actions and the columns future actions. The management action is a combination of initial and future. E.g. R1M1, R1M4 or R3M4
R1	V	NV	NV	V	NV	V	NV	
R2	NV	VN	LV	NV	VN	LV	NV	
R3	NV	VN	V	NV	VN	V	NV	
Re1	V	NV	LV	V	NV	V	NV	
Re2	NV	VN	V	V	VN	V	NV	
Re3	NV	VN	LV	LV	VN	LV	NV	
Initial \ Future	**M1**	**M2**	**M4**	**N**				
M1	V	NV	V	NV		NV	= NOT VIABLE FOR THE PVG	
M2	NV	VN	LV	NV		VN	= NOT VIABLE FOR THE MPC	
M3	NV	VN	V	NV		LV	= LESS VIABLE FOR THE MPC	
N	NV	NV	NV	V		V	= MOST VIABLE FOR THE MPC	

Activity Strings

Each Management Action, by MPC and by PVG, has a set of activities prescribed with a timing sequence. The timing sequence was strongly influenced by the fire regimes and other ecological processes for the PVGs. The activities allowed (mechanical, fire use, mechanical/fire use combination) were strongly influenced by the MPC and the ecological processes for the PVGs. Table B-8 provides the list of activities that could be included into the Management Action activity strings, either individually or in combination with each other. The number following the activity is the timing sequence. Once a management action is selected the activities will follow the timing sequence.

Table B-8. Activities Within Management Action Activity Strings

Activities	Brief Description of Activities
Wildland fire use (PNF in the SPECTRUM model)	Managing lightning-ignited fires to meet resource objectives (previously referred to as prescribed natural fire – PNF).
Prescribed fire (MIF in the SPECTRUM model)	Fires ignited by land management agencies to meet resource objectives (previously referred to as management ignited fire – MIF)
Precommercial Thinning (PCT)	Mechanically thinning the stand when the trees are generally less than 5 inches in diameter.
Commercial Thinning From Below (CTFB)	Mechanically thinning the stand when the trees are generally greater than 8 inches in diameter and focusing on taking the smaller, weaker, and poorest form trees to restore resilience.
Commercial Thinning (CT)	Mechanically thinning the stand when the trees are generally greater than 10 inches in diameter and focusing on generating increased growth rates and leaving high quality trees.
Irregular Shelterwood (IRSW)	Mechanically treating the stand to create space for regeneration of seral species while maintaining large tree structure on the site. Overstory trees remain on site and are not removed at a later date.
Shelterwood (SW)	Mechanically treating the stand to create space for regeneration of seral species while maintaining large tree structure on the site. A portion of the trees remaining onsite are removed later to favor the regenerated young trees.
Overstory Removal (OR)	Mechanically removing a portion of the trees remaining after a shelterwood treatment to favor the regenerated young trees.
Selection (Select)	Mechanically removing a portion of the trees of the various size classes to provide an unevenaged or unevenaged group structure. Also used to maintain the desired structure and species composition.
Planting (PLT)	Adding trees to the site, generally favoring the seral species
Site Preparation for Natural Regeneration (NR)	Preparing site conditions that will improve the success of getting natural regeneration to occur. Natural Regeneration often includes a mix of seral and climax species.

Table B-9, provides an example of the activity strings for Management Actions in Management Prescription Category 3.2 and Potential Vegetation Group 6.

Budgetary Costs

A cost was developed for each activity in the Management Action and this cost was incorporated into the activity string. This cost relates to the amount of funding the Forest Service has used historically to accomplish an acre of that activity, and therefore, is referred to as a budgetary cost. These costs are used to constrain the amount of management actions implemented in an alternative to reflect a "reasonable" budget level. These budgetary costs also provide a portion of the overall cost of implementing an alternative. The costs for each activity are held constant and therefore provide for consistency across alternatives.

Openings

Management Action activities that create openings using mechanical treatments were indicated on the activity strings. Often the intensity of a treatment creates an opening in one MPC or PVG, but not in others. Management-created openings are limited to 40 acres or less for the analysis process, as specified in the National Forest Management Act (NFMA). An adjacent opening cannot be created until the treated area is no longer considered an opening. This is referred to as dispersion, and modeling of that constraint (dispersion constraint) is covered in the Constraint section below.

Table B-9. Example of Management Action Activity Strings
Management Prescription Category 3.2 – Potential Vegetation Group 6

Mgt. Actions	First Activity	Second Activity	Third Activity	Fourth Activity	Fifth Activity	Sixth Activity	Seventh Activity	Eighth Activity
R1 R1	PNF	as needed						
Costs/ac.	35							
Opening Y/N	N							
R1 M1	PNF 0	MIF 4	MIF 8	every 40 years				
Costs/ac.	35	110	110					
Opening Y/N	N	N	N					
R1 M4	PNF 0	Plt/Nr 0	PCT 2	MIF 5	MIF 8	Select/PC T/Plt/Nr 10	MIF 14	Select/PC T/Plt/Nr 18
Costs/ac.	35	455	240	110	110	1715	110	1715
Opening Y/N	N	N	N	N	N	N	N	N
RE1 M1	MIF 0	MIF 4	every 40 years					
Costs/ac.	110	110						
Opening Y/N	N	N						
RE1 M4	MIF 0	Select/PC T/Plt/Nr 4	MIF 8	Select/PC T/Plt/Nr 12	every 40 years			
Costs/ac.	110	1715	110	1715				
Opening Y/N	N	N	N	N				
RE2 R4-small/med	CTFB 0	IRSW 3	Plt/Nr 3	PCT 5	MIF 8	MIF 11	IRSW 14	Plt/Nr 14
Costs/ac.	510	1360	455	240	110	110	1360	455
Opening Y/N	N	N	N	N	N	N	N	N
RE2 M1-no PCT	CTFB 0	MIF 4	MIF 8	every 40 years				
Costs/ac.	510	110	110					
Opening Y/N	N	N	N					

Mgt. Actions	First Activity	Second Activity	Third Activity	Fourth Activity	Fifth Activity	Sixth Activity	Seventh Activity	Eighth Activity
RE2 M4-small/med	CTFB 0	MIF 4	Select/PC T/Plt/Nr 8	MIF 12	Select/PC T/Plt/Nr 16	every 40 years		
Costs/ac.	510	110	1715	110	1715			
Opening Y/N	N	N	N	N	N			
M1 M1	MIF 0	MIF 4	every 40 years					
Costs/ac.	110	110						
Opening Y/N	N	N						
M1 M4	MIF 0	Select/PC T/Plt/Nr 4	MIF 8	Select/PC T/Plt/Nr 12	every 40 years			
Costs/ac.	110	1715	110	1715				
Opening Y/N	N	N	N	N				
M3 M4	MIF/Select /plt/nr 0	MIF 4	Select/PC T/Plt/Nr 8	MIF 12	Select/PC T/Plt/Nr 16	every 40 years		
Costs/ac.	1585	110	1715	110	1715			
Opening Y/N	N	N	N	N	N			
R3 R4	MIF/IRSW 0	Plt/Nr 0	PCT 3	MIF 7	MIF 11	IRSW 15	Plt/Nr 15	PCT 18
Costs/ac.	1470	455	240	110	110	1360	455	240
Opening Y/N	N	N	N	N	N	N	N	N
R3 M4	MIF/IRSW 0	Plt/Nr 0	PCT 3	MIF 7	MIF 11	Select/PC T/Plt/Nr 15	MIF 19	
Costs/ac.	1470	455	240	110	110	1715	110	
Opening Y/N	N	N	N	N	N	N	N	

Predicted Yields

Yield tables were developed using the Forest Vegetation Simulator (enhanced Prognosis Growth model (Wykoff et al. 1982)) that is maintained by the Inventory and Monitoring Institute of the Forest Service in Fort Collins, Colorado. The PVGs were used as the basis for the yields and, of the 11 PVGs, yield tables were developed for ten; PVGs 8 and 9 were combined.

Mechanical activities that included harvest of commercial size timber were given a volume figure from the yield tables developed; both in cubic feet and board feet (MCF and MBF). Initial treatments were assigned volumes from existing yield tables based on FVS runs to represent the empirical yields. Subsequent treatments accessed managed yield tables, which were constructed using information from FVS runs, but were tailored and adjusted to match the activity strings. When a management action and associated activity string was selected to achieve the desired future condition, the acres of the selected action (if it was a mechanical treatment) were multiplied by the volume per acre from the yield tables to accumulate volume for that management action and alternative.

Yields from the management actions were then used to calculate TSPQ and ASQ. Using volume from the yield tables when activity strings are initiated allows for constraints such as non-declining flow and can be included to predict sustainable levels of wood products while focusing on achieving the DFCs for forested vegetation. Constraints related to ASQ are discussed in the Constraint section below.

Yield tables also included an estimate of mortality occurring by PVG and age for existing yield tables. In subsequent treatments, estimates of mortality were linked to the activity string yields.

Goals, Objective Functions, And Constraints

Desired Future Conditions

The Desired Future Conditions for each alternative are described in the Forested Vegetation section in Chapter 3. Alternatives differ in how well they meet the DFCs for forested vegetation. Modeling vegetation change over time was accomplished using the SPECTRUM model; this allows for a comparison between alternatives relative to attainment of DFCs.

DFCs for forested vegetation were determined using HRV as the reference condition (Morgan et al. 2001). HRV relates to size class and canopy closure, and varies by PVG.

Goals

DFCs were input into the analysis process as goals to achieve in the SPECTRUM model. Generally, DFC goals were assigned in SPECTRUM for the first growth stage (grass/forbs/shrub/seedlings) and the last growth stage (large tree) as a percentage of the total acres for a PVG.

Each alternative had a unique set of goals to represent DFC. Goals to represent DFCs for the alternatives were based on the theme and intent of those alternatives.

- Alternative 1B was formulated to represent the DFCs contained in the current Forest Plans. Those DFCs generally called for a fairly even distribution of size classes on forested suited lands, and late successional conditions on forested unsuited lands.
- Alternative 2 used the halfway point between the low end of HRV and the mean as the best link to the theme of the alternative.
- Alternative 5 was developed to provide goods and services that indicate promotion of growth and yield. Therefore a larger percentage of the landscape would be in plantations that would tend to be of smaller size class and denser canopy closures than HRV.
- Alternatives 3 and 4 use the mean of HRV, but differ in the MPCs (and mix of tools) to achieve the DFCs, linked to their themes of restoration (Alt. 3) and natural processes (Alt. 4).
- Alternative 6 used weighted means that were adjusted by the amount of PVGs within or outside of IRAs and unroaded areas. Within IRAs and unroaded areas, the mean of HRV was used (similar to Alt. 3 and 4) to weight acres, while outside of IRAs and unroaded areas, the low end of HRV was used to weight acres. This provided the best estimate of HRV to match the theme of the Alternative.
- Alternative 7 also used weighted values that were adjusted by the amount of PVGs within or outside of Inventory Roadless Areas, and values differed by fire regimes. Within IRAs the mean of HRV was used (similar to Alt. 3 and 4) to weight acres for lethal and mixed 2 fire regimes, and midway between the mean and high end of HRV was used for non-lethal and mixed 1 fire regimes. Outside of IRAs the low end of HRV was used to weight acres for lethal and mixed 2 fire regimes, and values similar to Alternative 5 were used for non-lethal and mixed 1 fire regimes. This provided the best estimate of HRV to match the theme of Alternative 7.

Table B-10 displays the goals for each alternative with the Historical Range of Variability included as a reference for the Boise National Forest. Because weighted values were used for some alternatives, values would be different by Forest.

Objective Function

Goal programming is a special kind of linear programming, and both are referred to as mathematical programming techniques. Both linear and goal programming involve optimization of an objective function. An objective function is either maximized or minimized over time, subject to satisfying all specified constraints, in order to derive a model solution. Examples include minimizing budget, maximizing sustainable harvest, or minimizing deviations from a set of goals.

Primarily, goal programming was used to derive solutions to models representing each alternative. This was done by describing the desired future conditions for forested vegetation for each alternative and then penalizing under-achievement of these goals. The objective function for the modeling efforts was to minimize deviations from the DFC goals (an objective function of zero would indicate that all the goals are satisfied in all decades). When total deviations are minimized over time, the resulting model solution indicates when and which management actions, if any, need to be carried out in each vegetation type in order to attain DFC as quickly as possible and then stay as close as possible to that set of conditions.

Table B-10. SPECTRUM Goals Related to Desired Future Conditions

PVG	Growth Stage	Alt. 1 Goal	Alt. 2 Goal	Alt. 3 Goal	Alt. 4 Goal	Alt. 5 Goal	Alt. 6 Goal	Alt. 7 Goal	Historical Range Of Variability	
1	gf-ss	2%	2%	2%	1%	2%	1%	6%	0 – 6%	Grass Forbs
	low large	47%	69%	91%	91%	24%	81%	69%	47 – 99%	Large Tree
2	gf-ss	6%	3%	3%	2%	8%	2%	7%	0 – 7%	Grass Forbs
	low large	8%	60%	68%	68%	4%	65%	21%		
	mod large	51%	10%	12%	12%	26%	11%	31%		
	Total Large trees	59%	70%	80%	80%	30%	76%	52%	59 –99%	Large Tree
3	gf-ss	11%	10%	7%	4%	12%	5%	9%	1 – 14%	Grass Forbs
	low large	0%	5%	6%	6%	0%	6%	2%		
	mod large	23%	27%	35%	35%	20%	35%	29%		
	Total Large trees	23%	32%	41%	41%	20%	41%	31%	23 – 65%	Large Tree
4	gf-ss	5%	4%	4%	3%	6%	3%	14%	0 – 10%	Grass Forbs
	low large	0%	1%	1%	1%	0%	1%	1%		
	mod large	20%	26%	33%	33%	20%	29%	28%		
	Total Large trees	20%	27%	34%	34%	20%	30%	29%	20 - 47%	Large Tree
5	gf-ss	7%	3%	3%	3%	10%	3%	6%	0 – 10%	Grass Forbs
	low large	9%	26%	29%	29%	4%	27%	10%		
	mod large	57%	49%	55%	55%	29%	49%	41%		
	Total Large trees	66%	75%	84%	84%	33%	76%	51%	66 - 99%	Large Tree
6	gf-ss	11%	9%	7%	4%	12%	5%	9%	5 - 16%	Grass Forbs
	mod large	28%	42%	56%	56%	20%	46%	33%	28 - 90%	Large Tree
7	gf-ss	11%	12%	9%	5%	10%	7%	15%	0 - 20%	Grass Forbs
	low large	3%	1%	1%	1%	7%	1%	1%		
	mod large	7%	19%	20%	20%	13%	19%	19%		
	Total Large trees	10%	20%	21%	21%	20%	20%	20%	10 - 29%	Large Tree*
8&9 #	gf-ss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2 - 20%	Grass Forbs
	mod large	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	high large	N/A	N/A	N/A	N/A	N/A	N/A	N/A		
	Total Large trees	N/A	N/A	N/A	N/A	N/A	N/A	N/A	25 - 39%	Large Tree*
10	gf-ss	15%	21%	14%	6%	10%	10%	22%	11 – 25%	Grass Forbs
	mod medium	5%	18%	18%	18%	9%	18%	16%		
	high medium	6%	2%	2%	2%	11%	2%	4%		
	Total Med trees	11%	20%	20%	20%	20%	20%	20%	11 - 27%	Medium Tree*
11	gf-ss	16%	16%	11%	5%	16%	8%	14%	8 – 21%	Grass Forbs
	low large	9%	1%	2%	2%	13%	2%	2%		
	mod large	5%	20%	25%	25%	7%	25%	25%		
	Total Large trees	14%	21%	27%	27%	20%	27%	27%	14 - 43%	Large Tree*

* requirements for wildlife set large tree Desired Future Conditions to at least 20% for Alternative 2-6, and 10% for Alternative 1 (Medium tree for PVG 10).
# - average of PVG 8 and PVG 9 – N/A is not applicable (the PVGs were not modeled for the Boise).

Goal programming requires assigning penalties to deviations from goals. Goals can be described for multiple conditions and/or outputs simultaneously in a single model. If the goal is to provide 100,000 acres of PVG 2 in moderate canopy closure large trees, then deviations from this goal are penalized. Penalties can be weighted to differentiate priorities. For example, under-achievement of a goal can be penalized more than over-achievement or vice versa. In this effort, goals were limited to desired future vegetative conditions only, penalties applied to under-achievement only, and all goals were weighted equally. A penalty of 1.0 was assigned for each acre of under-achievement of the DFC associated with each alternative. The objective function is measured in the amount of penalty points accrued over the planning horizon (16 decades). Sensitivity analysis of the effects of differential goal weighting revealed no improvement in attaining overall DFC. However, there was a loss in the level of understanding and the ability to interpret and compare model results when differentially weighted goals, or when combined use of DFC and output-oriented goals, were included in the same analysis.

For modeling purposes, goal attainment was described as being within 5 percent of the actual DFC target. The target was expressed as an acreage amount by growth stage within a PVG. Penalty points were not accrued as long as the solution was within 5 percent of the target or was above the target. Penalty points were only accrued to the objective function when acreages were below 95 percent of the target. Alternatives with higher total penalty points either took longer to achieve DFC or were farther away from DFC over the planning horizon (16 decades). Table B-11 displays the goal ranges for Alternative 3 for PVG 6.

Table B-11. Example of SPECTRUM Goals for PVG 6 in Alternative 3 for the Payette National Forest

PVG	Total Acres	Growth Stage	Code	Goal	Target DFC	Lower Bound -5%	SPECTRUM Goal
6	229,460	gf-ss	0611	7%	16,062	15,259	**15,200**
		mod large	0635	56%	128,498	122,073	**122,000**

In the example in Table B-11, penalty points would be accrued to the objective function if the amount of grass/forbs-shrub/seedlings (gf-ss) was less than 15,200 acres; one point for each acre below the goal. The amount of penalty points accrued to the objective function by decade for PVG 6 in Alternative 3 is displayed in Table B-12.

Table B-12. Example of Penalty Points for PVG 6 in Alternative 3 for the Payette National Forest

	Decade	1	2	3	4	5	6	7	8	
PVG - GS										
06 gf-ss	penalty	0	3724	0	103	3526	6400	7805	8803	
06 mod large	penalty	100781	83665	79563	52877	10732	1826	0	0	
	Decade	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**Total**
PVG - GS										**Penalty**
06 gf-ss	penalty	11675	13011	11819	11800	10974	9300	7865	7064	113869
06 mod large	penalty	0	0	0	0	0	0	0	0	329444

The objective function (amount of penalty points) per alternative for the planning horizon (16 decades) can be graphically and numerically displayed. Baseline runs for each alternative, discussed below, contain MPCs and the objective function to minimize the deviations from DFCs without additional constraints such as budget, visuals, or fire limits. Alternatives (with constrained budget) and baseline model objective functions are displayed in Table B-13 and are rounded to the nearest 100.

Table B-13. Objective Function Results for Alternatives and Baselines by National Forest

Alternative	Boise National Forest		Payette National Forest		Sawtooth National Forest	
	Alternative Penalty Points	Baseline Penalty Points	Alternative Penalty Points	Baseline Penalty Points	Alternative Penalty Points	Baseline Penalty Points
1	4,282,905	1,600,035	2,282,272	1,219,015	831,258	202,254
2	2,903,433	2,546,786	1,987,581	1,826,818	445,855	404,344
3	3,814,691	3,414,687	2,543,852	2,321,108	655,161	587,863
4	3,867,706	3,598,349	2,836,861	2,632,134	813,219	792,073
5	2,324,671	768,107	1,579,130	716,772	1,051,576	239,147
6	3,740,717	3,209,040	2,971,913	2,392,329	754,366	726,626
7	2,363,846	1,844,738	2,074,115	1,739,546	711,951	620,761

The timing of when penalty points are accrued can also provide a trend line to gain an understanding of how rapidly the alternatives are moving toward DFCs. In the baseline model, forested vegetation progresses toward DFC faster for all alternatives than does the constrained model runs. Modeling results indicate that some alternatives show the baseline move very rapidly toward DFC, but when budget considerations are added there is relatively slow movement toward DFC. Figure B-2 and Figure B-3 show Alternative 5 for the Sawtooth National Forest, the baseline runs and the fully constrained run (with budget considerations) respectively in relation to when penalty points are accrued.

Figure B-1. Graphic Display Of Objective Function By Alternative And Baseline For The National Forests

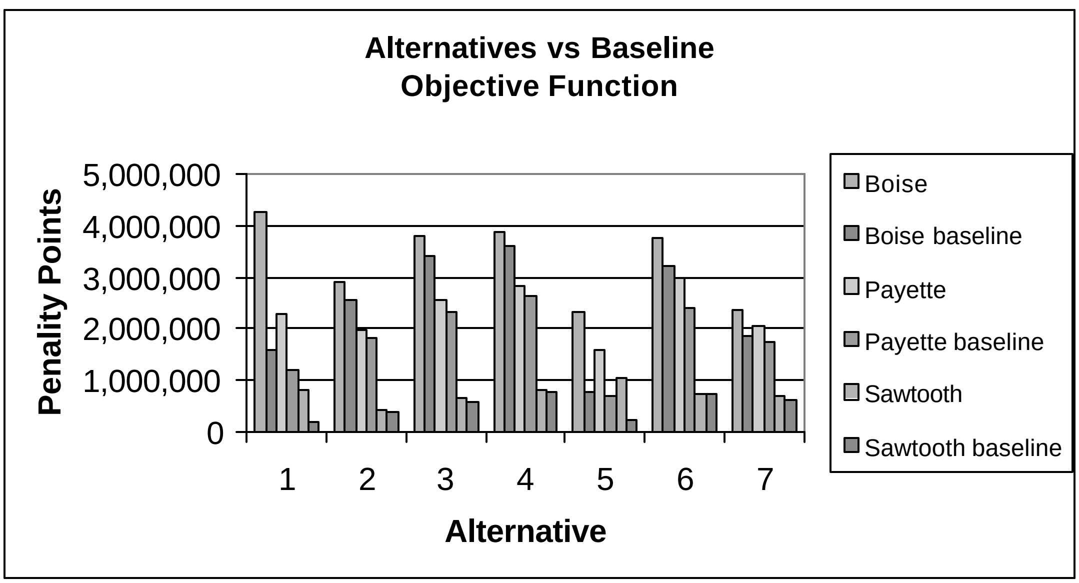


Figure B-2. Sawtooth NF Alt. 5 Baseline

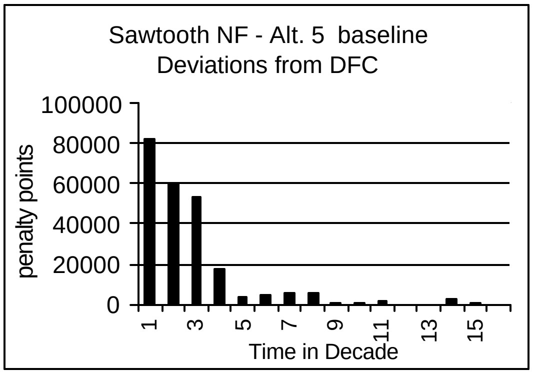
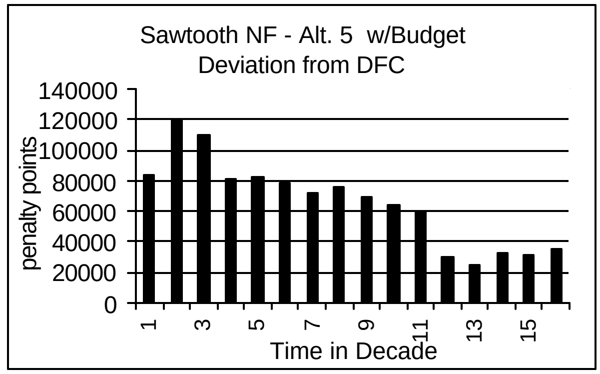


Figure B-3. Sawtooth NF Alternative 5 w/Budget



Analysis of Goal Weights

Selection of goal weights (accruing different amounts of penalty points per goal) can have a strong influence on model outcomes when using goal programming as an analytical technique. For this reason, equal as well as unequal goal weights were tested to determine their effect. For each alternative, a DFC for vegetation was specified (see discussion above). As long as the model maintained growth stage distributions within 95 percent of the DFC goals, no penalties or deviations from the goals accrued. Using a singular penalty weight of 1.0, under-achievement of DFC goals for all vegetation types and growth stages over all time periods was equally penalized. A sensitivity analysis of goal weights was used to address the question of whether or not solutions could be improved (come closer to the DFC) by assigning heavier penalty weights to those vegetation types farthest away from the specified goals. Goal weights were increased to 10.0 and then 100.0 successively for those vegetation types farthest from the DFC goals. The results did not improve overall DFC attainment. This suggested that the management actions and vegetation pathways being modeled were controlling DFC attainment, as they should, and not the arbitrary choice of goal weights for modeling purposes. Therefore, penalty weights of 1.0 for under-achievement of DFC goals were applied in all time periods. By doing this, the value of the objective function for each alternative could be readily compared in a more understandable manner.

Constraints

Even though SPECTRUM utilizes optimization techniques, in order for a model solution to be feasible, it must comply with all specified constraints within the problem. Constraints, in a modeling sense, are used to represent physical, ecological, financial, legal, or social thresholds that a solution must fall within in order to be considered reasonable or appropriate. For example, budgetary requirements to implement an alternative must be within reason compared to historic levels, and DFC attainment must comply with other resource management objectives consistent with a given alternative. Models of alternatives had to satisfy numerous types of constraints in order to be feasible.

Visual Quality Objectives - Limitations were placed on the amount of disturbance, by type, allowed in each MPC. Visual Quality Objective (VQO) constraints controlled the maximum number of acres that could be treated in a decade, and varied by MPC and activity type. Activities were differentiated between fire versus mechanical types and by whether the treatment objective was to replace a stand, reset canopy closure, or maintain conditions. Only MPC groups 2, 4, 5, and 6 were constrained for VQOs in the model. Individual treatment type categories were limited, as well as the combined total of all mechanical treatment types. Table B-14 display the maximum percent of activity acres that can be selected by the model.

B-14. Maximum Percent of MPC Acres Treatable Per Decade

MPC	Replace (R)		Reset (Re) Canopy Closure		Maintain (M)		Combined Total
	Fire	Mech.	Fire	Mech.	Fire	Mech.	Mech.
MPC 1	100	NA	100	NA	100	NA	NA
MPC 2	13.6	2.8	100	25.7	100	38.2	38.2
MPC 3	100	NA	100	NA	100	NA	NA
MPC 4	7.2	3.8	100	29.5	100	43.1	43.1
MPC 5	7.7	4.2	NA	32.4	NA	46.1	46.1
MPC 6	8.8	5.4	NA	38.5	NA	52.9	52.9
MPC 7	100	NA	100	NA	100	NA	NA

Wildlife Management Requirements (WMR) - In all alternatives other than 1B, model solutions had to maintain at least 20 percent of the acres in each PVG in large trees (or medium trees in the case of PVG 10, since this is the largest size attainable). In Alternative 1B, 10 percent of the acres in each PVG had to be maintained with large trees to reflect current management in the Forest Plan. This constraint was removed when it was infeasible in the first decade. In other words, where current conditions within a PVG did not provide the Wildlife Management Requirement, this constraint was not applied until such time as succession or management made it feasible to require the WMR level of acres with large trees.

Budget - Each alternative had a budget constraint applied in all decades for management actions that adjust the structure of forested vegetation. These values were derived from the Budget Formation and Execution System (BFES), which the Forest Service uses to determine outyear budgets. Values were increased or decreased based on activity types and the intent and theme of the alternatives. Budget constraints were for mechanical and fire activities and varied by alternative and are displayed in Table B-15 in millions of dollars annually. These values do not include items such as recreation, minerals, fire suppression, or other activities not modeled in SPECTRUM.

Table B-15. Annual Budget Values Used as Model Constraints

MM$	Alt. 1, 2, 3, 7	Alt. 4, 6	Alt. 5
Boise NF	$13.091	$6.526	$16.000
Payette NF	$8.766	$4.690	$10.244
Sawtooth NF	$2.003	$1.496	$2.183

Fire Activity Threshold - An ecologically based ceiling on fire activity was developed for each Forest based on historical fire regime frequencies and acres in the different fire regimes. The constraint represented the maximum total acres of fire per decade that could be applied to the landscape, either using prescribed fire or wildland fire use. Table B-16 displays the amount of fire activity that can occur as a ceiling each decade in the SPECTRUM model.

Table B-16. Decade Fire Activity Threshold

National Forest	Acres per Decade
Boise	567,400
Payette	415,695
Sawtooth	149,875

Dispersion of Created Openings - Limiting the maximum area that can be treated at one time can limit the overall level of vegetation treatment activities on a Forest. For example, if only 40 acres can be treated at a time because that activity creates an opening in the forested vegetation, and for modeling purposes these openings must be separated by at least an area equal to the size of the created opening, then dispersion of created openings may become a limiting factor in scheduling management activities on the landscape. The NFMA specifies maximum harvest unit sizes. Dispersion in the SPECTRUM model was applicable only when openings were created. The only management actions that created openings in the model were those representing shelterwood and reserve tree clear-cuts. When created, openings required two decades to no longer be considered open. Dispersion constraints were developed by observing unconstrained solutions; and noting any Analysis Units where more than 50 percent of the acres were in created openings. Generally, less than 5 percent of all analysis units met this condition. Constraints were then formulated for those specific analysis units limiting openings to 50 percent or less of the total analysis unit acres in decades 1-6. It was only necessary to constrain for six decades in order to capture the majority of the dispersion problems observed in solutions. Limiting the constraint to six decades also assisted in reducing model complexity and the time it took to solve the model. Since openings are considered open for two decades, this constraint effectively ensured that any single analysis unit could not be completely treated in less than 40 years utilizing management actions that created openings. In other words, if the model scheduled treatment to achieve DFC using activities that create openings, at least four decades would be required to treat 100 percent of the acres in a single analysis unit.

Allowable Sale Quantity (ASQ) Assumptions - In all alternatives except 4 and 6, constraints representing minimum amounts (floors) for ASQ were specified to meet the overall intent of an alternative. In Alternative 1B an ASQ assumption was set to represent the current forest plan as amended by Pacfish and Infish for the Boise and Payette National Forests. Suited acres in Riparian Conservation Areas were adjusted out of the suited base and a minimum level was established. If the model could not attain the initially established minimum, it was adjusted down until a feasible run was completed. The ASQ was not constrained for Alternative 1B on the Sawtooth National Forest. For Alternatives 2 and 3, an amount was established based on the average volume sold in 1997 through 2001. This time period was selected to remove the influences of large fire and insect salvage that occurred before 1997 on the Boise and Payette National Forests. In Alternative 5 an ASQ amount was established by maximizing first decade ASQ and then setting the ASQ amount to provide 90 percent of the maximum. In Alternative 7, an ASQ amount was established similarly to Alternative 5 for those MPCs that contain suited forested acres (acres in Riparian Conservation and High Risk Landslide Prone Areas are not part of the suited forested acres). ASQ, measured in cubic feet, was also constrained to be non-declining over time in all alternatives. The alternative runs that did not contain a budget constraint were used to set the Allowable Sale Quantity, which is a ceiling limitation. ASQ assumptions are summarized below in Table B-17. Amounts are in millions of board feet per year (mmbf) and applied only to the first decade.

Table B-17. Allowable Sale Quantity Assumptions by Alternative and National Forest
(In millions of board feet per year)

National Forest	Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Boise	72.0	26.5	26.5	NA	130.0	NA	45.0
Payette	60.0	21.7	21.7	NA	111.3	NA	32.5
Sawtooth	NA	4.3	4.3	NA	48.3	NA	11.7

NA = Not Applicable

Natural Disturbance - Stand-replacing wildfire was modeled to represent natural disturbance occurring over time in concert with management and is described above. Constraints, specified by PVG and growth stage, were used to require historical fire levels to occur in the model. For example, if the historical stand-replacing fire occurrence in PVG 3 with high canopy closure and small trees is 8 percent per decade, constraints in SPECTRUM permitted a maximum of 8 percent of the total acres of high canopy closure and small trees present each decade in PVG 3 to experience lethal fire. Additional constraints specified the minimum Forest-wide total amount of stand replacing wildfire to occur in each decade. The combination of growth stage specific maximums and Forest-wide minimums ensured appropriate distribution of total wildfire across applicable vegetation types. After disturbance, burned acres followed natural pathways for stand development and could experience stand-replacing wildfire again based on historical fire cycles. Decadal constraints on Forest-wide minimum wildfire were applied as follows. Wildfire had to equal historical levels in decade one; be at least at 80 percent of historical levels in decade two; and could decline by approximately 5 percent of historic levels per decade to a minimum floor of 50 percent of historic levels. Table B-18 displays the acres representing natural disturbance, exclusive of existing Wilderness.

Table B-18. Acres Representing Minimum Level of Natural Disturbance per Decade

National Forest	Decade 1	Decade 2	Decade 3	Decade 4	Decade 5	Decade 6	Decade 7	Decade 8-16
Boise NF	29,700	24,000	22,500	21,000	19,500	18,000	16,500	15,000
Payette NF	26,600	21,600	20,250	18,900	17,550	16,200	14,850	13,500
Sawtooth NF	12,300	9,840	9,225	8,610	7,995	7,380	6,765	6,150

High Fire Hazard Reduction - In all alternatives except 1B, a combination of objective functions and constraints were used to reduce acres of high fire hazard over time. The general idea was to reduce high hazard as much as possible without reducing DFC attainment by more than 10 percent (measured in terms of increased goal penalty points). For some situations, this was accomplished by utilizing multiple objective functions in sequence. First, high hazard acres were minimized and then DFC attainment was maximized subject to maintaining high hazard at the minimum levels. In other cases, minimizing high hazard caused reductions in DFC attainment greater than the target 10 percent. In these situations, upper limits on high hazard were incrementally tested until levels of reduction were found that did not result in more than a 10 percent decrease in DFC attainment.

Controls on Management Actions - For a variety of reasons, specific types of management actions were sometimes limited, or required to fall within a specified range, for certain alternatives. Constraints were used to require recent historical levels of wildland fire use (PNF in the model) in existing Wilderness Areas to continue based on approved Wilderness Plans. Wilderness was modeled separately. Constraints were also used to require recent historical levels of wildland fire use and prescribed fire (MIF in the model) to occur in areas outside existing wilderness in the budget-constrained model runs; no limitations were placed on fire use in the model runs without a budget constraint. In Alternative 1B, a maximum of 20 percent of the total fire use activities (MIF and PNF) could take place in MPC 3.1. In this alternative, by the way MPCs were assigned and adjustments made for Riparian Conservation Areas (RCA), the only acres within MPC 3.1 were RCAs and therefore a limit to the amount of fire activity was appropriate.

Lastly, Alternative 1B on the Payette National Forest was constrained in the first decade so that the mix of mechanical treatments scheduled to achieve the ASQ target reflected the proportions of the current mix of activities (thinning, selection, shelterwood, etc.) consistent with the existing Forest Plan. Based on evaluating model solutions, these types of constraints were not necessary on the other Forests. Constraints on management actions containing fire activity are summarized below in Table B-19, and the amounts are in acres per decade for areas within and outside of designated wilderness.

Alternative Modeling - In general, each alternative was modeled in a three-step process. The initial baseline run reflected MPC assignments and natural disturbance at historical levels without any other constraints. This run explored the maximum potential of each alternative to achieve its DFC and provided an understanding of the alternative's intent and theme related to ecological processes without social or economic considerations. The second step added all of the constraints needed to reflect the intent of the alternative with the exception of budget constraints and fire activity constraints. These runs added the NFMA requirements (e.g., non-declining flow of ASQ, dispersion of created openings, wildlife management requirements) and the resource management objectives for that particular alternative (e.g., VQO constraints, ASQ assumptions) to the baseline. The third and fully constrained step added budget and fire activity constraints.

Additional modeling steps were involved for some of the alternatives. Alternatives 5 and 7 had the additional step of maximizing first decade ASQ to determine sustainable potential. Ninety percent of this potential ASQ was then specified and tested as an assumption within those alternatives. For all alternatives except 1B, an additional step involved minimizing wildfire hazard to the greatest extent practicable without reducing DFC attainment by more than about 10 percent. Lastly, separate models for existing Wilderness on the Payette and Sawtooth National Forests were run independently of the alternatives. This was done because DFC and management pertaining to existing Wilderness is a constant across all alternatives.

Table B-19. Controls on Management Actions That Include Fire Activities

Within Wilderness	**Alt. 1**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Payette National Forest							
*PNF in MPC 7 (minimum)	50,000	50,000	50,000	50,000	50,000	50,000	50,000
*PNF in MPC 7 (maximum)	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Sawtooth National Forest							
*PNF in MPC 7 (minimum)	0	2,000	2,000	2,000	2,000	2,000	2,000
*PNF in MPC 7 (maximum)	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Outside of Wilderness	**Alt. 1**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Boise National Forest							
Fire use (minimum)	70,000	70,000	70,000	70,000	0	70,000	70,000
Payette National Forest							
Fire use (minimum)	70,000	70,000	70,000	70,000	0	70,000	70,000
Sawtooth National Forest							
Other Fire Use (minimum)	7,000	7,000	7,000	7,000	0	7,000	7,000

***** Wildland fire use (PNF in the model).

As described in Chapter 3 and above, when objective functions are compared across the three steps the overall effects of the constraints can be evaluated. If there are considerable differences in penalty points between the baseline and the fully constrained alternative, then the combined effect of all of the constraints for that alternative are significantly limiting potential attainment of DFC. Efforts to gain an understanding of constraints and their effects were included in a constraint sensitivity analysis process.

Constraint Sensitivity Analysis - Sensitivity analysis of constraints applied to the alternatives was conducted in two ways. First, each alternative was developed in a three-step process, as described above, so that the overall effect of constraints on DFC attainment could be recognized. This involved modeling the alternative once without any constraints other than the assignment of acres to MPCs and requiring natural disturbance to approximate historical levels of stand-replacing wildfire. A second running of the alternative added the full set of constraints associated with the alternative with the exception of budget and fire activity constraints. The final run then added these last two constraints. Comparing the results provided several insights. The unconstrained alternative model indicated the potential for the alternative to achieve DFC, regardless of effects on other resources or objectives, and the budget required to do so. The fully constrained run measured the decline or cost to DFC attainment when budget was limited; ASQ assumptions had to comply with non-declining flow and harvest dispersion policy; visual quality objectives and wildlife management requirements had to be met; and the amount and mix of fire treatments had to be consistent with the intent of the alternative.

Table B-20 compares selected results from baseline (unconstrained) models, partially constrained, and fully constrained models. Results are annual amounts for the first decade of each model except DFC penalty and acres of high fire hazard, which are totals for sixteen decades. Acres of "No Management" reflect acres where no management actions are scheduled during the 160-year planning horizon. Fire activity is total prescribed fire and wildland fire use. Total management activity is the sum of all types of management actions, including fire activity. Several management activities may take place on the same acre in a single decade, e.g. selection harvest, pre-commercial thinning, and planting.

Table B-20. Comparison Between Baselines and Alternatives

Constraint	Boise National Forest			Payette National Forest			Sawtooth National Forest		
	Baseline	No Budget Or Fire	Fully Constrained	Baseline	No Budget Or Fire	Fully Constrained	Baseline	No Budget Or Fire	Fully Constrained
Alternative 1B									
DFC	1600000	1691100	42829000	1219000	1678600	2282300	202200	202200	831250
Budget	8906000	15440800	13091000	5038100	10642400	8766000	4877600	3530100	1175000
ASQ	47	72	68	24.5	60	45	18.7	15.8	6.4
High Haz	2335660	2219300	3790100	1303800	1132700	1949000	90800	91600	112400
Fire Activity	123600	142900	70000	137400	82400	70000	49800	59200	7000
Total Mgmt.	210300	278300	204000	180600	166200	142500	88600	94900	20900
No Mgmt.	204800	179200	328900	214000	177600	418900	140900	78000	497100
Alternative 2									
DFC	2546800	2770900	2903400	1826800	1980600	1987600	404300	416000	445900
Budget	13918100	11928400	9656400	5760500	4752700	4638300	6292200	2901300	1735600
ASQ	65.3	51.2	34.1	23.7	19.3	17.8	16.5	9.8	2.6
High Haz	2088300	1063700	1076400	1127700	521500	517400	73500	21500	21500
Fire Activity	113600	148000	147800	137700	140800	99900	93000	83600	65800
Total Mgmt.	289100	314200	298400	198500	213800	165700	143400	121600	90300
No Mgmt.	210900	50800	284400	218021	201631	339640	152194	50420	276319
Alternative 3									
DFC	3414700	3710400	3814700	2321100	2522500	2543900	587900	596700	655200
Budget	11474200	10244300	10364200	7497700	7949300	5817300	4791200	2598200	1635200
ASQ	49.4	38.1	28.3	33	23.8	16.8	17	6.1	2.2

Constraint	Boise National Forest			Payette National Forest			Sawtooth National Forest		
	Baseline	No Budget Or Fire	Fully Constrained	Baseline	No Budget Or Fire	Fully Constrained	Baseline	No Budget Or Fire	Fully Constrained
High Haz	1481100	905500	911400	904600	379400	379100	50800	18000	18000
Fire Activity	119200	151100	106200	109600	107400	72800	49800	58600	53400
Total Mgmt.	288335	305200	295900	205300	212000	174600	105600	93600	79900
No Mgmt.	229900	116900	261600	175100	199900	388800	149400	57300	371125
Alternative 4									
DFC	3598300	3867700	3867700	2632100	2836900	2836900	792100	813200	813200
Budget	5375900	4818400	3511100	1406100	2765300	2776300	745600	952200	600650
ASQ	1	0.3	0.4	0	0	0	0.2	0	0
High Haz	1624000	901900	901900	883800	308600	308600	50300	24600	24600
Fire Activity	228400	299900	266000	170000	230000	194400	102700	114700	68200
Total Mgmt.	282800	337400	293600	177200	253800	215000	108300	123800	73500
No Mgmt.	362500	262900	333100	269700	293000	328000	184200	109900	366000
Alternative 5									
DFC	768100	1282300	2324700	716800	1342800	1579100	239100	289700	1051600
Budget	10460100	29276500	15901300	7640300	22640800	10244000	4888400	11002600	2183000
ASQ	55.8	130	74.2	43.8	111.3	52.9	27.2	48.3	12
High Haz	3416800	1282300	1501600	1715200	600900	657600	103400	19000	19000
Fire Activity	37000	37700	27800	56800	44500	39000	41200	34900	15100
Total Mgmt.	151300	297700	214400	138500	228900	142000	103400	137700	41600
No Mgmt.	224400	65800	538100	157100	113600	393500	131300	4300	438700
Alternative 6									
DFC	3209000	3504600	3740700	2392300	2642400	2971900	726600	754400	754400
Budget	4767300	6265600	3608800	3798100	4742700	2878800	756400	470200	470300
ASQ	21.3	25	14.1	18.9	16.1	10.9	0.9	0.4	0.6
High Haz	1860700	953400	954500	1011300	312000	311200	57800	30000	30000
Fire Activity	240600	279200	256400	149500	196700	176800	135300	94300	78300
Total Mgmt.	300100	340900	308200	185000	236400	206000	138600	96700	81000
No Mgmt.	360200	355300	477100	197400	275700	455900	277500	159100	389400
Alternative 7									
DFC	1844700	2041300	2363800	1739500	1924450	2074100	620800	680100	712000
Budget	7275500	14162800	12709200	5115100	8530500	7781300	5047200	5277700	2003000
ASQ	27.5	45	45	18.1	32.5	32.5	10.4	11.7	6
High Haz	2749700	1160200	1846500	1465900	979300	979600	63700	18800	18800
Fire Activity	141500	161200	122300	136400	130000	92300	114700	102000	75400
Total Mgmt.	214200	284600	262500	176300	191400	158300	163500	162200	102900
No Mgmt.	63900	59300	206600	127300	144600	301700	53500	27900	146400

The second type of sensitivity analysis conducted on constraints involved an incremental series of model runs made using the fully constrained version of Alternative 7 for all three National Forests as the context for measuring effects. Constraints were tested individually by relaxing them one at a time to gain understanding about their affect on DFC attainment and other model outcomes. Table B-21 summarizes selected results. In each case, the specified constraint was first removed, the model re-run, and the constraint then replaced prior to testing the next constraint. The NFMA constraints referred to in the table include harvest policy constraints (non-declining flow on ASQ at or below the long-term sustained yield capacity while leaving sufficient ending inventory to sustain harvest in perpetuity), dispersion of created openings, and wildlife management requirements.

A number of general conclusions were drawn from this analysis. The effect of VQO constraints and controls on fire-related management actions were minimal in terms of attaining DFC. This is because VQO constraints are seldom binding, and controls on the amount and placement of fire on the landscape were not stringent enough to affect DFC attainment significantly. Budget constraints dramatically affect the number of acres receiving no management treatments of any kind over time. Unmanaged acres follow natural pathways where succession is the primary vegetative process at work.

Table B-21. Individually Testing Constraints

	DFC	Budget	ASQ	High Haz	Fire Activity	Total Mgmt.	No Mgmt.
Model Description		$/yr	mmbf/yr	acres	acres	acres	acres
Period:	1-16	1	1	1-16	1	1	1-16
Boise NF Alternative 7							
Fully Constrained	2363800	12709200	45.0	1846500	122300	262500	206600
No Budget Constraint	2041400	14163500	45.0	1659600	130900	262700	58500
No Hazard Reduction	2121700	11457600	45.0	2530000	103800	219600	228200
No ASQ assumption	2047600	8454200	24.2	1738900	158000	251800	163400
No Fire Activity Floor	2363800	11480200	45.0	1845700	153100	262400	206300
No VQO Constraints	2361500	12504700	45.0	1832500	123700	261500	197700
No NFMA Constraints	2025100	10982500	45.0	1677100	135400	268900	193600
Payette NF Alternative 7							
Fully Constrained	2074100	7781300	32.5	979600	92300	158300	301700
No Budget Constraint	1924900	8173300	32.5	974600	103500	163300	106100
No Hazard Reduction	1942500	7507600	32.5	1428400	90000	157000	324600
No ASQ Assumption	1862300	3021500	8.4	978700	110400	143500	290300
No Fire Activity Floor	2070400	7517000	32.5	1000800	96400	160200	303000
No VQO Constraints	2071800	7457100	32.5	986100	88700	152200	299600
No NFMA Constraints	1864300	7657400	32.5	947800	99000	167500	281200
Sawtooth NF Alternative 7							
Fully Constrained	712000	2003000	6.0	18800	75400	102900	146400
No Budget Constraint	640100	3328900	6.0	18800	110100	153500	45300
No Hazard Reduction	681800	2030000	6.0	63900	71800	100500	142900
No ASQ assumption	669400	2030000	1.3	18800	98800	126900	147900
No Fire Activity Floor	707000	2030000	6.0	18800	75200	103500	146400
No VQO Constraints	706400	2030000	6.0	18800	74600	102300	147400
No NFMA Constraints	677000	2030000	6.0	18100	72900	101800	157200

SPECTRUM Model

The SPECTRUM model (USDA Forest Service 1995) was developed collaboratively by the Inventory and Monitoring Institute (IMI), formerly the detached Washington Office Ecosystem Management Analysis Center located in Fort Collins, CO., and the Rocky Mountain Forest and Range Experiment Station. SPECTRUM is based on FORPLAN Version 2 (USDA Forest Service 1983) but includes many model formulation and user interface enhancements. The purpose of SPECTRUM is its use in modeling alternative management scenarios over time. It is being used as a tool to support revisions of Forest Plans across the nation. The present effort used Version 2.6 (released 11/26/01) of the SPECTRUM system.

Model Type

SPECTRUM utilizes mathematical programming and optimization techniques to derive solutions to models. The specific commercial optimization software employed is C-Whiz from Ketron Management Science. When designing SPECTRUM models, two mathematically different approaches are available to the user. These are referred to simply as Model I and Model II formulations. With a Model I approach, management actions are defined for individual land units over the entire planning horizon (16 decades in this case). With Model II, separate management actions are defined to treat current vegetation and future vegetation. Once current conditions have been treated, acres are transferred into classes with similar characteristics. This second approach has potential advantages in terms of a more compact representation of a model and increased scheduling flexibility. It has the disadvantage of losing track of the spatial location over time of land units in the model. For the Ecogroup, a Model I formulation was selected for simplicity of explanation, for understandability when interpreting results, and to enable spatial approximation of management activity for purposes of evaluating alternatives.

Complexities

During earlier Forest Plan modeling efforts, FOREPLAN was the primary analysis tool used to project information into the future for a mix of alternatives. FORPLAN ran on mainframe computers and is no longer supported by the IMI. SPECTRUM brings forward all of the capabilities of FORPLAN Version 2, runs on IBM compatible Personal Computers (PC), and offers multiple enhancements for problem analysis, model design, and interfacing with the user. For the Ecogroup, SPECTRUM models ranged in size up to approximately 8,000 rows by 40,000 columns. Rows generally represent the number of mathematical constraints in a model, while columns generally represent management action options applying to land units. Models generally ran and solved within 15 minutes on a 1.7 GHz Pentium 4 PC.

Inter-relationship Between Portions of the SPECTRUM Modeling Process

The SPECTRUM model includes extensive data, assumptions, and relationships. Figure B-4 displays a schematic diagram of the relationships between data, other modeling efforts, assumptions, and outcomes.

Outcomes From The Modeling Process

The SPECTRUM model projects a wide variety of outcomes from the different alternatives and other model formulations, such as baseline and sensitivity runs. These outcomes can be used to gain an understanding and to discuss effects of the alternatives related to a wide range of resource areas and social/economic considerations.

National Forest Management Act (NFMA) regulations (36 CFR 219.12(f) (9)) require that each alternative indicate

- The conditions and uses that would result from long-term application of the alternative;
- The goods and services to be produced, and the timing and flow of these resource outputs together with associated costs and benefits;
- Standards and guidelines for resource management; and
- The purpose of the proposed management direction.

Chapters 2 and 3 and Appendix B of the Environmental Impact Statement, along with the Forest Plan for each National Forest, meet the requirements listed above for the NFMA.

Acres of Forest Vegetation Structure

The objective function for the SPECTRUM model is to minimize the deviation from DFCs of the forested vegetation. The formulation of the model is driven by how forested vegetation changes over time with and without management actions being applied. The primary output from the modeling for effects analysis is the acres of the different forest vegetation structures by PVG. Acres of current structure (size class and canopy closure), structure in decades 1 – 6, 8, 10, and 15 for each growth stage by PVG are provided as part of the reports generated by the modeling process. This information is critical for understanding habitat conditions for wildlife, insect and wildfire hazards, species composition, integrating ecological processes, and predicting short- and long-term effects. Displayed in Table B-22 is a sample of SPECTRUM outputs from the Boise National Forest, PVG 6, in Alternative 2.

Figure B-4. Schematic Diagram of the Interrelated Portions of the SPECTRUM Model

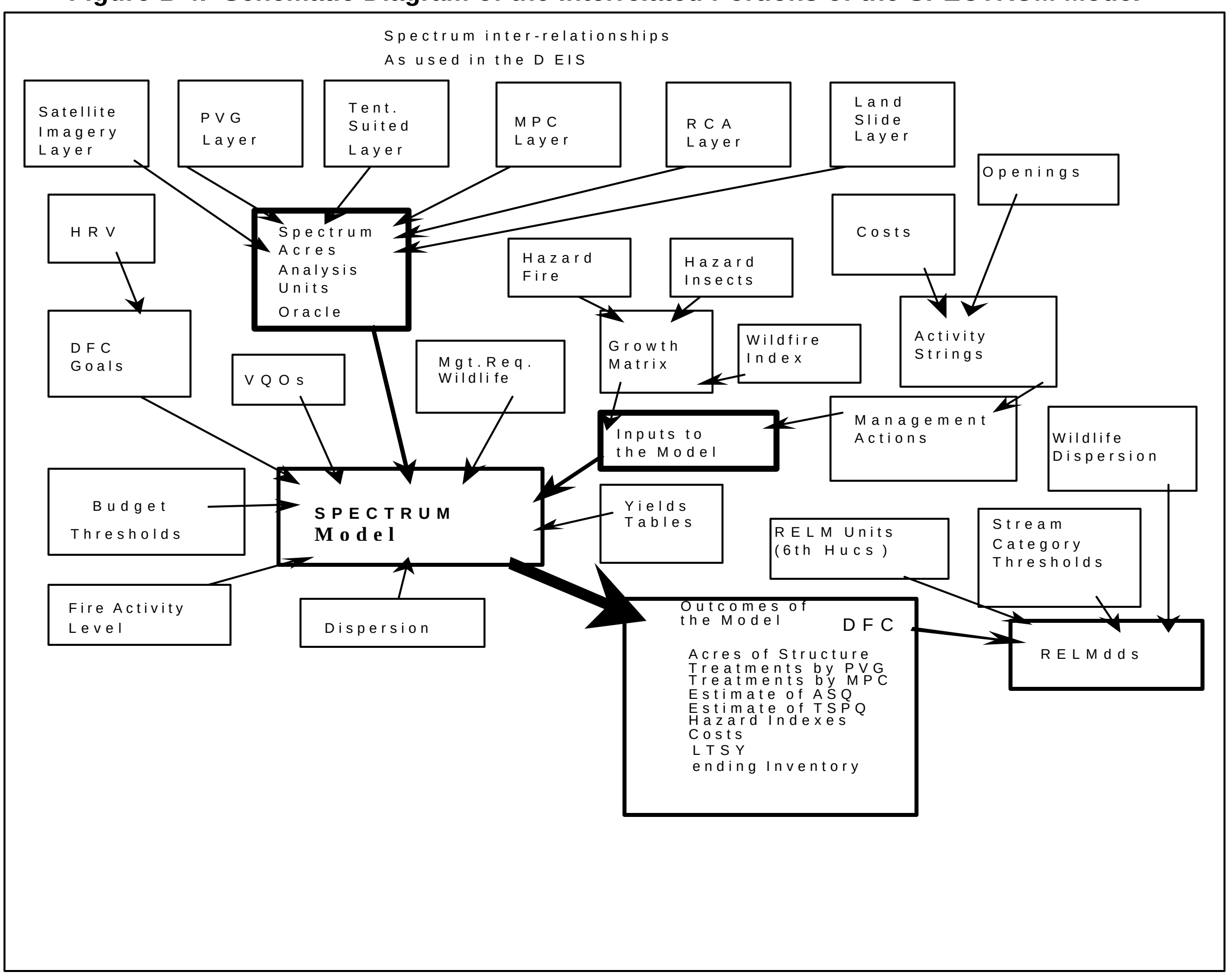


Table B-22. Sample of Size Class and Canopy Closure Report from SPECTRUM For PVG 6 in Alternative 2 for the Boise National Forest

Decade ———		Year 0 0	Year 10 1	Year 20 2	Etc… 3	4	5	6	8	10	15
Growth Stage		Current									
grass/forbs-seedling/shrub	Ac.	20850	5575	8100	10111	11277	9022	10126	2562	3086	2859
low density saplings	Ac.	1438	19182	0	5575	2525	7586	3691	4795	1248	1129
low density small trees	Ac.	1262	1237	0	0	0	0	0	0	0	0
low density medium trees	Ac.	682	675	675	0	0	0	0	0	0	0
low density large trees	Ac.	327	324	324	0	0	0	0	0	0	0
moderate density saplings	Ac.	4336	1424	19182	0	5575	2525	7586	5331	1314	1201
mod. density small trees	Ac.	11480	3295	1424	16008	0	5575	2525	3691	4795	1790
mod. density medium trees	Ac.	23041	22580	24032	2755	2700	453	0	0	0	0
mod. density large trees	Ac.	11390	12467	15753	16157	36472	37800	37800	37800	37800	37800
high density small trees	Ac.	4787	11250	12045	4719	17111	13005	5575	10111	9022	3086
high density medium trees	Ac.	8031	11348	3398	9121	10919	10482	16684	15457	23001	16379
high density large trees	Ac.	7133	5400	9824	30311	8177	8309	10769	15010	14491	30513
Total	Ac.	94757	94757	94757	94757	94757	94757	94757	94757	94757	94757
The DFC for this PVG is to have 42 percent in large tree moderate density and 9% in grass/forbs-seedling/saplings											

The SPECTRUM model also summarizes forest vegetation conditions by suited acres, unsuited acres, size class, and canopy closure.

Wildlife Viability Modeling

The forested vegetation conditions from the SPECTRUM model were used in the wildlife viability modeling process (Chapter 3, EIS). Often there appears to be a dip in large tree structure in the first or second decade as part of the outcomes from the modeling effort. This is occurring as an artifact of how the growth matrix was input into the model. Each growth stage has an inherent age range (such as 100 to 140 for medium tree high density) that may differ by PVG. The model uses the mid-point of the range (120) as the starting point for moving the vegetation through the modeling process. Therefore, in the model it may take two decades before medium trees move into the large tree structure, while management actions or background fire are taking large tree structure to grass/forbs shrub seedling structure. Thus a reduction in large trees is being reflected in the model that may not actually be occurring on the landscape. The mid-point was used as a simplification process in model development. To use a growth stage for each 10 years of age would significantly increase the size of the model, while not significantly changing the rate or timing of achieving DFC.

The Wildlife Viability model that was used has an important spatial component. The spatial component was used for historical and current vegetation structure, but was not used for future structure, as the SPECTRUM model does not spatially track changes to each analysis unit. Thus, the full capabilities of the Wildlife Viability model were not used during the analysis.

Management Actions Selected

The SPECTRUM model used management actions to change the forested vegetation to achieve the DFCs for each alternative based on the MPCs assigned to reflect the intent and theme of the alternatives. The management actions contain different sets of activities that are applied to the analysis units (growth stage/PVG/MPC). The management actions are summarized by alternative, while the activities are summarized by PVGs and by MPCs. These activities have different costs, occur at different timing sequences, produce different effects on the landscape, and different amounts of ASQ and TSPQ. As an example, Table B-23 shows the management actions that were selected by Alternative 2 for the Boise National Forest in decades 1-6, 8, 10, 15. Activities occur at the mid-point of the decade (e.g., decade 1 is year 0 to 9 and the activities occur at year 5). Values for forested vegetation conditions are for the beginning of the decade (e.g., decade 1 is year 0 to 9 and the condition is for year 0 (current)–see Table B-22).

Table B-23. Management Actions Selected by SPECTRUM For Alternative 2 on the Boise National Forest

Management Actions		Year 5 0	Year 15 1	Year 25 2	Year 35 3	Year 45 4	Etc.… 5	6	8	10	15
M1M1	Ac.	31583	23387	3355	9053	5001	4309	0	0	0	0
M1M4	Ac.	0	0	0	0	0	0	0	0	0	0
M2M2	Ac.	7587	7773	0	0	0	0	0	0	0	0
M2M4	Ac.	256	11074	0	1370	0	0	0	0	0	0
M3M4	Ac.	0	0	746	3352	506	0	0	0	0	0
N1N1	Ac.	0	0	0	0	0	0	0	0	0	0
R1M1	Ac.	0	0	0	0	0	0	0	0	0	0
R1M4	Ac.	0	0	0	0	0	0	0	0	0	0
R1R1	Ac.	47304	32878	4874	24036	302	31150	38556	4597	819	0
R2M1	Ac.	0	0	0	0	0	0	0	0	0	0
R2M2	Ac.	0	0	0	0	0	0	0	0	0	0
R2M4	Ac.	0	0	0	0	0	0	0	0	0	0
R2R2	Ac.	0	0	0	0	9187	5073	0	0	0	0
R2R4	Ac.	7017	0	0	5233	1466	19833	0	0	0	0
R3M4	Ac.	0	0	0	0	0	0	0	0	0	0
R3R4	Ac.	0	0	0	0	0	0	0	0	0	0
Re1M1	Ac.	65509	9949	35937	44570	24174	303	0	240	0	0
Re1M4	Ac.	0	0	0	0	0	0	0	0	0	0
Re1R4	Ac.	4067	3785	0	0	0	0	0	0	0	0
Re2M1	Ac.	28099	4082	5942	18070	3179	3967	0	0	0	0
Re2M2	Ac.	20371	6235	9912	0	8428	0	0	0	7581	0
Re2M4	Ac.	77070	28929	58287	35098	19006	0	0	0	0	0
Re2R2	Ac.	2499	7835	4859	777	4687	12696	0	0	0	1530
Re2R4	Ac.	7697	9202	9036	131	0	0	0	2543	3796	17629
Natural Disturbance	Ac.	29700	24000	22500	21000	19500	18000	16500	15000	15000	15000
Total	Ac.	328759	169129	155448	162690	95436	95331	55056	22380	27196	34159

Treatments by PVGs

Activities contained in the management actions are summarized by PVG to assist in effects analysis. Acres of activities initiated by decade (mid-point) are captured for decades 1-6, 8, 10, and 15. Table B-24 provides an example of SPECTRUM outputs for PVG 2, Alternative 2, for the Boise National Forest. Activities are discussed above.

Table B-24. Activities Selected by SPECTRUM
For Alternative 2 in PVG 2 on the Boise National Forest

Activities		Year 5 0	Year 15 1	Year 25 2	Year 35 3	Year 45 4	Etc…. 5	6	8	10	15
PNF	ac/dec	20279	2200	20279	2200	26101	2200	26101	26101	26101	2200
MIF	ac/dec	31184	4390	58173	71706	96996	35497	63362	59203	95263	71612
MIF/IRSW	ac/dec	0	0	0	0	0	0	0	0	0	0
MIF/SELECT	ac/dec	0	0	746	2789	506	0	0	0	0	0
MIF/SEL/P-NR	ac/dec	0	0	0	0	0	0	0	0	0	0
PCT	ac/dec	7007	0	19474	0	8428	0	2914	0	0	0
CT/CTFB	ac/dec	114179	34996	39563	1014	19140	0	0	1701	5184	18571
IRSW	ac/dec	0	0	0	0	2914	0	0	0	0	2914
SW	ac/dec	0	0	0	0	0	0	94	7697	0	867
RT-OSR	ac/dec	0	0	0	0	0	0	0	0	0	0
RT-OSR/PCT	ac/dec	0	0	0	0	1388	1688	3985	94	7697	0
RT-REGEN	ac/dec	0	0	1388	1688	3985	1014	0	0	0	1406
RT-CC	ac/dec	0	0	0	0	0	0	0	0	0	0
SELECT	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/PCT	ac/dec	7843	15735	15271	22870	15271	26148	82494	38682	34456	47922
SEL/PCT/PLT	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/PCT/P-NR	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/PLANT	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/NR	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/P-NR	ac/dec	0	0	0	0	0	0	0	0	0	0
PLANT (PLT)	ac/dec	0	0	1388	1688	3985	1014	0	0	0	1406
NAT-REG (NR)	ac/dec	0	0	0	0	2914	0	0	0	0	2914
PLT/NR (P-NR)	ac/dec	0	0	0	0	0	0	94	7697	0	867
Total	ac/dec	180492	57320	156283	103955	181630	67561	179044	141174	168701	150679

Treatments by MPCs

Activities are also displayed by MPCs to assist in effects analysis. These differ by alternative and reflect the intent and theme of the alternative. For example, Table B-25 displays MPC group 5 for Alternative 2 on the Boise National Forest; while Table B-26 displays the first decade activity acres for MPC group 5 by alternative for the Boise National Forest. Alternatives differ in the types of activities initiated in the first decade. Tables B-27 to B-29 display first decade activity levels for each alternative by Forest.

Table B-25. Activities selected by SPECTRUM
For MPC Group 5, Alternative 2 on the Boise National Forest

Activities		Year 5 0	Year 15 1	Year 25 2	Year 35 3	Year 45 4	Etc…. 5	6	8	10	15
PNF	ac/dec	0	0	0	0	0	0	0	0	0	0
MIF	ac/dec	14405	4181	27821	94616	80505	80947	59223	35983	72381	108938
MIF/IRSW	ac/dec	0	0	0	0	0	0	0	0	0	0
MIF/SELECT	ac/dec	0	0	0	0	0	0	0	0	0	0
MIF/SEL/P-NR	ac/dec	0	0	0	0	0	0	0	0	0	0
PCT	ac/dec	7007	0	17615	0	0	0	0	0	0	0
CT/CTFB	ac/dec	69206	47753	52928	33730	23692	10918	0	2543	3796	26831
IRSW	ac/dec	0	0	0	5233	1466	19833	0	0	0	5233
SW	ac/dec	0	0	0	0	514	886	94	8786	0	2011
RT-OSR	ac/dec	0	0	0	0	0	0	0	0	0	0
RT-OSR/PCT	ac/dec	0	0	0	0	0	0	514	94	8786	0
RT-REGEN	ac/dec	0	0	0	0	0	0	0	0	0	0
RT-CC	ac/dec	0	0	0	0	9345	2501	0	4687	0	2501
SELECT	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/PCT	ac/dec	7843	11074	15271	7259	15271	5889	76071	37935	33949	24874
SEL/PCT/PLT	ac/dec	0	1696	0	2042	0	7010	0	9548	4348	2042
SEL/PCT/P-NR	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/PLANT	ac/dec	0	0	0	0	0	0	0	5861	19183	0
SEL/NR	ac/dec	0	0	0	0	0	0	0	0	0	0
SEL/P-NR	ac/dec	0	0	0	0	0	0	0	0	0	0
PLANT (PLT)	ac/dec	0	0	0	0	514	886	0	1089	0	1144
NAT-REG (NR)	ac/dec	0	0	0	5233	10810	22334	0	4687	0	2501
PLT/NR (P-NR)	ac/dec	0	0	0	0	0	0	94	7697	0	867
Total	ac/dec	98461	64704	113635	148114	142117	151204	135996	118910	142443	176942

Table B-26. Activities Selected by SPECTRUM in the First Decade
For MPC Group 5 on the Boise National Forest for all Alternatives

Activities		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
PNF	ac/dec	0	0	0	0	0	0	0
MIF	ac/dec	0	14405	13096	0	8700	2278	3328
MIF/IRSW	ac/dec	0	0	0	0	0	0	0
MIF/SELECT	ac/dec	0	0	0	0	0	0	0
MIF/SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PCT	ac/dec	681	7007	8072	0	6857	4376	3083
CT/CTFB	ac/dec	26457	69206	76908	0	66857	35868	14672
IRSW	ac/dec	0	0	0	0	0	0	1159
SW	ac/dec	5532	0	0	0	15375	0	6421
RT-OSR	ac/dec	0	0	0	0	0	0	0
RT-OSR/PCT	ac/dec	0	0	0	0	0	0	0
RT-REGEN	ac/dec	0	0	0	0	0	0	0

Activities		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
RT-CC	ac/dec	16591	0	0	0	2823	0	4094
SELECT	ac/dec	0	0	0	0	0	0	0
SEL/PCT	ac/dec	3644	7843	0	756	0	0	0
SEL/PCT/PLT	ac/dec	0	0	0	0	0	0	301
SEL/PCT/P-NR	ac/dec	0	0	0	0	0	0	0
SEL/PLANT	ac/dec	211	0	0	0	0	0	0
SEL/NR	ac/dec	0	0	0	0	0	0	0
SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PLANT (PLT)	ac/dec	0	0	0	0	6624	0	3042
NAT-REG (NR)	ac/dec	16591	0	0	0	2823	0	5253
PLT/NR (P-NR)	ac/dec	5532	0	0	0	8751	0	2766
Total	ac/dec	75239	98461	98076	756	118811	42522	44119

Table B-27. Activities Selected by SPECTRUM in the First Decade on the Boise Forest for All Alternatives

Activities		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
PNF	ac/dec	70000	87307	34802	117025	5330	231281	85746
MIF	ac/dec	0	60505	71374	148988	22517	25152	36562
MIF/IRSW	ac/dec	0	0	0	0	0	0	0
MIF/SELECT	ac/dec	0	0	0	0	0	0	0
MIF/SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PCT	ac/dec	3324	7181	8072	0	10100	4376	5921
CT/CTFB	ac/dec	33946	128555	181638	26810	87369	47404	72135
IRSW	ac/dec	5686	0	0	0	0	0	1159
SW	ac/dec	5532	0	0	0	15375	0	6421
RT-OSR	ac/dec	0	0	0	0	0	0	0
RT-OSR/PCT	ac/dec	0	0	0	0	0	0	0
RT-REGEN	ac/dec	15663	0	0	0	6194	0	8532
RT-CC	ac/dec	21373	7017	0	0	9186	0	4094
SELECT	ac/dec	0	0	0	0	0	0	0
SEL/PCT	ac/dec	3644	7843	0	756	27555	0	23956
SEL/PCT/PLT	ac/dec	0	0	0	0	0	0	301
SEL/PCT/P-NR	ac/dec	0	0	0	0	0	0	0
SEL/PLANT	ac/dec	211	0	0	0	0	0	0
SEL/NR	ac/dec	0	0	0	0	0	0	0
SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PLANT (PLT)	ac/dec	12066	0	0	0	12818	0	9623
NAT-REG (NR)	ac/dec	27059	0	0	0	9186	0	5253
PLT/NR (P-NR)	ac/dec	5532	0	0	0	8751	0	2766
Total	ac/dec	204036	298409	295885	293580	214381	308212	262469

Table B-28. Activities Selected by SPECTRUM in the First Decade on the Payette Forest for All Alternatives

Activities		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
PNF	ac/dec	61188	79109	39426	118606	34084	157736	54507
MIF	ac/dec	8812	19647	33352	71156	4910	19063	37772
MIF/IRSW	ac/dec	0	0	0	0	0	0	0
MIF/SELECT	ac/dec	0	1139	0	4677	0	0	0
MIF/SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PCT	ac/dec	2744	1531	487	0	4847	1372	635
CT/CTFB	ac/dec	19152	58026	99740	20587	35789	19515	28640
IRSW	ac/dec	338	0	0	0	12	0	0
SW	ac/dec	9775	0	0	0	9335	0	5481
RT-OSR	ac/dec	0	0	0	0	0	0	0
RT-OSR/PCT	ac/dec	0	0	0	0	0	0	0
RT-REGEN	ac/dec	12091	0	0	0	9201	666	4507
RT-CC	ac/dec	3821	920	1346	0	8274	0	2002
SELECT	ac/dec	0	0	0	0	0	0	0
SEL/PCT	ac/dec	1129	1969	225	0	8054	6934	4262
SEL/PCT/PLT	ac/dec	0	3327	0	0	0	0	7262
SEL/PCT/P-NR	ac/dec	0	0	0	0	0	0	0
SEL/PLANT	ac/dec	0	0	0	0	0	0	609
SEL/NR	ac/dec	372	0	0	0	3900	0	3755
SEL/P-NR	ac/dec	3249	0	0	0	0	0	1246
PLANT (PLT)	ac/dec	12583	0	0	0	15326	666	6183
NAT-REG (NR)	ac/dec	4159	0	0	0	8286	0	1420
PLT/NR (P-NR)	ac/dec	3133	0	0	0	0	0	0
Total	ac/dec	142546	165668	174575	215026	142019	205952	158280

Table B-29. Activities Selected by SPECTRUM in the First Decade on the Sawtooth Forest for All Alternatives

Activities		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
PNF	ac/dec	6139	57084	42194	42194	3932	76204	68222
MIF	ac/dec	861	8683	11157	11157	11173	2141	7167
MIF/IRSW	ac/dec	0	0	0	0	0	0	0
MIF/SELECT	ac/dec	0	19	0	0	0	0	0
MIF/SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PCT	ac/dec	0	94	94	94	0	0	0
CT/CTFB	ac/dec	2427	22227	26207	26207	8012	2287	17838
IRSW	ac/dec	0	0	0	0	3200	0	0
SW	ac/dec	0	0	0	0	0	0	0
RT-OSR	ac/dec	0	0	0	0	0	0	0
RT-OSR/PCT	ac/dec	0	0	0	0	0	0	0
RT-REGEN	ac/dec	558	0	0	0	975	0	0

Activities		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
RT-CC	ac/dec	5078	1866	0	0	5056	0	4818
SELECT	ac/dec	0	0	0	0	0	0	0
SEL/PCT	ac/dec	179	356	206	206	0	63	0
SEL/PCT/PLT	ac/dec	0	0	0	0	0	0	0
SEL/PCT/P-NR	ac/dec	0	0	0	0	0	0	0
SEL/PLANT	ac/dec	0	0	0	0	0	326	0
SEL/NR	ac/dec	0	0	0	0	0	0	0
SEL/P-NR	ac/dec	0	0	0	0	0	0	0
PLANT (PLT)	ac/dec	558	0	0	0	975	0	0
NAT-REG (NR)	ac/dec	5078	0	0	0	8256	0	4818
PLT/NR (P-NR)	ac/dec	0	0	0	0	0	0	0
Total	ac/dec	20878	90329	79858	79858	41579	81020	102863

Estimation of Allowable Sale Quantity (ASQ)
The sustainable level of timber harvest volume from suited acres is referred to as ASQ, and the NFMA requires estimation of this outcome. Suited acres are defined by MPC and are discussed above.

The NFMA provides direction to determine the maximum (i.e., ceiling) amount of volume that can be sustainable removed from suited acres. This value was determined from model runs without a budget limitation, to generate the ceiling based on ecosystem management concepts. Values are summarized in Table B-31. The models for the alternatives were also run with a budget constraint to provide a relative amount that would be used as an objective in a Forest Plan; these values are summarized in Table B-32.

Estimates of the timber volume generated from mechanical treatments on suited acres were included in the SPECTRUM model to estimate ASQ. Yield estimates for the activities within management actions, discussed above, were the basis for determining ASQ. The constraint of non-declining flow was included in all alternatives.

Estimation of Total Sale Program Quantity (TSPQ)
The level of timber harvest volume from forested acres is referred to as TSPQ and the NFMA requires estimation of this outcome. This total volume amount includes the ASQ.

Estimates of the timber volume generated from mechanical treatments on forested acres were included in the SPECTRUM model to estimate the modeling portion of TSPQ. Yield estimates for the activities within management actions, discussed above, were the basis for determining the modeled portion of TSPQ. Table B-30 displays the model-generated portion of TSPQ by Alternative for each Forest as calculated by SPECTRUM without budget constraints. Additional volume estimates from salvage, post and poles, and firewood were added to the model estimates to determine the final amount of TSPQ in the Forest Plans.

Table B-30. ASQ and TSPQ Estimates (ceilings) from SPECTRUM for Alternatives in Millions of Cubic Feet (MMCF) and Millions of Board Feet (MMBF) Determined from Model Formulations Without Budget Constraints

Boise National Forest		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Allowable Sale Quantity	mmcf/yr	13.96	10.16	7.63	0.07	25.35	4.96	8.84
Allowable Sale Quantity	mmbf/yr	72.00	51.15	38.14	.38	130.00	25.01	45.00
Total Sale Program Quantity	mmcf/yr	14.02	13.91	12.18	3.30	25.54	5.47	12.96
Total Sale Program Quantity	mmbf/yr	72.30	70.04	61.33	16.00	131.00	27.57	66.27
Payette National Forest		**Alt. 1B**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Allowable Sale Quantity	mmcf/yr	11.73	3.80	4.71	0.00	21.71	3.33	6.38
Allowable Sale Quantity	mmbf/yr	60.00	19.30	23.82	0.00	111.30	16.11	32.50
Total Sale Program Quantity	mmcf/yr	12.09	7.20	9.65	2.01	21.96	3.74	7.96
Total Sale Program Quantity	mmbf/yr	61.87	36.29	48.17	9.39	112.62	18.01	40.27
Sawtooth National Forest		**Alt. 1B**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt.7**
Allowable Sale Quantity	mmcf/yr	3.03	1.89	1.17	0.00	9.25	.07	2.26
Allowable Sale Quantity	mmbf/yr	15.79	9.80	6.14	0.00	48.30	0.38	11.70
Total Sale Program Quantity	mmcf/yr	3.14	3.45	3.48	.86	9.66	0.21	5.66
Total Sale Program Quantity	mmbf/yr	16.43	18.08	18.32	4.47	50.50	1.09	29.43

Table B-31. ASQ and TSPQ Estimates (objectives) from SPECTRUM for Alternatives in Millions of Cubic Feet (MMCF) and Millions of Board Feet (MMBF) Determined from Model Formulations With Budget Constraints

Boise National Forest		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Allowable Sale Quantity	mmcf/yr	13.12	6.82	5.67	0.07	14.49	2.86	8.75
Allowable Sale Quantity	mmbf/yr	68.00	34.15	28.34	0.38	74.24	14.12	45.00
Total Sale Program Quantity	mmcf/yr	13.12	12.14	14.47	2.72	15.32	3.38	13.03
Total Sale Program Quantity	mmbf/yr	68.00	61.26	72.76	13.52	78.45	16.72	66.78
Payette National Forest		**Alt. 1B**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Allowable Sale Quantity	mmcf/yr	8.77	3.51	3.30	0.00	10.28	2.24	6.35
Allowable Sale Quantity	mmbf/yr	45.00	17.80	16.76	0.00	52.87	10.95	32.50
Total Sale Program Quantity	mmcf/yr	8.91	6.47	9.67	2.34	10.35	2.58	8.00
Total Sale Program Quantity	mmbf/yr	45.71	32.46	48.39	11.09	53.20	12.61	40.56
Sawtooth National Forest		**Alt. 1B**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Allowable Sale Quantity	mmcf/yr	1.23	0.50	0.43	0.00	2.31	0.11	1.16
Allowable Sale Quantity	mmbf/yr	6.35	2.60	2.24	0.00	11.96	0.60	6.00
Total Sale Program Quantity	mmcf/yr	1.23	2.31	2.30	0.51	2.31	0.25	2.46
Total Sale Program Quantity	mmbf/yr	6.38	12.13	12.07	2.69	11.96	1.30	12.89

Hazard Index Values

Each growth stage by PVG was assigned hazard index values for wildfire and insects. As vegetation changed overtime by implementation of management actions (including 'no treatments') the hazard index values for each PVG changed. Also, the model determined the hazard index values by MPC group for use in the effects analysis. These values were used to estimate the amount of risk to the forested vegetation from uncharacteristic wildfire and insects. These are discussed in the Vegetation Hazard section of Chapter 3. Table B-32 displays the hazard index for PVG 2 and MPC Group 5 in Alternative 2 for the Boise National Forest.

Table B-32. Example of Hazard Values from SPECTRUM Reports

Hazard Values		0	1	2	3	4	5	6	8	10	15
PVG 2 – Fire											
Low (0.0)	Ac.	76931	122652	166606	201473	229777	254067	252618	285118	284634	279944
Moderately Low (0.5)	Ac.	0	46743	56682	65298	53381	49911	58417	52383	56981	50809
Moderate (1.0)	Ac.	111930	154060	36469	36200	40344	40250	40454	12292	8832	9006
Moderately High (1.5)	Ac.	52489	37367	105430	92542	54678	19607	14972	14277	9149	19160
High (2.0)	Ac.	124524	17994	32314	14607	20004	868	620	0	0	0
Very High (2.5)	Ac.	13442	24580	5387	1501	649	12332	44629	40278	43705	15732
Extreme (3.0)	Ac.	35358	11278	11787	3053	15841	37638	2962	10326	11372	40023
Total	Ac.	414674	414674	414674	414674	414674	414674	414674	414674	414674	414674
PVG 2 - Insect											
None (0)	Ac.	90278	90591	14004	38208	21699	25607	13879	18607	9301	7293
Low (1)	Ac.	100478	251908	326976	280928	305338	338228	345161	334151	344429	347355
Moderate (2)	Ac.	175118	36318	56521	90984	71147	868	8042	11312	5867	4271
High (3)	Ac.	48800	35858	17174	4554	16490	49971	47592	50603	55077	55755
Total	Ac.	414674	414674	414674	414674	414674	414674	414674	414674	414674	414674
MPC Group 5 - Fire											
Low (0.0)	Ac.	287726	247682	258760	285870	337120	341894	362946	373950	374922	393966
Moderately Low (0.5)	Ac.	69758	129045	143883	139494	165537	153477	149187	150559	153551	139808
Moderate (1.0)	Ac.	186014	229389	171064	144617	101126	126646	123828	95988	94912	71461
Moderately High (1.5)	Ac.	51018	47814	90324	99140	66631	37720	23950	38843	40411	67891
High (2.0)	Ac.	77544	19864	25881	29494	20992	310	266	2949	1795	840
Very High (2.5)	Ac.	7690	20044	2173	131	349	10218	38569	35915	28740	2919
Extreme (3.0)	Ac.	18996	4909	6661	0	6990	28482	0	543	4415	21861
Total	Ac.	698746	698746	698746	698746	698746	698746	698746	698746	698746	698746
MPC Group 5 - Insect											
None (0)	Ac.	190139	182355	37662	36741	24202	33502	57557	57126	36287	70991
Low (1)	Ac.	157057	220138	339888	288002	304974	286688	287821	285593	306607	295235
Moderate (2)	Ac.	245444	163786	211763	209212	219337	199322	188283	139085	137403	114135
High (3)	Ac.	106106	132467	109433	164791	150234	179234	165085	216941	218449	218385
Total	Ac.	698746	698746	698746	698746	698746	698746	698746	698746	698746	698746

Budgetary Costs and Other Outcomes

Budgets received for management activities can have an effect on achievement of DFCs. Budgetary costs in the SPECTRUM model are for management actions that change the forested vegetation. Other budget information from activities such as recreation, wildlife restoration, riparian restoration, and others is discussed in Chapter 3.

Alternatives that have large differences in the objective function from the baseline model indicate that constraints (including budget) are having major effects. Alternatives that differ little in the objective function from the baseline model indicate that management direction in the form of MPCs are having the most effect on achieving DFCs of the forested vegetation.

Previous forest planning efforts generally did not constrain the level of budget in the alternatives. This provided activity levels and outcomes from the first round of planning that were not sustainable within actual budget received and raised public expectations on the level of work to be accomplished well above what could actually be accomplished. Differences in the type and mix of funding occurred, which brought into question whether goals, objectives, and standards could be met in the earlier plans (USDA Forest Service 1996).

During the revision process, budgets were constrained to be reflective of historical levels or anticipated levels if activity levels were substantially increased. Other outcomes from the model provided information for evaluating the differences between the alternatives and were used in the effects analysis. Table B-33 displays the budget level in thousands of dollars for each alternative by Forest, along with other outcomes for the first decade. The budget includes all types of treatments to forested vegetation, including fire use, precommercial thinning, planting, and other treatments.

Table B-33. Budget Levels by Alternative by Forest and Other Outcomes

Boise National Forest		Alt. 1B	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Budget for treatments of forested vegetation	M$/yr	13,091	9,656	10,364	3,511	15,901	3,609	12,092
Created openings	Ac/yr	3,704	702	0	0	1,538	0	1,262
Mechanical Harvest	Ac/yr	8,606	14,342	18,164	2,758	14,568	4,740	11,660
Payette National Forest		**Alt. 1B**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Budget for treatments of forested vegetation	M$/yr	8,766	4,638	5,817	2,766	10,244	2,879	7,781
Created openings	Ac/yr	1,591	92	135	0	1,748	67	651
Mechanical Harvest	Ac/yr	4,993	6,424	10,131	2,059	7,457	2,712	5,776
Sawtooth National Forest		**Alt. 1B**	**Alt. 2**	**Alt. 3**	**Alt. 4**	**Alt. 5**	**Alt. 6**	**Alt. 7**
Budget for treatments of forested vegetation	M$/yr	1,175	1,736	1,635	601	2,183	470	2,003
Created openings	Ac/yr	564	187	0	0	603	0	482
Mechanical Harvest	Ac/yr	824	2,445	2,641	533	1,724	268	2,266

Sensitivity Analysis Conducted For The DEIS

Sensitivity analysis was conducted for the Draft Environmental Impact Statement. This analysis is a process in which one or more model parameters are altered, such that successive runs provide insight into the influence of those parameters on the outcomes being modeled. For example, the effects of a budget constraint on DFC attainment can be measured by removing the constraint completely, or by incrementally increasing or decreasing budget levels, and rerunning the model. In order to better understand model behavior and to explore the management policies or goals they represent, several types of sensitivity analysis were conducted: sensitivity analysis of goal weights; of constraints applied to alternatives; and of the effects of uncharacteristic wildfire on alternatives.

Also, when consistent with the intent of an alternative, or for purposes of conducting sensitivity analysis, model solutions were also explored that maximized sustainable harvest levels or minimized the amount of acres in high fire hazard condition.

These analyses were used to help reshape the SPECTRUM model for the Final Environmental Impact Statement (FEIS).

Uncharacteristic Wildfire as Major Events

This sensitivity analysis involved modeling incremental levels of uncharacteristic wildfire. This was conducted on Alternative 2 in the DEIS for the Boise and Payette National Forests. The idea was to explore the ramifications of implementing a management strategy, as represented by Alternative 2 (the proposed action), and then experiencing large-scale stand-replacing fire. This analysis was intended to test the robustness of alternatives. The question to answer was: Could adjustments be made in scheduling future management actions such that DFC is still attained?

Scenarios representing increasing amounts of uncharacteristic wildfire were developed for the Boise and Payette National Forest. The focus was on nonlethal fire regime PVGs such as PVG 2 – Warm dry Douglas-fir/Warm Moist Ponderosa Pine, PVG 5 – Dry Grand Fir, and PVG 1 – Dry Ponderosa Pine/Xeric Douglas-fir. A wildfire hazard assessment based on fire regime departure was used to determine which areas (combinations of sixth-field HUs) were most at risk to uncharacteristic fires. On the Boise, five areas were identified that were about 50,000 acres each, and on the Payette, three areas were identified. The Sawtooth National Forest did not have enough acres of the nonlethal fire regime to conduct an analysis. The analysis units (acres of MPC/PVG/Growth stage) in each high-risk area were assigned to a management action that most closely matched the uncharacteristic event (selected from the list of viable actions). This could be a replace with fire, replace with mechanical, or reset. These management actions were then hard-wired into the fully constrained model to occur in the first decade. Model runs were made for each scenario to represent an ever-increasing amount of simulated uncharacteristic wildfire. The objective function (penalty points for deviating from DFC) could be compared to Alternative 2 for the Boise and Payette to see if any significant changes occurred as the amount of uncharacteristic wildfire increased across the landscape. Table B-34 displays the objective function value for Alternative 2 and each of the scenarios.

Table B-34. Objective Function Values for Uncharacteristic Wildfire Scenarios

Boise NF	Obj. Funct		Burn Ac		Payette NF	Obj. Funct		Burn Ac
Alternative 2	3,249,500		0		Alternative 2	3,568,500		0
Fire Scenario 1	3,472,800	+7%	46,474		Fire Scenario 1	3,872,800	+8.5%	35,096
Fire Scenario 2	3,745,400	+15%	97,298		Fire Scenario 2	4,298,700	+20.5%	75,764
Fire Scenario 3	4,221,700	+30%	151,811		Fire Scenario 3	5,789,000	+62.3%	103,477
Fire Scenario 4	4,515,300	+39%	206,985					
Fire Scenario 5	4,962,300	+53%	262,206					

Because mechanical replacements and resets were used to simulate fire activity, first decade outcomes related to ASQ, TSPQ, Equivalent Replacement Treatment acres (used in RELMdss), budget, or mechanical treatment acres were not entirely valid and should not be used to compare directly against Alternative 2. The simulation was focused primarily on attainment of DFC and effects of uncharacteristic wildfires. On the Boise Forest, there appeared to be two points that show large increases in objective function – between scenarios 2 and 3, and between scenarios 4 and 5. On the Payette, a large increase in objective function occurred between scenarios 1 and 2, with an even larger jump between scenarios 2 and 3. Since these are uncharacteristic wildfires, many constraints had to be relaxed in the model to accommodate the occurrence of these events. Constraints such as VQO, budget, non-declining flow between decades 1 and 2, and dispersion were among those relaxed for this sensitivity analysis.

Hazard Reduction as the Objective Function

Wildfire hazard on all three Forests increased over the first 5 decades in all alternatives. After decade 6, hazard leveled off or began to decline slightly for most alternatives. At question was the degree to which wildfire hazard could be reduced, or minimized, and the effect this would have on DFC attainment. A sensitivity analysis was therefore developed around hazard reduction. Alternative 2, the proposed action, for the Boise was used as the basis for the sensitivity analysis. The objective function was changed from minimizing deviations from DFC to minimizing the total number of acres over time with hazard ratings of 1.5 to 3.0 (High Hazard). All constraints and other model specifications were the same as Alternative 2.

By minimizing high hazard, a 40 percent reduction in the occurrence of acres with hazard indices of 1.5 or higher was realized. The cost to DFC attainment was a 92 percent increase in total deviations from DFC. This suggested that the objectives of minimizing high wildfire hazard and attaining DFC were mutually exclusive. However, further sensitivity analysis revealed that the majority of high hazard reduction could be achieved while incurring only a fraction of the reduction in DFC attainment. Additional runs were made that required 90 percent and 75 percent, respectively, of the maximum potential reduction in high hazard acres. Capturing 90 percent of the maximum potential hazard reduction resulted in a 17 percent increase in total deviations from DFC. Capturing 75 percent of the maximum potential hazard reduction resulted in only a 9 percent increase in total deviations from DFC (Table B-35). This indicates that including hazard reduction as a management objective within an alternative, along with attainment of DFC, can result in a significant reduction in the acres of high wildfire hazard with only a slight to moderate decrease in DFC attainment.

Table B-35. Acres in High Hazard and Deviations from DFC

Model Formulation	Total High Hazard Acres over 16 Decades		Total Deviations From DFC over 16 Decades	
BNF Alt. 2 fully constrained	2,040,381		3,249,500	
100% of Potential High Hazard Reduction	1,220,402	-40%	6,234,900	+92%
90% of Potential High Hazard Reduction	1,297,439	-36%	3,802,350	+17%
75% of Potential High Hazard Reduction	1,417,962	-30%	3,534,750	+9%

During formulation of this sensitivity model, all other constraints were the same as Alternative 2 (the base model). This sensitivity analysis led to including high fire hazard reduction as an objective in the FEIS (described above).

Maximize Sustainable Harvest Levels

For the Boise and Payette National Forest, a model was formulated to explore maximum sustainable harvest levels for Alternative 6. The Alternative 6 model formulation was adjusted to include a goal to maximize first decade ASQ with non-declining flow in cubic feet. These two maximization runs were to address the internally generated question of "How much volume could be produced from roaded areas?"

Alternative 6 was the best fit to address this question. The Sawtooth historically has not produced large volumes of ASQ, so this sensitivity analysis was not completed only for the Boise and Payette National Forests. The results, displayed in Table B-36, indicated that levels similar to Alternative 3 could be produced from maximizing the sustainable harvest level from roaded areas.

Table B-36. ASQ and TSPQ Maximizing Volume from Roaded Areas

	Boise NF				Payette NF		
Per Year	Max. Sust.	Alt. 6	Alt. 3		Max. Sust.	Alt. 6	Alt. 3
ASQ - mmcf	5.69	2.36	5.47		3.40	2.36	5.05
ASQ - mmbf	34.20	13.50	31.92		20.70	13.30	28.20
TSPQ – mmcf	5.79	2.51	7.22		3.40	2.39	6.04
TSPQ - mmbf	34.78	14.39	41.75		20.72	13.45	33.54

RELMdss Model Components

Using RELM software, two five-decade models were created for each alternative. Taken together, these RELM models were intended to help test the spatial feasibility of implementing each alternative. One model was designed to evaluate whether the total acres of vegetation treatments, scheduled by decade to achieve Desired Future Condition, could be distributed to sixth-field hydrologic unit subwatersheds without placing too much activity within 4th field hydrologic units (subbasins). A second RELM model was designed to evaluate, over time and for each alternative, if acres of the largest tree size class were well distributed across sixth-field subwatersheds.

In both types of RELM models, SPECTRUM solutions for the first five decades were simply prorated to sixth-field subwatersheds (approximately 200 per National Forest) using GIS techniques. Each SPECTRUM model tracked the amount of vegetation treatment applied each decade to analysis units (polygons delineating lands with similar attributes) as well as tracking the vegetation size class for each analysis unit in each decade. By overlaying analysis units with sixth-field subwatersheds using GIS, the proportion of each analysis unit occurring in each subwatershed was known. Relevant SPECTRUM solution attributes were prorated to subwatersheds based on the proportion of an analysis unit present in a watershed. For example, if a 1,000-acre analysis unit was characterized as large trees and was mapped as occurring in five separate subwatersheds, each subwatershed would be assigned a share of the 1,000 acres of large trees based on how much of the analysis unit fell within that subwatershed. If 20 percent of the analysis unit acres fell within each subwatershed, then each subwatershed was assigned 20 percent of the large tree acres. Similarly, if a vegetation treatment was scheduled to take place on that same 1,000 acre analysis unit, each of the five subwatersheds would be assigned 20 percent of the management activity.

RELM Equivalent Replacement Treatment Model

Vegetation treatments, such as thinning, selection, prescribed fire, and stand replacing fire, were first converted into Equivalent Replacement Treatments (ERT) and attributed to all management activities modeled in SPECTRUM. The following are the management action ratios used in the SPECTRUM model:

- 1 acre of Replace = 1 acre ERT
- 8 acres of Reset = 1 acre of ERT
- 8 acres of Maintain = 1 acre of ERT
- 15 acres of MIF (prescribed fire) = 1 acre of ERT
- 10 acres of PNF (wildland fire use) = 1 acre of ERT

Table B-37 display the Equivalent Replacement Treatment acres for each alternative by Forest for the first decade treatments using the budget constrained model runs.

Table B-37. Equivalent Replacement Treatment Acres

Boise NF		Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6	Alt. 7
Equivalent Replacement	Ac/yr.	9,375	8,033	5,581	5,075	5,394	7,776	11,202
Payette NF								
Equivalent Replacement	Ac/yr.	5,692	5,061	3,840	5,760	6,694	7,248	6,370
Sawtooth NF								
Equivalent Replacement	Ac/yr.	663	5,527	4,492	4,198	2,486	4,625	7,153

SPECTRUM solutions for the first five decades displaying the amount of ERT resulting from vegetation treatments applied to analysis units prorated to sixth-field subwatersheds. This provided an estimate of total ERT occurring in each subwatershed by decade. Each subwatershed was previously assigned a sensitivity class and these classes inferred thresholds, or constraints, on the maximum amount of ERT that could occur in a watershed in any one decade. Sensitivity Class I subwatersheds were limited to 6.0 percent of their acres having an equivalent replacement treatment per decade. Sensitivity Class II and III subwatersheds were limited to 8.0 percent and 13.0 percent, respectively, of their acres having an equivalent replacement treatment per decade.

RELM evaluated ERT levels against these thresholds, and graphically displayed the results. Color-coded visual displays indicated which subwatersheds were above or below the thresholds and the degree to which thresholds were over- or underachieved. Tabular information was used in the effects analysis of alternatives.

RELM Large Tree Model

While Forest-wide wildlife management requirement constraints required 20 percent of each PVG to be in the largest tree size class (for PVG-10 it is medium tree), SPECTRUM model solutions needed to be assessed in terms of how well this size class was distributed. Well distributed was defined for purposes of this evaluation as having at least 5 percent of the total acres of each sixth-field subwatershed classified as large trees.

Each analysis unit in SPECTRUM was attributed with an initial vegetation size class that changed over time based on the effects of natural succession and/or management activities. Consequently, acres of analysis units classified as large trees could be prorated each decade to sixth-field subwatersheds. RELM compared the estimated acres of large trees in each subwatershed to the 5 percent threshold and graphically displayed the results. Color-coded maps indicated which watersheds did not have the desired amount of large trees and this information was utilized in the effects analysis of alternatives. Tabular reports were prepared that also allowed evaluation of alternate thresholds. For example, if a 10 percent large tree threshold were to be used, they indicated how many subwatersheds would then be above or below that threshold. In general, a very small number of subwatersheds did not meet the 5 percent threshold with this number decreasing over time.

NON-FORESTED VEGETATION

Introduction

The basic analytical framework for the revision of the Southwest Idaho Ecogroup Forest Plans is prescribed in the NEPA process. A set of alternative scenarios, representing different approaches to the identified needs for change and issues, were simulated over time to provide information to compare and contrast those alternatives in terms of their ability to achieve the Desired Future Conditions (DFCs). Non-forested vegetation types were modeled using the Vegetation Dynamics Development Tool (VDDT) developed by ESSA Technologies, Ltd., of Vancouver, B.C. The VDDT is a user-friendly computer tool that provides a modeling framework for examining the role of succession, various disturbance agents, and management actions in vegetation changes (Beukema and Kurz 2000). The VDDT was designed to project changes in vegetation composition and structure over time for use in landscape-level analyses. It enables the projection of the combined effects of multiple factors, such as wildfires, management treatments, pathogens, growth, and competition over long periods of time. The interaction of these factors can be quite complex, and it can be difficult to project the combined effects over long periods of time. VDDT is a software tool that allows the construction of models for the purpose of simplifying those combined effects over time, and examining the roles of various disturbance agents and management activities in vegetation change.

The VDDT assumes a landscape stratified into units, or vegetation types, with similar successional pathways. It allows users to create successional pathway diagrams for vegetation units by defining predominant vegetation states, or successional classes, based on characteristics such as canopy cover, age, and structural stage. Pathways between classes are either disturbance driven or the result of succession. Change along successional pathways is a function of time spent in a particular class and the next class along the pathway. Movement along disturbance pathways is based on the probability of the disturbance happening and the impact of that disturbance on the vegetation.

The model partitions the landscape, or the vegetation unit, into pixels; the number of pixels, and hence the resolution of a particular model run, can be adjusted by the user within the limits of the model. Pixels are initially assigned to classes based on user-created definitions, and the model randomly assigns ages to each pixel within the age parameters of the class. During model simulations, probabilities of disturbance are applied to pixels and pixels are moved accordingly along the defined pathway to the appropriate class. Disturbance probabilities are applied independently to each pixel, based only upon the parameters of the class in which it resides. They are independent of the state of the neighboring pixels and the disturbance history. Therefore, the VDDT does not simulate spatial relationships. Individual disturbances or groups of disturbances may be turned on or off for model runs. Disturbance-related pathways specify, for each class, the type of disturbance, its probability (which defines the return frequency), and its impact on vegetation. Changes due to successional processes are defined by the time a vegetation type remains in a structural stage (or canopy cover type) and by the successional class it will move to after this time has passed.

The model allows for further partitioning of pixels into "regions". Within a particular successional class, pixels can be assigned to regions and a different set of disturbance probabilities applied to each region. The model currently accommodates up to six regions. For analysis of Forest Plan alternatives, regions were defined as groups of management prescription categories (MPCs), as described below.

Outcomes from multiple simulations are then averaged to gain insight into how landscape conditions might change over time. This is relative to the management objectives for a given alternative and as a result of the interaction between ecological processes and management activities. Version 4.2 of the VDDT was used in this analysis.

Perhaps the most important contribution of this modeling framework is that it provides a common platform for specialists of different disciplines, e.g., entomology, pathology, fire ecology, silviculture, wildlife biology and ecology, to collectively define the roles of various processes and agents of disturbance on landscape-level vegetation dynamics. Moreover, the development tool allows for rapid testing of the sensitivity of the system to alternative assumptions. It thus provides a tool for learning and communication.

Differences with SPECTRUM Model

Similar to SPECTRUM, VDDT can model the outcomes of vegetation condition classes over time. However, an important difference exists between them. VDDT has the capability to incorporate stochastic events into the modeling process through the methods involved of assigning probabilities. Using this feature has enabled us to account for wildfire as a large stochastic event where suppression efforts have failed (failed fire suppression). This type of modeling has not been possible using SPECTRUM for forested vegetation successional modeling, yet provides information about an important component of vegetation succession.

Analysis Process

DFCs for each alternative were represented as goals for the number of acres to be maintained in specific structural stages, by cover type or groups of cover types. The DFCs for each alternative are described in Chapter 3, Vegetation Diversity, and are based on properly functioning condition. Properly functioning condition describes a state in which the risk of losing biological and physical components becomes greater as vegetation types move further away from a properly functioning condition state. Several vegetative attributes or components, such as composition, structure, disturbance, and landscape patterns, are used to describe properly functioning condition and determine a landscape's risk of departure (USDA Forest Service 1996). The concept of Historical Range of Variability (HRV) is incorporated as a part of these components.

For each alternative, four questions relating to non-forested vegetation were considered. First, what mix of structural stages is likely to occur over time within each vegetation type as a result of the mix of MPCs in a particular alternative? Second, what level of management activities is necessary to achieve DFCs? Third, how is attainment of DFCs affected if chemical treatment and/or wildland fire use is unavailable? Fourth, what are the effects on structural stages as a result of wildfire and how does this influence vegetation hazard?

Four vegetation types were identified on the Mountain Home District of the Boise National Forest, and eleven were recognized on the Sawtooth National Forest. Within each vegetation type, between four and eleven structural stages were represented. Modeling was not completed on the Payette National Forest and the remainder of the Boise National Forest due to the low number of acres of non-forested vegetation in the types modeled.

Management Prescription Regions

All National Forest lands were assigned to a particular MPC based on management opportunities and needs, and the approach of the alternative for addressing issues. See Chapter 2 in this EIS and Chapter III in the revised Forest Plans for a description of MPCs. GIS layers were created for each alternative that displayed the MPC assignments. These layers were merged with the vegetation layer to determine the number of acres in each MPC for each alternative. The resultant data was used to create initial condition files for each alternative in VDDT that reflected the distribution of acres into MPCs. The number of acres within each MPC and where those prescriptions are mapped on the land are the primary differences between alternatives. For example, a particular area may be assigned to 5.2 in Alternative 5, while it may be assigned to 3.2 in Alternative 3.

Pixels were divided into regions in order to assign different probabilities of disturbance to different groups of MPCs. A disturbance probability worksheet was developed that displayed a probability for each MPC region along every disturbance pathway used in the model. These matrices needed to be as small as possible within the parameters of the model, while enabling the model to be sensitive to important differences in management scenarios (i.e., differences in the relative mix of MPCs among alternatives). MPCs were grouped to fit the limited number of regions available within the model and to simplify the development of initial conditions and disturbance probabilities. MPC groups are assumed to have similar probabilities based on the interpretation of the MPCs as they relate to changes in vegetation.

In this analysis, probabilities of disturbance varied by disturbance type, vegetation type, structural stage, and management region. Five management regions were recognized in the VDDT corresponding to MPC groups, as outlined in Table B-38.

Table B-38. MPC Groups Used in Modeling

MPC Groups	MPCs in each Group with Management Emphasis
1	Wilderness / Roadless Areas (MPC 1.1, 1.2, 4.1a, 4.1b)
2	Research Natural Areas / Passive Restoration (MPC 2.2, 3.1)
3	Restoration (MPC 3.2, 4.1c, 6.1)
4	Range Commodity (MPC 4.2, 4.3, 5.1, 6.2)
5	Timber Commodity (MPC 5.2)

Probabilities were specified for each of eight potential disturbance events; all disturbance events did not occur in every vegetation type:

1. Mechanical treatment
2. Chemical treatment
3. Regeneration harvest
4. Grazing
5. Prescribed fire
6. Wildland fire use
7. Failed fire suppression (Wildfire)
8. Background wildfire

Model Parameters

Four types of parameters are user specified within VDDT: initial conditions, time span for simulation, number of simulations, and the number of pixels simulated. Initial conditions were described in terms of the current number of acres in each structural stage and vegetation type as represented by available GIS data. A time span of 150 years applied to all simulations. Fifty simulations were run for each combination of alternative, management region, and vegetation type, and the results of each set of 50 simulations were averaged. The number of pixels specified within VDDT varied for each set of the 50 simulations based on the number of acres for that combination of alternative, management region, and vegetation type. If the total area was less than 1,000 acres, 100 pixels were specified. If the total area was greater than 1,000 acres but less than 20,000 acres, 1,000 pixels were specified. If the total area was greater than 20,000 acres, the number of pixels specified was based on 20 acres per pixel up to the maximum of 10,000 pixels allowed by the VDDT software.

Model Calibration

Two types of model calibration took place. First, user-specified parameters such as number of simulations run and the number of pixels per simulation were tested to determine if outcomes were biased when these values were arbitrarily set. Second, results were reviewed to determine if conditions fell within expected outcomes. For example, the probabilities assigned to background wildfire in Alternative 1B were assumed to be the same levels of fire in the future that have been observed over the last 50 years. This assumption was tested during the calibration process.

VDDT results were compared when 1, 10, 50, and 100 simulations were run at a time. Results were also compared when the number of pixels increased from 1,000 to 10,000. Increasing the number of simulations had very little effect, if any, on ending structural stage conditions. Increasing the number of simulations reduced year-to-year variation in disturbance levels but widened the overall range (minimum and maximum levels observed) for acres disturbed. For the present analysis, it was concluded that more than 50 simulations did not add additional information or insight but did capture most, if not all, of the variation observed when running larger numbers of simulations.

A pixel in VDDT represents a unit of land within a specific vegetation class. Pixels are never split and they move along vegetative pathways independently of one another. Each pixel is evaluated in each year of the simulation for disturbance based on the probabilities specified by the user. Increasing the number of pixels in a simulation means that each pixel represents fewer acres and disturbance events can be evaluated at a finer scale. For example, if a 100-acre area is simulated as only one pixel, the entire area will either advance along the successional pathway or be affected by a disturbance in a given year. If the same 100-acre area is simulated as 100 pixels, then some pixels will advance successionally while others will be affected by disturbance based on the probabilities specified.

When pixel numbers were increased from 1000 to 10,000 pixels, the between year variations in disturbance levels diminished as did the range between the minimum and maximum levels of disturbance observed across all simulations. However, the average disturbance levels and ending structural stage outcomes were essentially unchanged. For the present analysis, it was concluded that specifying the maximum number of pixels allowed (10,000) did not necessarily provide “better” results. Pixel numbers were selected so that pixel size did not generally exceed 20 acres.

The final step in model calibration related to handling failed fire suppression wildfire in a more realistic manner. While historical information can be used to calculate an average annual probability for wildfire, obviously the average number of acres does not burn each year. Instead, we wanted to simulate failed fire suppression wildfire as a less frequent and more erratic type of event. This was facilitated in VDDT through the use of Year Sequence Groups and annual multipliers, along with some trial and error. These software features allow the user to describe classes of years (year groups) for fire occurrence from extremely low to extremely high, and the proportion of acres likely to burn in each year group. More detail is presented below in the section, Development of Disturbance Probabilities.

Development of Initial Conditions

Non-forested Vegetation Mapping
Existing vegetation or cover type is a seral stage to a climax plant community, and generally results from some form of disturbance. The dominant overstory can vary with this successional change. Cover type classifications typically describe the current dominant vegetative cover or species occupying a site. Cover types can be used to describe seral stage species composition in relation to climax species composition or historical conditions. Existing non-forested vegetation groups or cover types may approximate the dominant climax vegetation, or in other situations, display variations from past use, management, and/or disturbance. This form of classification recognizes ecological influences that contribute to broad-scale cover type extent and future development. Unlike forested vegetation, shrubland and woodland successional change is not likely to be fully detected at the broad scale using only cover types, because the same overstory species may occur as part of several successional stages for the vegetative community. However, a cover type's density or canopy cover can be used as a complimentary indicator to define, in part, successional change, ecological condition, and disturbance regime influence. Similar to forest canopies, shrub or woodland overstories exert a competitive influence on herbaceous understory composition and productivity. For those reasons, cover types of non-forested vegetation were used as a proxy for potential vegetation, and mapping utilized a remote sensing classification with LANDSAT of both cover types and canopy covers for several non-forested vegetation types. These types included several subspecies of *Artemesia tridentata* (basin big sagebrush, Wyoming big sagebrush, mountain big sagebrush), low sagebrush, and areas of pinyon-juniper with mountain big sagebrush and/or Wyoming big sagebrush. McClure et al. (in press) describe the mapping procedures in detail.

On the Minidoka Ranger District, a different method was used to map the climax aspen and pinyon-juniper stands. Ranger District personnel mapped all conifer stands and many aspen and pinyon-juniper stands. Stands were delineated on aerial photos and orthophoto quandrangles. Information associated with each stand was entered in the Forest's database (Rocky Mountain Resource Information System – RMRIS) and, as a minimum, included habitat type, cover type, tree size class, and canopy closure class.

Vegetation Cover Types
Forested potential vegetation groups (PVGs) are being modeled separately with SPECTRUM. With VDDT, we tried to get a picture of some of the other dominant vegetation types that were not included as a forested PVG. Sagebrush species and subspecies were deemed important types that required analysis to evaluate changing landscape patterns and sage grouse habitat. Climax aspen and pinyon-juniper were also evaluated with VDDT, as these were not covered by the SPECTRUM modeling. Seral aspen is included as a component of the forested PVGs. The types selected represented broad vegetation types that are predominant on the landscape, and for which adequate information exists to develop current conditions and model parameters (Table B-39). Riparian vegetation was not modeled because this type exists as a complex and fairly fine-grained mix of communities. These communities are not accurately represented with just a few successional pathway diagrams. Riparian vegetation mapping was further complicated by the lack of sufficiently detailed data to establish current conditions for riparian vegetation.

Table B-39. Vegetation Cover Types and Codes

1401 Basin Big Sagebrush (ARTRTR) 1402 Mountain Big Sagebrush (ARTRVA) 1403 Wyoming Big Sagebrush (ARTRWY) 1406 Low Sagebrush (ARAR) 1411 Climax Aspen (POTR) 1412 Juniper Woodlands (Juniper) 1421 Mountain Big Sagebrush with Chokecherry, Serviceberry or Rose (CSR-ARTR) 1422 Mountain Big Sagebrush with Snowberry (SYM-ARTR) 1423 Mountain Big Sagebrush with Bitterbrush (PUTR-ARTR) 1425 Mountain Big Sagebrush with Juniper 1426 Wyoming Big Sagebrush with Juniper	11 Cover Types (Cover.txt)

Structure Classes

Structure classes for sagebrush were based on the canopy covers:

- Low (0-10 percent canopy cover)
- Medium (11-20 percent canopy cover)
- High (21-30 percent canopy cover)
- Very High (>31 percent canopy cover)

Very high was only used for the Mountain Big Sagebrush types. The canopy covers refer only to the canopy cover of sagebrush, and do not include the associated species that may be found co-occurring with sagebrush.

Climax aspen utilized a combination of size and canopy covers. They following classes apply to climax aspen:

- Grass/Forb/Shrub/Seedling (<10 percent canopy cover of aspen)
- Sapling (Size at DBH = 0.1-4.9"/All canopy covers of aspen)
- Small/Sparse (Size at DBH = 5-11.9"/<70 percent canopy cover of aspen)
- Small/Dense (Size at DBH = 5-11.9"/>70 percent canopy cover of aspen)
- Mature (Size at DBH >= 12"/>70 percent canopy cover of aspen)
- Mature/Managed (Size at DBH >= 12"/<70 percent canopy cover of aspen)

Pinyon-Juniper Woodlands utilized these classes:

- Stand Initiation (Size = 0.1-4.9" /all canopy covers)
- Stem Exclusion (Size = 5-11.9"/all canopy covers)
- Young Multistory (Size >=12"/10-39 percent canopy cover)
- Old Multistory (Size >=12"/40-69 percent canopy cover)
- Old Single Story (Size >=12"/>70 percent canopy cover)

An additional class used was the Grass/Forbs (pre-shrub), which represented the condition after a failed fire suppression wildfire. The vegetation structural classes are outlined in Table B-40.

Table B-40. Vegetation Structural Classes and Codes

1	Low	Low(0-10)	16 Structure Classes (Structur.txt)
2	Med	Medium(11-20)	
3	Hi	High(21-30)	
4	VHi	VeryHigh(>31)	
11	GFS	GFSS(<10%CC-Aspen)	
12	Sap	Sapling(Size 0.1-4.9/Allcovers)	
13	SmS	SmallSparse(Size5-11.9/<70%cover)	
14	SmD	SmallDense(Size5-11.9/>70%cover)	
15	Ma	Mature(SizeMedium(large)/>70%cover)	
16	MaM	MatureMgd(SizeMedium(large)/10-69%cover)	
21	SI	StandInitiation(Sapling/Allcovers)	
22	SE	StemExclusion(Small/Allcovers)	
23	YMS	YoungMultistory(Medium/10-39%)	
24	OMS	OldMultistory(Medium/40-69)	
25	OSS	OldSingleStory(Medium/Large/>70%)	
30	GF	Grass/Forbs(pre-shrub)	

Development Of Disturbance Probabilities

In most cases, probabilities were based on levels of disturbance observed over the last decade and the MPC group. These levels were adjusted to account for foreseeable changes anticipated during the next planning period. For example, levels of prescribed fire in MPC Region 3 (restoration) approximate the historical fire return interval, as the intent in these MPCs is for vegetation restoration. These baseline figures were then adjusted up or down to develop a probability for a given MPC region based on the management emphasis of that region. Some treatments would not occur in certain MPC Regions (e.g., wildland fire use in MPC Region 5), or their application might be limited (e.g., wildland fire use in MPC Region 2), or less limited (wildland fire use in MPC Region 1). These probabilities were further adjusted to account for the likelihood of disturbance in a particular successional class. Some classes might be targeted for a particular treatment or susceptible to a disturbance, and so were assigned a much larger probability than pathways from classes that might be affected only by incidental inclusion in a disturbance or treatment. For example, in MPC Region 3, prescribed fire would target the denser canopy cover classes of sagebrush; the adjusted baseline probability would be applied to these classes. Some incidental acres of less dense sagebrush might also be burned, and a minimal probability is assigned to reflect this.

<u>Succession and Disturbance</u>
The primary conceptual model for vegetation dynamics is that any given unit of vegetation will change over a period of time, succeeding through some defined set of stages if undisturbed. If disturbed, the vegetation will instead change through a different set of stages. Each potential set of stages, in sequence, is called a pathway.

Successional pathways, with or without disturbances, summarize scenarios in vegetation dynamics. Modeling such scenarios so as to have a quick and simple, yet useful, way of observing changes over time necessarily requires that only the most basic driving forces be included. Perhaps more importantly, many of those forces exert themselves as events that are expected to occur but for which the timing and frequency are essentially random. While management activities are disturbances that may be accurately predicted, other disturbance agents may only reasonably be predicted in terms of historical probabilities. The outcomes from those disturbances, then, are also necessarily probabilistic. Clearly, the interaction of the many biological and physical factors that are at work can be quite complex, and it can be difficult to project their combined effects over long periods of time; indeed, the longer the scenario, the less certain the outcome. More details on the successional pathways used can be found in the project record.

Undisturbed Succession
Changes in vegetative conditions due to dynamics such as regeneration, growth, and self-thinning, form the basic successional pathway in the absence of disturbance. Some successional pathways are cyclical, indicating the likelihood of some self-limited lifespan, followed by self-regeneration and repetition of the cycle, unless disturbed. Other successional pathways have an end condition that represents a steady state that can be maintained perpetually. Modeled changes due to successional dynamics are defined by the time that a vegetative unit remains in a particular stage, and by the stage into which it will move after that time has passed.

Alternate Succession
Alternative successional pathways were used for both the aspen and pinyon-juniper cover types. Succession could take several paths, based on disturbance history. Different probabilities were assigned to reflect the likelihood that vegetation would progress along one pathway or another.

In climax aspen, an alternate successional pathway was defined whereby 90 percent of the aspen succession would progress from the Small/Sparse structure class to the Small Dense structure class. This would be the undisturbed successional pathway. However, it was estimated that approximately 10 percent of the aspen would progress from the Small/Sparse structural class to the Mature/Managed structural class. This would likely result from management actions such as livestock grazing disturbances that kept canopy closures lower through inhibited regeneration, or from site potential differences.

In pinyon-juniper, the alternate successional pathways tried to make predictions about the rates of sagebrush conversion to pinyon-juniper. These reflect the assumption that in those areas mapped as mixed mountain big sagebrush with pinyon-juniper (pinyon-juniper canopy cover less than 10% in these mixed types), their probability of conversion to a pinyon-juniper type would increase the longer they remained on the successional pathway without disturbance. In the mixed Wyoming big sagebrush with pinyon-juniper type, the probabilities reflect a high susceptibility to conversion if there are already some low levels of juniper present in the stands. Obviously, this is a simplified model of sagebrush conversion, as we did not take into account site-specific conditions such as soils, vegetation at the plant association level, disturbance history, and other factors relevant to conversion.

Wildfire Disturbances
Disturbance-related pathways specify, for each stage, the type of disturbance, its probability (which defines its return frequency) and its impact on the vegetation. The impact is represented by the different stage to which the vegetative unit has been transferred as a result of the disturbance. That new stage may be on the undisturbed pathway, representing a simple setback in succession, or it may be on another pathway entirely.

Background Wildfire - Wildfires that are successfully suppressed during initial attack were modeled as background wildfire. These types of fires were treated as frequent, small-scale events. Based on development of background wildfire probabilities for forested vegetation, we found that fire suppression and other changes have had about a 10-fold decrease in the number of acres burned currently than historically. Therefore, all probabilities were divided by 10. Table B-41 represents the historical fire frequencies determined from the Fire Effects Information System. Landscape probabilities were developed from the mean of the historical frequency (the reciprocal of the historical frequency) and in most cases, the dense canopy condition was assumed to have the highest chance of burning. Table B-42 represents an example of probability development for mountain big sagebrush. Table B-43 was used to calibrate the model by using the acres burned in the past to adjust the historical probabilities to current probabilities for non-forested VDDT modeling purposes. We used A through D sized fires to represent acres burned by background wildfire.

Table B-41. Historical Fire Frequencies

Cover Type	Historical Frequency	Comments
ARAR	Less than 100 years	Mean = 100; Probability = 0.01 Because of low fuels, rock, etc, fires are comparatively rare in this type. Assigned the lowest probability compared to other non-forested types.
ARTRWY	10-70 years – patchy effect	Mean = 40; Probability = 0.025
ARTRTR	Between ARTRWY and ARTRVA = 10-70 and 5-15 years	Mean of 15-70 = 42.5; Probability = 0.0235
ARTRVA	15-25 years	Mean = 20; Probability = 0.05 Al Winward: 2-3 percent of the area burned annually historically
SYM-ARTR	Use ARTRVA value	
CSR-ARTR	Use ARTRVA value	
PUTR-ARTR	Use ARTRVA value	
POTR	Low severity = 7 to 10 years assume high severity occurs later in the lifecycle: 70 to 100 years	Mean of 70-100 years = 85; Probability = 0.01176
Juniper	11-23 years – use 25 years	Frequency = 25; Probability = 0.04

Table B-42. Probability Development for Background Wildfire for Mountain Big Sagebrush

	0-10% Canopy Closure	11-20% Canopy Closure	21-30% Canopy Closure	>30% Canopy Closure
Probability that a stage will burn	0%	0%	5%	95%
Landscape probability X probability of stage burning (0.05 times %)	0%	0%	0.0025%	0.0475%
10-fold reduction described above	0%	0%	0.00025% (1/4000)	0.00475% (1/211)

Total landscape probability = 0.05 (1/20)

Table B-43. Sizes of Fire Classes

Class	Range of Acres	Class	Range of Acres
A	0 - 0.25	E	300 - 999.9
B	0.26 - 9.9	F	1000 - 4999.9
C	10 - 99.9	G	≥5000
D	100 - 299.9		

Failed Fire Suppression - Wildfires that escape initial attack and require extended attack or an incident management team to suppress were modeled as failed fire suppression. For non-forested VDDT modeling purposes, we used E through G fires (Table B-43) to represent acres burned by failed fire suppression. These fires were treated as infrequent, large-scale events.

The VDDT model provides a "multiplier" feature to account for low-frequency, large-scale events (in our case failed fire suppression) to differentiate them from frequent, small-scale events (i.e., background wildfire). Background wildfire assumes some level of wildfire disturbance each year based on the fact that many of our ignitions occur from lightning, and frequency of ignitions has not changed over time. The multiplier allows us to interject large wildfire events tied to some kind of condition like weather, which in combination with certain fuels, can lead to large wildfires. We used fire size as an indicator of the frequency of very low, low, normal, high, or severe wildfire years as follows:

- Very low year—no fires greater than A;
- Low year—no fires greater than B;
- Normal year—no fires greater than C and/or D;
- High year—no fires greater than E and/or F;
- Severe year—G fire occurred.

When the model "hits" one of these conditions, a multiplier is applied to the background wildfire probabilities that creates a larger event than would result from the background levels alone. The multiplier for very low, low, and normal were assumed to be part of the background acres and assigned 0. We developed the information for high and severe years based on whether a fire occurred in that size class. These relationships of normal to high or severe were used to develop multipliers for the model. Failed fire suppression is the only disturbance that will set the pathway back to a Grass/Forb (pre-shrub) stage.

<u>Management Disturbances</u>

Management disturbances are the controlling input factors for the model. The objectives for a particular scenario may call for a certain mix of vegetative stages by a certain time, and the management disturbances must be adjusted up or down in terms of probability so as to achieve those objectives, while taking into consideration the more stochastic disturbances that may also occur.

For example, where initial conditions are that most of a cover type is in older stages, the scenario objectives may require that at least half of that cover type is in an immature or younger condition within some time span. To accomplish that, some combination of management activities that result in moving the vegetation to younger stages must be implemented. A set of initial probabilities can be calculated as a starting point for the model. If the objectives are not achieved after running the model, the probabilities can be adjusted up or down in successive runs until the desired results are seen, or until it is reasonably proven that the desired results are not feasible.

Models of alternatives had to satisfy numerous types of limits in order to be feasible. The most common limits applied were for acres treated in any given time period. Limits, in a modeling sense, are used to represent physical, ecological, financial, legal, or social thresholds that simulation must fall within, in order to be considered reasonable or appropriate. For example, budgetary requirements to implement an alternative must be within reason compared to experienced budget levels; and DFC attainment must comply with other resource management objectives consistent with a given alternative.

Prescribed Fire - Intentional disturbance by setting fire to the vegetation is prescribed fire in these models. The result of the fires depends on the cover type and structural stage in which they occur. The impacts in some cases are lethal, causing the vegetation to be transferred to a regenerated stage; or the impacts may be non-lethal, resulting in transfer to a less dense stage. In some cases, fire simply maintains the vegetation in its current stage, preventing it from moving along its undisturbed successional pathway. Table B-44 provides an example of how a probability was determined for prescribed fire in MPC Group 3 (restoration)

Table B-44. Example of Probability Determination for Prescribed Fire

	0-10% Canopy Closure	11-20% Canopy Closure	21-30% Canopy Closure	>30% Canopy Closure
Percent of historical	20% of historical	50% of historical	historical	20% of historical
Probability of prescribed fire in ARTRVA and SYM-ARTR	.005 (1 in 200 years)	.0125 (1 in 80 years)	.025 (1 in 40 years)	.005 (1 in 200 years)

ARTRVA and SYM-ARTR
Historical mean = 20. ARTRVA is at 40 years (Al Windward, personal communication, 1999). We used for the target class of 21-30% CC (to prevent acres from moving into >30%). The others were modified to reflect expected levels of prescribed fire in those canopy classes.

Wildland Fire Use - A management action that allows lightning-ignited fires to burn for resource benefits, is treated as wildland fire use in these models. The result of the fires depends on the cover type and structural stage in which they occur. The impacts are typically lethal, causing the vegetation to be transferred to a regenerated stage.

Chemical Treatment - Chemical treatment occurs in the sagebrush types as a management action for thinning in the restoration MPCs by patchily breaking up canopy covers in dense stands, thus allowing for subsequent prescribed fire and/or reproduction of seral species. It can also be used as a tool to increase forage production in commodity MPCs. The assumption was that we would be using chemicals that are applied at small scales, such as tebuthiuron pellets, and not large-scale aerial spraying.

Mechanical Treatment - The pinyon-juniper cover type model included mechanical treatment to reduce densities and average ages of the vegetation units. Essentially similar to a thinning harvest treatment, there is no commercially viable commodity produced by this management activity. The objectives would be to restore sagebrush and grassland understories, to increase forage production, or to reduce frequency and intensity of fires.

Regeneration Harvest - This was used in the climax aspen model only. In our model, regeneration harvests were assumed to achieve silvicultural objectives and to serve as a restoration tool where necessary.

Livestock Grazing - Grazing by permitted livestock was modeled only in the climax aspen cover type as a management disturbance, due to the effects that grazing has on many aspects of vegetation dynamics. For example, we modeled grazing as suppressing regeneration of aspen, thus maintaining it in the grass/forb/shrub/seedling class and not progressing further on the aspen pathway. Grazing was not modeled in the sagebrush types, due to its extensive nature, but it is discussed in the effects analysis as it pertains to increases in shrub cover, effects to understory vegetation, and changes in fire cycles.

Model Outputs

For each alternative for the Boise and Sawtooth National Forests, VDDT simulation results were averaged and reported. Two types of results were displayed both graphically and in tabular spreadsheets. The first estimates the distribution of acres by structural stage by vegetation type and management region for each decade (Table B-45). The second shows likely decadal acres of each disturbance type by vegetation type and management region (Table B-46).

Table B-45. Example of Output Produced for Distribution of Acres by Structural Stage

Boise NF				Alternative 2		Structural Class Acres by Years					
Cover Type	Structural Class	0	10	20	30	40	50	60	70	100	150
Region 1											
1402	Grass/Forbs	0.0	30.1	738.8	706.9	4234.4	2167.3	1594.5	24.2	2086.0	2738.3
	Low	14775.2	6720.3	3667.9	4792.1	4629.7	5966.8	8122.2	5503.2	6168.1	4043.9
	Medium	1085.4	8685.5	5250.8	1961.0	2992.2	3338.8	1795.8	5905.2	2381.5	2633.6
	High	1645.6	844.1	6804.3	4063.9	1545.1	2352.5	2631.9	1422.9	2811.8	2836.4
	VeryHigh	0.0	1226.1	1044.4	5982.2	4104.9	3680.9	3361.9	4650.7	4058.6	5254.0
	Totals	17506.2	17506.2	17506.2	17506.2	17506.2	17506.2	17506.2	17506.2	17506.2	17506.2

Table B-46. Example of Output Produced for Decadal Acres of Disturbance

Sawtooth Alternative 6		Total Acres of Disturbance by 10-Year Intervals								
Cover Type	Disturbance	10	20	30	40	50	60	70	100	150
Region 1										
1401	Succession	5629.4	3734.1	3522.7	2420.8	4233.9	3461.2	3986.0	3531.0	3212.3
	Mechanical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Chemical	198.1	355.9	382.2	345.3	282.2	311.0	308.5	356.0	392.4
	RegenHarvest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Grazing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	RxBurn	318.9	293.8	289.3	295.2	277.5	291.5	301.2	293.5	300.9
	WildlandFireUse	859.5	840.3	790.7	794.6	763.9	819.8	827.0	825.3	824.6
	FailedSuppression	35.3	794.9	11.3	1084.5	302.1	637.1	11.6	353.2	418.1
	BackgroundWildfire	47.5	78.2	86.6	74.3	61.0	72.0	70.3	80.5	81.6
	AlternateSuccession	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Sensitivity Analyses

Sensitivity analyses were conducted to evaluate the effects of two management actions: wildland fire use and chemical treatment. These two were chosen as they are not currently used to potential levels and they are tools that inspire resource management conflicts among various user groups.

Sensitivity analyses were conducted on Alternative 7, the new alternative for the FEIS. Three scenarios were examined:

- No wildland fire use, yet chemical treatment available.
- No chemical treatment, yet wildland fire use available.
- Neither is available.

The results of the analyses are discussed in Chapter 3, Vegetation Diversity.

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