Appendix B - The Modeling and Analysis Process

Table of Contents

Appendix B - The Modeling and Analysis Process

Introduction

The purpose of this Appendix is to present a technical discussion of the analysis process and models used in Forest planning. Basic assumptions, model components and inputs, modeling rules and methods, and modeling constraints imposed, along with their rationale and impacts, are described in this Appendix. Information presented here supplements the broader and less technical descriptions that are included elsewhere in this Environmental Impact Statement (EIS). See Chapter 2 for a description of the overall process, the results of the benchmark analysis, additional discussion of the alternatives and a discussion of opportunity costs associated with Forest constraints.

FORPLAN, a linear programming model, is the primary modeling tool used to assure that land allocations and output schedules are made in a way that meets all constraints in the most cost-efficient manner possible. In addition to being used to formulate alternatives and benchmarks, FORPLAN is used to perform detailed accounting work and to generate summary reports of information needed to construct the display tables in this EIS.

Eight additional models were used to generate input data for use in FORPLAN, to interpret output data from FORPLAN and to assist in the spatial allocation of FORPLAN to meet various alternative themes.

The National Fire Management Analysis System (NFMAS) fire model was used to estimate the fire organization, activity levels and fire management costs required to efficiently achieve the program direction for each alternative.

The Forest Service IMPLAN system was used to develop impact multipliers, plus employment and income estimates for the alternatives analyzed in this EIS.

A Forest Plan Data Base was developed to define land units (i.e. analysis areas) and acres of suitable prescriptions by alternative.

A Geographic Information System (GIS) used the Forest Plan Data Base to visually display timber suitability which, in turn, was used in the mapping and development of the Forest's alternatives.

A Wildlife Habitat Relationship system (WHR) was used to model and analyze the alternative's effects on forest habitats.

The Effective Alteration (EFFALT) modeling employed perspective plot computer simulations to correlate levels of timber harvesting with visual quality objectives (VQOs). More detailed descriptions of these models appear in Section F. Outputs (see Modeled Outside FORPLAN) of this Appendix.

A sediment model was developed on the Forest to estimate sediment outputs based upon existing and future management activities.

A Spatial Disaggregation model developed at the University of California at Santa Barbara in conjunction with the Forest Service was used to test the implementability of the Final Preferred Alternative.

The Forest Planning Model

A. Overview

FORPLAN is a specialized matrix generator and report writer for a linear programming model. Linear programming is a standard mathematical technique for solving simultaneous linear equations subject to a certain set of constraints and a particular objective function. In its *simplest* form, this is expressed mathematically as:

Maximize: $Z = c_1 x_1 + c_2 + x_2 + \ldots c_n x_n Z$
(Objective function)

Subject to:

$$\begin{cases} a_{11} x_1 + a_{12} x_2 + \ldots a_{1n} x_n \le b_1 \\ a_{21} x_1 + a_{22} x_2 + \ldots a_{2n} x_n \le b_2 \\ a_{m1} x_1 + a_{m2} x_2 + \ldots a_{mn} x_n \le b_m \\ x_j \ge 0 \end{cases}$$

(Constraint Set)

These mathematical expressions can also be shown in a matrix (refer to Table B-1).

In the FORPLAN formulation, the linear equations (rows) represent resource production functions, costs and acreage or other types of constraints. For example, row 1 might represent timber production; row 2 might represent total cost; row 3 might represent acres burned by wildfire. The columns "$j=1,n$" represent the different activities (prescriptions) which can occur over time on specific units of land called analysis areas (represented by x_j). The a_{ij} coefficients in the Matrix are the production, cost or resource coefficients associated with each prescription/analysis area combination. The b_1's are the right-hand side constraints representing exact amounts (=) or upper(≤) or lower (≥) constraint levels that must be met. In the example above, if row 1 represented timber production, the interpretation of the constraint:

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 \ldots + a_{1n}x_n \ge b_1$$

would be the total amount of timber produced from all prescriptions and analysis areas must be greater than or equal to the amount of b_1.

Table B-1. Mathematical Expressions.

	Column j=1	Column j=2	Column j=3	Column j=n	Constraint Type	Right-Hand Side Constraint
Objective function	C_1X_1	C_2X_2	C_3X_3	C_nX_n	Maximize	
Row i = 1 (Timber)	$a_{11}x_1$	$a_{12}x_2$	$a_{13}x_3$	$a_{1n}x_n$	≥	b_1
Row i = 2 (Cost)	$a_{21}x_1$	$a_{22}x_2$	$a_{23}x_3$	$a_{2n}x_n$	≤	b_2
Row i = m	$a_{m1}x_1$	$a_{m2}x_2$	$a_{m3}x_3$	$a_{mn}x_n$	=	b_m
				x_j	≥	0
				$i = 1,..m$		$j = 1,..n$

Two sets of objective functions are used in the Forest planning model:

- Maximize timber volume in the first period followed by maximize present net value (PNV) for 12 decades for each prescription/analysis area combination.
- Maximize PNV for 12 decades.

The FORPLAN model was built by representing the production functions, costs, values and resource supplies for the Forest in the mathematical format described above. For the Klamath National Forest, the resulting model contained approximately 6,400 columns and 1,400 rows. Once the model was formulated, a number of test runs were made to check the model for reasonableness and to make additional calibrations. Land allocations, activity and output schedules, costs, benefits and PNV were developed by altering the prescriptions' intensity; the objective function and constraints were set to meet the theme of each alternative and benchmark and then the model was run.

Unique constraint sets were developed to represent management requirements (MRs), implementation requirements (IRs) and specific land allocations and output schedules needed for individual alternatives.

An iterative process was used to formulate these constraint sets prior to making final FORPLAN runs for the alternatives and benchmarks (see the Benchmarks and Alternatives Sections [M and N], respectively, of this Appendix).

FORPLAN was used to determine the most cost-efficient mix of goods and services that could be produced from the Forest based on the objectives and constraints of each alternative. The tradeoffs made among alternatives were examined, and the costs and benefits associated with each objective or constraint were measured. This analysis provided a way of indirectly evaluating the nonpriced benefits by measuring the amount of PNV foregone. This criteria used to evaluate alternatives was net public benefits, the PNV plus consideration of non-quantifiable Forest resource benefits.

Management activities modeled in FORPLAN were determined by the Forest's interdisciplinary (ID) team. This pre-FORPLAN analysis included identifying:

- The activities that could be applied to National Forest System (NFS) land;
- those activities that could be modeled in FORPLAN;
- the kinds of land to which each activity could be applied;
- The costs, outputs and benefits which would result from the application of each activity to a specific type of land; and
- the compatibility of activities when applied to the same land area.

This provided the basis for a matrix of all possible management activities which could be modeled, along with their associated costs, outputs and benefits.

B. Land Units

Capability areas are the smallest units of land (or water) for which data is collected in forest planning. They are discrete and recognizable units classified according to physical (soil), biological (vegetation) and administrative factors. All land within a capability area is homogeneous in its ability to produce resource outputs and in its production limitations. The capability areas are homogeneous with respect to land status, forest type and condition class.

Additional information was also needed for each capability area to assess resource opportunities and

issues. A few of the important items assessed included timber productivity class, timber suitability for regeneration, perennial and intermittent stream inner gorges and spotted owl habitat conservation areas. (For more detailed information see the Forest Planning Record Data Base Dictionary for Land Management Planning.)

Because there are over 250,000 capability areas within the Forests, they could not all be used in FORPLAN. Use of such a large number of land units would be cumbersome and expensive and major effects would have been masked by inability to interpret the overlapping effects of an enormous amount of detail. Analysis areas were created to handle this problem. Conceptually, an analysis area is an aggregate of capability areas that responds to a given management prescription in a uniform way.

The delineation of the analysis areas involved aggregation of the capability areas into approximately 100 analysis areas, based on physical, biological and administrative attributes. Major considerations in attribute selection were timber yield capability and spotted owl category. The selection of which attributes to include in FORPLAN was guided by factors such as forest type, condition class and owl constraints; these factors are the largest determinants of yield and cost.

Next, the analysis areas were defined using each attribute as a level of stratification or level identifier in FORPLAN. Because of model size limitations, the number of attributes selected initially exceeded the number that could be used. This necessitated the selection of the most critical attributes necessary to address the planning problems and to consider the reliability of the data for making yield and cost estimates. The attributes selected and the categories within each attribute were defined as follows:

Northern spotted owl category

- Lands within or outside of conservation areas

Timber Suitability

- Lands suitable for clearcutting, green tree retention (GTR), shelterwood and uneven-aged management
- Lands not capable, available or suitable for timber harvest

Forest Type

- Douglas-fir (DF)
- Mixed conifer westside forest (MC)
- Red fir westside forest (RF)
- Lodgepole pine (LP)
- Mixed conifer eastside forest (JM)
- Ponderosa pine (PP)
- Red fir eastside forest (EF)
- Non-forest

Condition Class

- 10-year old plantations
- 20-year old plantations
- 30-year old plantations
- 3G small and medium sawtimber greater than 40% crown closure
- 3P small and medium sawtimber less than 40% crown closure
- 4P large sawtimber less than 40% crown closure
- 4G large sawtimber greater than 40% crown closure
- NS Non-stocked
- XX All size and density classes

Post 1987 wildfire burn category

- Burned in 1987 at a high fire intensity level
- Not burned in 1987

The **northern spotted owl category** was used to identify lands subject to the 50-11-40 constraint for dispersal habitat as required by scientific teams such as the Interagency Scientific Committee.

The **timber suitability level** identifier was used to determine what range of timber intensities could be applied to each analysis area based on suitability for regeneration.

The **forest type and condition class** identifiers were structured in accordance with the RAMPREP yield tables used in FORPLAN. A unique set of cost/financial tables was also used with various combinations of these identifiers.

The **wildfire burn** identifier was to designate the large areas of the forest burned during the wildfires of 1987. These identifiers were instituted to model further constraints on the harvest scheduling of these large contiguous areas, if necessary, and also to assess watershed effects.

C. Management Areas

NFS land within the Klamath National Forest has been divided into 17 management areas. Each area has distinct management direction in response to local issues and intrinsic resource opportunities. However, these areas were not identified as management areas in FORPLAN. They will be used for project-level direction with their associated standards and guidelines.

D. Prescriptions

A prescription consists of a set of management practices and the schedule for application to achieve desired objectives on a specific area. For a given analysis area, the range of prescriptions describes what could be done (i.e., the possibilities) on that area. FORPLAN is used to determine what should be done based on the constraints and objective function of an alternative.

Prescriptions used in Forest modeling were derived from management prescriptions developed by the Forest's Interdisciplinary (ID) team. Management prescriptions are a mix of compatible management practices. The ID team quantified the outputs, costs and benefits that would occur when a prescription is applied to a given analysis area or unit of land. This quantification process produced the outputs, costs and benefit coefficients that were used in the FORPLAN yield and economic tables.

Management Prescriptions

It is important to distinguish between FORPLAN prescriptions and management area prescriptions. FORPLAN prescriptions are sets of activities which could occur on the analysis areas; they can be modeled in FORPLAN. They are "generic" activities in that they are written without imposition of standards and guidelines needed to fit activities to site specific conditions. Management area prescriptions, on the other hand, are written as a result of allocating FORPLAN prescriptions to specific land areas and imposing certain standards and guidelines. A management area prescription includes the FORPLAN prescription as one of its parts, but it also includes additional practices needed to meet standards and guidelines at specific sites.

FORPLAN prescriptions are developed to allow for a full range of management activities on an analysis area. In that way a choice can be made between an intensive management practice or a non-intensive management practice. Limiting the number of prescriptions to choose from is a type of "built-in" constraint. The choice of prescriptions identified for each analysis area was constrained only by technical feasibility. The FORPLAN prescriptions which were analyzed are described briefly below. Additional information, as well as the management area prescriptions and the prescription development process, is included in Chapter 2 and in the official planning records at the Forest Supervisor's Office, 1312 Fairlane Road, Yreka, CA 96097.

FORPLAN Prescriptions

The prescriptions listed below consist of 2 levels: Management Emphasis (ME) and Management Intensity (MI). ME levels are generally equivalent to prescriptions, while MI levels are analogous to management practices or options related to the prescription itself.

The descriptions below summarize the ME/MI combinations shown in detail in Table B-2. This table shows the relationship between FORPLAN prescriptions and management prescriptions. Some of the FORPLAN prescriptions are applied to more than one management prescription or to certain types of analysis areas (e.g., unsuitable timber land analysis areas).

The following are timber management-related prescriptions:

1. Timber Management-Unsuitable Lands (TU)

This prescription applies to all lands from which no chargeable timber volume is planned. Management objectives either preclude timber production or are so restrictive that silvicultural objectives cannot be met. Examples are noncapable, unavailable and unsuitable lands; wildernesses and research natural areas (RNAs); cultural and developed recreation sites; and threatened and endangered species (T&E) habitats (which may also include portions of spotted owl territories).

2. Timber Management-Minimal Yield Objectives (TM)

This prescription includes suitable timber lands where management objectives are such that some minor timber yields are scheduled. Average rotation age is 200 years. Stand maintenance and salvage are included in this prescription. Examples of where this prescription applies are in visual retention areas such as foreground viewsheds of rivers proposed for scenic and recreational status.

3. Timber Management-Modified Yield Objectives (TR)

Includes suitable timber lands where management objectives allow for even-aged and uneven-aged systems but not at high yield levels. Rotations vary from 60 to 160 years on harvested acres. Approximately one-third of the existing inventory on the regulated land base is not harvested at the end of the 160-year planning horizon, mostly within the TM prescription above. This prescription represents harvest regimes on lands designated to meet non-timber objectives that result in a mean rotation longer than optimum for timber production. Rotations on future stands that leave large numbers of residual trees are extended 20 years due to effects on growth by residuals in the former stand on the new stand. These trees are older, but the same size at rotation. Examples of lands included in this prescription are geologically sensitive soils and visual partial retention areas.

4. Timber Management-Timber Emphasis Objectives (TF)

Includes suitable timber lands where management objectives allow for even-aged and uneven-aged systems with higher timber yields. Average rotation is approximately the same as in TR above, with the same qualifications. An example of lands included in this prescription are those managed for modification visual objectives.

Table B-2. Management Prescription/FORPLAN Prescription Linkage*

Timber Management-Related Prescriptions		
Management Area Prescriptions	FORPLAN Prescriptions ME	MI
Research Natural Areas	TU	Unsuitable
Wilderness	TU	Unsuitable
Designated and Recommended Wild Rivers	TU	Unsuitable
Wild River Viewsheds-middleground	TM TR TF	Stand Maintenance Shelterwood, Group Selection, GTR, Clearcut Shelterwood, GTR, Clearcut
Butte Valley National Grassland	TU	Unsuitable
T&E Species Habitat Areas Northern Spotted Owls Bald Eagles Peregrine Falcons	TU	Unsuitable
Sensitive Species Habitat Areas Siskiyou Mariposa Lily	TU	Unsuitable
Northern Goshawk	TU TM TR	Unsuitable Stand Maintenance Shelterwood, Group Selection, GTR, Clearcut
Marten/Fisher	TU TM TR	Unsuitable Stand Maintenance Shelterwood, Group Selection, GTR, Clearcut
Special Interest Areas	TU	Unsuitable
Cultural Areas	TM TU	Stand Maintenance Unsuitable
Backcountry Areas (Semi-Primitive Non-Motorized)	TU TM TR TF	Unsuitable Stand Maintenance Group Selection, Shelterwood, GTR, Clearcut Shelterwood, GTR, Clearcut

Table B-2. Management Prescription/FORPLAN Prescription Linkage*

Timber Management-Related Prescriptions		
Management Area Prescriptions	FORPLAN Prescriptions ME	MI
Riparian Areas		
Perennial/Intermittent Streams Inner Gorges	TU TM	Unsuitable Stand Maintenance
Mapped Riparian Reserves (RRs)/ Riparian Management Zones (RMZs)	TU TM	Unsuitable Stand Maintenance
Retention Visual Quality Areas	TM	Stand Maintenance
Designated and Recommended Scenic Rivers	TM	Stand Maintenance
Scenic River Viewsheds-Middleground	TM TR TF	Stand Maintenance Group Selection, Shelterwood, GTR, Clearcut Shelterwood, GTR, Clearcut
Designated and Recommended Recreational Rivers	TM TR	Stand Maintenance Group Selection, Shelterwood, GTR, Clearcut
Recreational Rivers Viewsheds-Middleground	TM TR TF	Stand Maintenance Group Selection, Shelterwood, GTR, Clearcut Shelterwood, GTR, Clearcut
Winter Range/Big Game Habitat Areas	TM TU TR	Stand Maintenance Unsuitable Group Selection, Shelterwood, GTR, Clearcut
Partial Retention Visual Quality Areas	TR	Group Selection, Shelterwood, GTR, Clearcut
Forage	TU TM TR	Unsuitable Group Selection, Shelterwood, GTR, Clearcut Shelterwood, GTR, Clearcut
Habitat Linkage	TM	Stand Maintenance
General Forest	TU TM TR TF	Unsuitable Stand Maintenance Group Selection, GTR, Clearcut Shelterwood, GTR, Clearcut

* **Abbreviations:** **ME**=Management Emphasis, **MI**=Management Intensity, **TU**=Timber Management - Unsuitable Lands, **TM**=Timber Management - Minimum Yield Objectives, **TR**=Timber Management - Modified Yield Objectives, **TF**=Timber Management - Timber Objectives, **T&E** = Threatened and Endangered.

Prescriptions were also made for developed recreation, dispersed recreation and fire management. Alternative program levels were analyzed for each alternative. These resource program-related prescriptions were defined as follows:

1. **Developed Recreation-Low Standard (DS-LS)** - Existing facilities would be open at a level such that the user's willingness to pay is less than at the standard level.

2. **Developed Recreation-Standard (DS-SD)** - Existing facilities would be open with all improvements and operation at standard levels.

3. **Developed Recreation-Rehabilitation (DS-RH)** - Facilities at low standard condition are rehabilitated to the standard level resulting in outputs at the standard level.

4. **Developed Recreation-New Construction (DS-NC)** - Facilities can be built on certain lands to standard level.

5. **Dispersed Recreation-Low Standard (RT-LS)**- Existing roads and trails would be open at a level such that the user's willingness to pay is less than at the standard level.

6. **Dispersed Recreation-Standard (RT-SD)** - Existing trails would be open and maintained at standard levels.

7. **Dispersed Recreation-Rehabilitation (RT-RH)**- Existing roads and trails at low standard are rehabilitated to the standard level resulting in outputs at the standard level.

8. **Dispersed Recreation-New Construction (RT-NC)** - Planned trails would be built to standard levels.

9. **Fire Management Program (FP)** - Consists of varied mixes of manpower, engines, prevention, detection and aircraft resources, along with fuels management. The most efficient program mixes were selected by theme and then driven at the following budget levels which were the available options for the fire program: (a) current, (b) down 20%, (c) up 20% and (d) up 40%.

Assignment of Timber Management Intensities by Analysis Area

Unsuitable is applied as an option on all lands. For any of the analysis areas doing nothing and allocating the land to Unsuitable is always an option.

Stand Maintenance is applied to all suitable timber land. Since this intensity removes so little timber volume during any entry, it can be applied on areas where regeneration is very difficult

Group selection, shelterwood, GTR and clearcutting are limited to lands identified as suitable for modified timber yields and timber emphasis lands.

From a financial analysis standpoint no timber management intensities were eliminated because of having a low or negative present net value (PNV).

E. Time Periods

To facilitate modeling the scheduling of outputs and activities on the Forests for the 160-year planning horizon, 10 years (1 decade) was the basic reporting period chosen. Consequently, outputs are modeled as totals or averages for 10-year periods and constraints were applied to outputs or activities on a 10-year basis. In order to reduce the complexity of data displayed in this EIS generally only decades 1 and 5 are used in display tables.

F. Outputs

Development of Modeling Coefficients

Following is a description of the coefficients used for outputs tracked inside and outside of FORPLAN. A brief discussion of how each coefficient was developed is also included here. A more detailed discussion is available in the Forest's planning records. Table B-3 shows a listing of all outputs used in the analysis process.

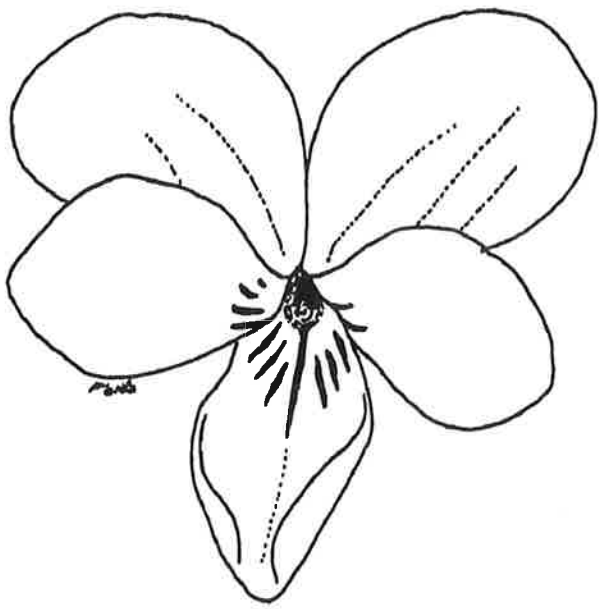


Table B-3. Outputs Used in Analysis			
Outputs	**Units of Measure**	**Modeled Inside FORPLAN**	**Modeled Outside FORPLAN**
Recreation			
(1) Developed Recreation	RVDs	X	
(2) Dispersed Recreation	RVDs	X	
(3) Wilderness Recreation	RVDs	X	
(4) Trail Construction/Reconstruction	Miles		X
(5) Areas Open to Summer OHV Use	Miles		X
(6) Areas Open to Winter OHV Use	Miles		X
(7) Visual Quality Index	-		X
Wildlife			
(8) Threatened and Endangered Species: Bald Eagle	Pairs	X	X
(9) Threatened and Endangered Species: Peregrine Falcon	Pairs	X	X
(10) Threatened and Endangered Species: Northern Spotted Owl	Pairs	X	X
(11) Sensitive Species: Goshawks	Pairs	X	X
(12) Wildlife User Days	WUDs	X	
(13) Direct Habitat Improvement - Big Game	Acres/# of Structures		X
(14) Direct Habitat Improvement - All Other Wildlife Species	Acres/# of Structures		X
(15) Seral Stages	Acres	X	
(16) Deer Population	Animals		X
Fisheries			
(17) Resident Fish (Other Than T&E)	M lbs.		X
(18) Anadromous Fish - Commercial Harvest	M lbs.		X
(19) Anadromous Fish - Sport	M lbs.		X
(20) Fish User Days - Total	FUDs	X	
(21) Direct Habitat Improvement - Total	Structures		X
(22) Riparian Habitat	Acres		X
Range			
(23) Grazing	AUM	X	

Table B-3. Outputs Used in Analysis			
Outputs	**Units of Measure**	**Modeled Inside FORPLAN**	**Modeled Outside FORPLAN**
Timber			
(24) Allowable Sale Quantity (ASQ)	MMCF/MMBF	X	
(25) Reforestation	Acres	X	X
(26) Timber Stand Improvement	Acres	X	X
(27) Long-Term Sustained Yield	MCF	X	
(28) Fuelwood	M Cords	X	
Water			
(29) Water Quality	Acre Feet		X
(30) Increased Quantity (Water Yield)	Acre Feet	X	
(31) Watershed Improvement	Acres		X
Lands and Minerals			
(32) Plans of Operation - All	# Plans		X
(33) Land Acquisition	Acres		X
Human Resources			
(34) Programs	# of Enrollees		X
Fire			
(35) Fuel Treatment (Timber)	Acres	X	
(36) Fuel Treatment (Fire)	Acres		X
(37) Fuel Treatment (Other)	Acres		X
(38) Expected Acres Burned by Wildfire	Acres	X	X
(39) Wildfire Intensities	Acres		X
Transportation			
(40) Road Construction/Reconstruction	Miles	X	
(41) Road Maintenance	Miles	X	
Facilities			
(42) Administrative Sites	Number		X

*** Abbreviations: RVDs** = Recreation User Days **WUDs** = Wildlife User Days **M** = Million **FUDs** = Fish User Days **AUM** = Animal Unit Month **MCF** = Million Cubic Feet

Modeled Inside FORPLAN

Transportation

Road Construction/Reconstruction - When the road network is completed, it is assumed that an average road density of 4.5 miles/square mile will exist on suitable timber land. For analysis areas defined as roaded, 3.1 miles per square mile are assumed to have already been built leaving 1.4 miles per square mile needing construction. A coefficient was developed for the number of miles of road reconstruction needed for a given level of timber volume based upon historical data.

Road Maintenance - The number of miles of maintenance was correlated to timber volume. A coefficient was developed based upon historical data.

For the Final Preferred Alternative, a reduced estimate of engineering road work was made based on standards and guidelines for Key Watersheds and RRs.

Fire

Expected Acres Burned by Wildfire - Wildfire potential acreage coefficients for plantations were calculated based on historical data. Coefficients developed were then loaded into FORPLAN. Suitable timber land acres burned in FORPLAN were reinitiated to year zero and reforested entailing an additional cost and loss of growth. Wildfire acreage coefficients varied over time and incorporated potential value lost from the timber resource.

Fuel Treatment (Timber) - Acres of fuel treatment were estimated based upon historical information and standards and guidelines.Coefficients developed were used in FORPLAN.

Fisheries

Fish User Days - Fish User Days are estimated from a publication of the Sport Fishing Institute and are assumed to occur as background. For all alternatives these are included in FORPLAN as 88,000 FUDs and they increase at 1.09 to 1.2% per decade. Approximately 63% of the background FUDs are assumed to be produced from anadromous fish and 37% from resident fish.

Range

Grazing - Animal unit months are based upon historical permitted demand. It varies from 34,000 AUMS only in Alternative E where grazing is not permitted in wilderness.

Recreation

Developed, Dispersed and Wilderness Recreation- Values for recreation visitor days (RVDs) were developed by determining the annual number of RVDs and dividing it into the average annual budget figures. One source of the data used in development of coefficients was the Recreation Information Management System. Demand cutoffs were used for developed and dispersed recreation to prevent valuation of excess capacity. Increased use follows population trends.

Timber

Allowable Sale Quantity (ASQ) - Timber yield coefficients were developed from a Forest timber inventory completed in 1988. Data from this inventory was used to develop yield tables using a growth simulation model called RAMPREP. Growth and yield modeling was done for each timber stratum/type for both existing and future regenerated stands.

Inventory data and RAMPREP yield tables are included in the Forest planning records and are available for review at the Forest Supervisor's Office in Yreka, California.

Reforestation - Reforestation acres were equal to the acres of regeneration timber harvests scheduled by FORPLAN plus any non-stocked areas planted. Regeneration harvests included clearcutting, shelterwood cutting, GTR and group selection cutting. Percentages of plantations that fail were determined from historical records. These stands return to age zero and are replanted in the model.

Timber Stand Improvement (TSI) - TSI includes release and precommercial thinning. For most alternatives, acres of TSI were based on historical percentages of reforestation acres. 24% of the reforestation acres (including backlog) were assumed to require a release treatment and 30% would be precommercially thinned.

Long-Term Sustained Yield (LTSY) - LTSY is calculated by the FORPLAN model based upon treatment intensity and harvest at 95% culmination of mean annual increment. Harvest levels are constrained to a maximum of LTSY to ensure sustainability of harvest over time.

Fuelwood - Fuelwood estimations in cords were based upon historical records. A coefficient was develop which was correlated with harvest level.

Visual Quality

Effective Alteration (EFFALT) - This output is expressed in acres effectively altered by vegetation changes. Acres are assigned alteration coefficients based upon type of treatment. An acre is no longer considered altered when growth of new trees reaches 30 feet. The

actual coefficients used were devised from analysis of perspective modeling done in Region 5. Coefficients used were developed by the Region and incorporated into the Forest's FORPLAN analysis.

Permissible maximums of visually altered acres were defined by VQO to regulate the maximum number of regeneration harvest acres that could be cut in any one decade to meet visual resource requirements. Maximums were defined for the percent of timber inventory that could be harvested by VQO class. These constraints were then linked to FORPLAN prescriptions.

For a Timber Emphasis regime (TF) not more than 29% of the EFFALT acres and not more than 18% of the timber inventory could be harvested over a decade (Modification VQO).

For Modified Timber Yields (TR) not more than 14% of the EFFALT acres and not more than 14% of the timber inventory could be harvested in a decade (Partial Retention VQO). For Minimal Timber yields (TM) not more than 5% of the acres or inventory may be harvested (Retention VQO). See planning records for more detail.

Water

Increased Quantity (Water Yield) - Water yield outputs were estimated to account for changes due to modification of the water balance caused by vegetative manipulation. Coefficients were developed for average yields for the eastside and westside of the Forest. Although water yield is affected by forest management practices, it is a coincidental output and requires no constraints on the suitable timber lands.

Watershed Condition/Cumulative Watershed Effects - The potential effects to watershed conditions were evaluated by developing a cumulative watershed effects model within FORPLAN which calculated Forest-wide Equivalent Road Acres (ERAs) generated from silvicultural activities and road construction for each decade. ERAs were calculated, within the model, through the use of disturbance coefficients for each type of harvest activity including clearcutting, selection harvesting, thinning, etc. These coefficients took into account site disturbance from harvest systems and roading levels necessary to access harvest units. The resulting ERAs were adjusted to account for natural recovery due to revegetation. A Forest-wide threshold (TOC) was calculated (8%) and used as a constraint in the model. For all benchmarks and alternatives the Forest-wide ERAs are lower than the Forest-wide threshold of concern (TOC) constraints. This occurs because the EFFALT constraints are more restrictive.

Wildlife

Threatened and Endangered (T&E) and Sensitive Species

Bald Eagle - The bald eagle was modeled by delineating a number of acres for bald eagle habitat and assigning them to a timber unsuitable prescription.

Goshawk Habitat - Goshawk territories were modeled the same as T&E species. Habitat acres were assigned a timber unsuitable prescription. For the Final Preferred Alternative, goshawk territories were not a land allocation, but zones would be established through standards and guidelines.

Peregrine Falcon - The peregrine falcon territories were classified as unsuitable timber land.

Northern Spotted Owl Habitat - Spotted owl territories were identified from Habitat Conservation Area (HCA) maps generated as a result of the Interagency Scientific Committee (ISC) report. For most alternatives these acres were considered as unsuitable for timber activities. Only Alternatives B and D considered timber management on HCAs. The G (SOHA) Alternative set aside Spotted Owl Habitat Areas (SOHAs) as timber unsuitable rather than HCAs.

Along with the HCA network, the ISC strategy includes the 50-11-40 rule for quarter townships (50% of the area must have an average minimum of 11 inch diameter trees with 40% crown cover). This rule was incorporated into the FORPLAN model on a Forest-wide basis. The Forest was deficit (below 50%) until the sixth decade and the model was constrained until this period.

For the Final Preferred Alternative, HCAs and the 50-11-40 rule were replaced by LSRs and RRs to provide for late-successional species habitat and viability.

Wildlife User Days Background - Includes consumptive (e.g. deer, bear) and non-consumptive WUDs. Total WUDs are estimated to be 53,900 and increase at a rate dependent upon population trends.

Seral Stages - Seven seral stages were tracked in FORPLAN ranging from seedlings and saplings to older over-mature habitat. Each forest type and condition class was assigned to a seral stage based upon strata qualities and age of the stand. FORPLAN thus tracked the number of acres by seral stage for each decade. Eastside Mixed conifer was considered deficit of the 5% required at the time of the Draft EIS in the oldest seral stage and was constrained for this reason until the fourth decade. Eastside ponderosa pine was deficit until the ninth decade and also was constrained.

Modeled Outside FORPLAN

See Chapter 4, Methodology section by resource area for a discussion of the assumptions and analysis procedures.

Sediment Modeling

A detailed process was created to portray sediment production resulting from management scenarios developed in alternatives. This procedure utilized locally obtained information from geologic, hydrologic and soils studies. The models used commercially available spreadsheet software to do calculations.

The model uses physical process relationships developed on the Klamath National Forest to produce sediment outputs. The activities that are planned and the acreage planned in each time period drive the model as do the types of landforms where the activities occur. The model assumes that sediment production rates will be equivalent to those experienced historically from similar types of activities.

Geologic output comes from predicted landslides and debris torrents based on historic production measurements. Forest lands are classified into components to estimate the area subjected to various landslide rates and the volumes produced. The categories for these lands are:

- Existing roads
- New roads, a projection of outputs from road construction rates and standards described in the alternative
- Lands which have no timber harvest programmed,(Non-CAS)
- Lands which could have harvest programmed on them but no harvest occurs (NOACT CAS) no activity capable available and suitable lands
- Lands subjected to partial timber harvest (PC CAS)
- Lands subjected to clear cut harvest (CC CAS)

The above sources produce the "new sediment" within the model. The model predicts that some of the sediment would reoccur over time as a result of the initial activities. The sediment rate carried over depends on the type of activity and the time following to initial disturbance. All roads carry over 100% of initial sediment rates through all decades. The subsequent decade has 80% of the sediment carried over from the initial entry. The second decade has 72% of the initial sediment and the third decade 32%. The fourth and fifth decades have 8% and 1.6% carried over respectively from geologic sources.

The total of the "New Sediment" and the "Carryover Sediment" from geologic erosion composed the "Landslides" component of the model.

The "Surface Erosion" model component used the Universal Soil Loss Equation to predict surface erosion impacts. The model depicted the forest as a series of timber compartments which had several land components. The model sorts and calculates the erosion impacts from various land components as well. Those categories are:

- Erosion from Existing Roads (Exist Roads)
- Erosion from new roads (New Roads)
- Surface erosion from lands not capable available or suitable for timber harvest (Other Land)
- Erosion from CAS lands less than or equal to 35% slope(CAS less than 35%)
- Erosion from CAS lands greater than 35% slope (CAS greater than 35%)

A portion of the impacts from one decade of soil erosion is carried over into the subsequent decades depending on the source of the sediment. All erosion from the road surface was assumed to continue because the road maintenance would keep the material exposed to rain and runoff. The cut and fill slopes had 10% of their previous losses carried forward one decade to show that chronic erosion persisted but at a small scale. No surface erosion was carried into the next decade from harvest units because they revegetate rapidly.

The "Landslides" component and the "Surface Erosion" component were added together to produce total sediment for each compartment. The compartmental sediment totals were aggregated to produce Forest outputs or watershed outputs.

The watershed discussion refers to channel erosion. This component was estimated from records relating to the 1964 flood. It overlaps the geologic erosion in that both have erosion from inner gorge lands. This should be considered in the interpretation of that portion of the analysis.

The fire component of land disturbance incorporated the effects of landslides resulting from wildfire and prescribed burning. The fire model predicted a total amount of fire by intensities. Each intensity level had an associated vegetation mortality. The mass erosion rates were applied, to the portion of acres that would be killed by wildfire, with the same rates of loss associated with clear cutting. This produced an estimate component of sediment attributable to fire. The fire related activity sediment calculations used forest wide production totals and were calculated separately from the model described above. No watershed or compartment totals using fire exist because a direct link between fire occurrence and vegetative type at the compartment or watershed scale could be quite misleading. This process represents the situation that no reasonable disaggregation of fire effects could be projected with available information.

Process records contain a more detailed description of the process used and the model instructions for operation of the system.

Effective Alteration (EFFALT) Modeling

A component of the FORPLAN Model called EFFALT simulates the impacts of timber harvest on visual quality characteristics of a landscape or the Forest. This model calculates a cumulative effect parameters from proposed harvesting systems in planning alternatives. This allows the land managers the freedom to harvest at rates which will not impact scenery beyond the limits that would be visually acceptable. The limits are set by defining objectives for the visual quality of each alternative. These visual quality objectives (VQOs) set standards for areas. These standards were analyzed on a regional basis to see what types of timber harvest could be associated with various VQOs. The rate of disturbance varies with the type of activity imposed on the land. Clearcutting has an effect of creating an acre of disturbance for each acre of activity. Other prescriptions create a smaller impact so they have a proportion of an acre of disturbance associated with each acre of activity.

The existing conditions which have resulted from past harvest and other activity created the starting point of calculations. The amount of impact for the treatments prescribed in FORPLAN is then added to the initial disturbance value and compared to the upper limit allowed within the Visual Quality Objectives.

The harvesting methods produce impacts in decades subsequent to the initial entry. The amount of impact lessens over time due to regrowth of forested vegetation. The model assigns coefficients for various treatment types for different broad terrane types. The westside of the Forest which is steep and dissected has one set of coefficients and the flatter eastern side a different set.

The model divides the treatment types up into categories, a short summary of which is described here.

- Thinning, all types of removal where the large majority of the overstory is left in place.
- Prescriptions which remove of 99-94% of overstory.
- Group selection, harvest of 1-2 acre groups of vegetation
- Regeneration leaving 15-30-plus % of overstory as clumps, 2-6 scattered trees and 1-5 scattered snags and 5 downed logs per acre.

The labels used in this modeling should be kept separate from other resource prescriptions applied to the Klamath National Forest. Some confusion to the descriptions of prescriptions will no doubt occur but careful attention to the description of harvest techniques should help prevent this.

Table B-4 presents the coefficients for the EFFALT model for each type of harvest prescription and shows how the recovery of natural conditions proceeds.

Table B-4. EFFALT Model Coefficients

Time Period	Eastside Lands				Westside Lands			
	Harvest	1	2	3	Harvest	1	2	3
Harvest Method:								
Thinning	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Regeneration Removing 99-94% of Overstory	1.0	0.8	0.3	0.0	1.0	0.9	0.4	0.2
Group Selection	0.8	0.6	0.2	0.0	0.8	0.7	0.3	0.1
Regeneration Leaving 15-30% of Overstory and Scattered Green Trees and Snags	0.7	0.4	0.1	0.0	0.8	0.5	0.3	0.1

The above prescriptions are viewed as a Forest total and the Regulation Classes 1 and 2 were combined because of the limited differences between them in recovery rates and harvest rates. An average value was used.

The value of the Regeneration Leaving 15-30-plus % of the overstory prescription results from its emulation of the natural landscape line, form, color and texture. The visual simulations using computer graphics also demonstrates this. Copies of some simulations are included with the EIS.

Fire Planning

The NFMAS is the primary modeling system used for Forest planning and budgetary analysis. NFMAS permits the user to analyze historical wildfire occurrence (Level 1) and to simulate different management scenarios (Level 2) according to the Plan management direction. Different wildfire detection, prevention, suppression and fuels situations can be evaluated. For a complete description of the NFMAS process, see Forest Service Handbook (FSH) 5109.19 (National Fire Management Planning and Analysis Handbook).

Level 1 is the analysis of the historical and current fire management situation. Fire weather and fire occurrence data from 1970 through 1988 were used.

Table B-5 shows a summary of wildfires by Fire Intensity Levels. Note that there are few high intensity fires that are in fire intensity levels 5 or 6. The reasoning, in part, is that even though a large fire exhibits high fire intensities during the period it is burning, it is uncommon for a large fire to consistently burn at high intensities on every acre within its perimeter.

Table B-5. Number of Fires and Acres Burned Per Decade
(based on 1970 through 1988 fire data)

Fire Management Analysis Zones		Fire Intensity Level *						Total
		1	2	3	4	5	6	
Klamath River East	fires acres	99 18	253 314	28 18,403	2 1,519			383 20,255
Klamath River West	fires acres	88 129	197 4,319	23 59,882	1 5,309			309 69,639
Salmon River	fires acres	45 24	75 54	29 38,752	2 32,085			151 70,914
Scott Valley	fires acres	45 5	46 25	3 2		1 1		95 32
Butte Valley	fires acres	112 8	20 86	2 447				134 542
Little Shasta Valley	fires acres	90 26	139 458	18 304				247 788
Marble & Siskiyou Wildernesses	fires acres	38 7	91 1,777	14 2,268	1 3			143 4,056
Russian & Trinity Alps Wildernesses	fires acres	52 7	13 11	2 114		1 1		66 132
Forest Total	fires acres	569 224	833 7,045	118 120,172	5 38,916	2 1		1528 166,358

*** Fire Intensity Level** is a range of flame lengths. Flame length is an indicator of fire intensity. FILs are a good determinant of possible effects of a fire on timber, soil, watersheds, etc. **FIL 1** has a flame length of 0 to 2 feet; **FIL 2**, 2 - 4 feet; **FIL 3**, 4 -6 feet; **FIL 4**, 6 - 8 feet; **FIL 5**, 8 - 12 feet; and **FIL 6**, 12-plus feet.

Fire Management Analysis Level II - is an analysis of various fire management program options (a wildfire suppression organization mix coupled with a wildfire prevention program), budget levels (costs) and their effectiveness. This analysis is based upon the simulation of representative fires using varying fuel models, differing suppression resources, historical occurrence patterns and by changing occurrence patterns based upon prevention efficiency. Following are several uses of Level II analysis:

- To evaluate fire program options appropriate for the principal Forest Plan alternatives identified by FORPLAN; and to provide detailed resource output, value change and program cost data for selection of the most efficient program level where fire program cost and effectiveness will affect the choice between these alternatives.
- To evaluate the efficiency of fire program options for a number of alternative management prescriptions or Forest Plan alternatives and to provide general estimates of fire program cost and consequences for FORPLAN.
- To evaluate the effectiveness of fire program options for a single Forest Plan alternative within a constrained budget and to establish the most effective program mix where the budget level is fixed.

From Fire Management Analysis Levels I and II, inputs by alternative to FORPLAN include:

- Probability of acres burned;
- Various program costs reflecting different fire management organizations; and
- Suppression costs reflecting the fire management organizational efficiency.

FORPLAN then determines the following by alternative:

- Acres burned;
- Suppression costs;
- Net value change for resources; and
- Optimum organization and budget level by period.

FORPLAN discussion at the beginning of Appendix B explains in detail how this is done.

Plantation Loss

Within the FORPLAN model, acres of plantation loss to fire has been factored into the ASQ calculations. The models project that fires damage 22% of plantations to the point requiring additional planting. This was based on the historical areas burned per decade, 166,000 acres, and that a timber stand on average will not have a merchantable value until age 40. Over this time period then, 644,000 acres of land are projected to burn on the Forest or about 41% of the Forest.

If fire burns randomly across the Forest then it will affect, on a probability basis, 41% of plantation acres. This is said in light of the high flammability of plantations. In 1987, 52% of the burned plantations did not meet Regional stocking standards and required some degree of replanting. 52% of 41% is 21.9 or rounded to 22%. This is likely too low as a number but will be adjusted in the future as monitoring indicates need.

Potential Wildfire Effects

Objective

The wildland fuels management objective from the fire suppression perspective may be found in FSM 5150.2. It says, "To identify, develop and maintain fuel profiles that contribute to the most cost-efficient fire protection and use program in support of forest plan land and resource management direction."

The Forest interpretation of this is that since NFMAS uses 90 percentile rates of spread then the initial attack organization at the "most efficient level" should be able to successfully contain a fire at the 90 percentile weather level as determined from weather analysis from representative weather stations for the analysis areas. Prevailing slope and current or predicted fuel models should be used.

The proposed process is comprised of 3 parts. Two of these have been seen and used in various forms in the past. The 3 parts are Fire Hazard, Fire Risk and the resultant Potential Wildfire Effects Matrix.

Fire Hazard

Fire hazard is measured by the ability of the initial attack fire organization, at the most efficient level as identified through Forest Plan NFMAS runs, to contain a wildfire on a 90 percentile day. Resistance to control is a consideration in that slope steepness and production rates are considered in a resource's ability to successfully contain a fire.

Hazard categories are:

- High Hazard - Initial attack forces are unable to contain a fire start.
- Average flame lengths are over 8 feet. If all of the fire behavior characteristics in the Medium Hazard category are present but slope steepness or fuels prohibit a successful initial attack, then the hazard category will be High. The resultant fire has a high probability of producing effects that could be classified as severe on two-thirds or more of the affected area.
- Medium Hazard - Initial attack forces are able to contain a fire but heavy equipment and air resources are the primary tools. Flame lengths are from 4 to 8 feet. Rate of spread and slope steepness still permit a successful initial attack although it will be an indirect attack. If the fire behavior characteristics in the Low Hazard category are present but slope steepness or

fuels inhibit the initial attack resource from successfully attacking the fire then the hazard would be considered a Medium Hazard. One- to two-thirds or more of the area could classified as severely burned.

- Low Hazard - Initial attack forces are able to control the fire with direct methods e.g., engines and hand tools. Average flame lengths are less than 4 feet. Less than one-third of the stand will be severely burned.

The primary method for analyzing this is through the use of the BEHAVE Fire Behavior Predictive System. The Level II runs from the Forest NFMAS runs or other compatible predictive system can be used. Determining fuel models at appropriate points in the future when analyzing alternatives is the cornerstone of this or any other system. Fuel models used will be one of the 13 Fire Behavior Predictive System models or a custom model developed and tested through BEHAVE.

These fuel models will be imposed over 3 slope classes; low (0-35%), medium (36-65%) and high (66%-plus). These will be represented by 25, 55 and 85% slopes respectively for analysis purposes. (These are the slope classes being carried in the Forest GIS database and the slope proxies were selected towards the upper end of each slope class.)

The fuel models identified will be "gamed" on the 3 slope classes using the "DIRECT" module of BEHAVE at 90 percentile weather parameters. "CONTAIN" can then be used to verify whether the identified resources are able to contain a fire start. This analysis assumes single fire starts. The results of these runs can then be placed into the appropriate Hazard Category.

Fire Risk

Fire risk is the probability of a fire occurring per thousand acres per decade. This is determined by analyzing at least 40 years of fire history. The primary concern is lightning. There are, however, high risk corridors of human-caused fires. These are primarily found along the railroad, rivers and high use recreation areas, and areas where there are many people living or recreating in a forested or vegetative environment. Risk Classes are:

- High Risk - at least 1 fire expected per thousand acres per decade expressed as 1 fire (or more) per 1,000 acres per decade.
- Moderate Risk - at least 1 fire expected in 11 to 20 years per 1,000 acres expressed as 0.5-0.99 fires per 1,000 acres per decade.
- Low Risk - at least 1 fire every 20 or more years per 1,000 acres expressed as 0-0.49 fires per 1,000 acres per decade.

Value

There is a need to classify values for a given piece of land. The NFMAS economic valuation process determination does an adequate job for those values that can quantified in economic terms. There is a need to "prioritize" those values that do not quantify easily. An approach could be done qualitatively until such time as Pacific Southwest Forest and Range Experiment Station finishes their research work into non-market amenity values. An example of this might be: given the Endangered Species Act versus timber land and that you have to chose which one needs to be initial attacked, which one will have the higher value and thus receive the initial attack action? Value will be incorporated into the Wildfire Effects process in the near future.

Potential Wildfire Effects Matrix

The potential to effect the expected management outcomes is the hazard category coupled with the risk. Table B-6 displays how the potential will be calculated.

Table B-6. Potential Wildfire Effects Matrix

Hazard Class	Risk Class			
	Low	1	1	2
	Medium	1	2	3
	High	2	3	4

1 = low probability of a stand being lost to wildfire;
2 = moderate probability of a stand being lost to wildfire,
3 = high or very probable chance of losing stand to wildfire,
4 = very high or quite probable that stand will be lost to wildfire.

In summary the modeling associates frequency of fire starts, fuel hazard class and fuel type to produce a potential effect on a portion of the Forest. Lands with high fuels, steep slopes and frequent ignition have higher chances of fire damage than sites with reduced fuel loading, flatter slopes and low ignition rates. The structural element of fire spread is not accounted for in this analysis. The fuel ladders which would produce crown fires have not been assessed within this process. This will require additional spatial analysis at the project-level.

Spatial Disaggregation Modeling

This model was used on the Final Preferred Alternative to test implementability of the FORPLAN harvest level at a smaller, watershed scale. Localized contributions of existing plantations, roads, fire disturbance and land ownership patterns appear at this scale which can affect the feasibility of a forest scale harvest estimate. Coefficients are used to estimate disturbance levels and establish a recovery cycle over time. Thresholds

determine a maximum disturbance tolerance for a given area.

Existing disturbance can be calculated using the coefficients for each decade. The difference between the threshold and the existing disturbance levels defines the additional disturbance allowable through management activities (slack). Models with this structure are relatively simple, work for a variety of resources and can be monitored at different scales to provide feedback for better estimates in the future. This type of analysis reveals which elements contribute the most to existing problems. It also indicates where different resource area problems overlap or where they operate differently.

For watershed/fisheries resource, coefficients were developed or adopted from the ERA and sediment models used in the Draft EIS analysis for disturbance elements. Thresholds were set at conservative "yellow flag" levels, in contrast to the more conventional "red flag" method. For visual cumulative effects, the same coefficients and threshold were used that were in the FORPLAN model.

Results for watershed effects show large numbers of watersheds over threshold, but the remaining areas have a lot of slack. Primary contributing factors to this situation were inclusion of the effects from private property harvest activities and from roads. Effects from the 1987 fires were also significant. Smaller contributions come from harvesting activities on Forest lands.

Results for visual effects show fewer areas over threshold, but less slack within these areas. The constraining factor is harvest activity on Forest lands. Areas managed intensively in the past have tended to stay in a shrinking regulated land base. This effect is compounded by the 1987 fires which resulted in further large disturbed areas. In general, standard contributions to volume are not expected from areas that have been intensely harvested in the recent past.

Because of different contributing factors, watersheds over threshold in each of these categories often do not overlap, resulting in further constraints on the ASQ than were apparent within the FORPLAN estimate.

G. Economics In FORPLAN

General

The subject of economics is discussed throughout this EIS. In Chapter 2 economics are covered in the alternative development process discussions, and they are displayed in various tables. Chapter 3 describes the economic environment; the economic consequences are discussed in Chapter 4; and Appendix D outlines how economics are used in this document.

Most of the economic efficiency analysis was done with the use of FORPLAN. The economic data and assumptions that were incorporated into that model are described below.

All dollar values are expressed in 1987 dollars. Refer to Table B-7 for the factors, based on the implicit price deflator for the gross national product, that were used to adjust values from other years to 1987.

Table B-7. Factors Used to Adjust Values for Other Years to 1987.

Year	Factor
1993-87	0.81
1992-87	0.83
1991-87	0.85
1990-87	0.89
1989-87	0.92
1988-87	0.97
1987-87	1.00

A discount rate of 4% was used to determine the PNV of future benefits and costs. This rate approximates the long-term cost of capital in the private sector as measured by the return on AAA corporate bonds after adjustment for inflation.

Real price trends for timber, range, recreation, wildlife and fish were used in all FORPLAN runs. Table B-8 shows the price trends that were used.

Table B-8. Decade 1-5 - Percent Average Annual Price Increases.

Timber	1.3
Range	0.4
Dispersed recreation	0.2
Developed recreation	0.1
Wilderness recreation	0.3
Wildlife and fish	0.2
Water	0.2

These price trends are projections from an econometric model of national and regional markets updated for the 1990 Resources Planning Act (RPA) Final EIS.

Costs

All costs used in the analysis are estimates based on accounting records and the experience of project managers. The most recent costs were collected (e.g. 1984 - 1988) and adjusted to 1987 dollars. The following costs were collected and loaded into FORPLAN:

Facilities

RD-R - road reconstruction due to acres harvested

RD-N - new road construction

RD-M - road maintenance

Fire

FFP - cost of fighting fires

Range

RNOA - range program

Recreation

DVC - developed recreation construction

DVOA - developed recreation program

B03B - wilderness program

DSPC - dispersed recreation construction

DSPA - dispersed recreation program

Timber

SALE - sale preparation and administration

SITE - site preparation including brush disposal

PLNT - reforestation

RLSE - release

PCTH - precommercial thinning

Wildlife and Fish

CW80 - wildlife program

CF80 - fisheries program

Other

TT1T - general administration

Base level operational costs total $8.9 million/year (1987 dollars) in FORPLAN Alterative MLV and represent 31% of the current budget (1987 dollars).

Costs were checked for reasonableness by comparing the first decade costs for Alternative CUR, developed with the use of FORPLAN, against actual expenditures for FY89 - FY90.

Benefits

The dollar values for outputs used to calculate PNV are the prices that consumers would be willing to pay for Forest outputs, whether or not such prices are actually collected by the Federal Government. At present, it is national policy to provide most Forest outputs either at no charge to consumers or at a charge less than the willingness to pay price. (Refer to Table B-9).

Benefits for outputs were computed by multiplying the output by the willingness to pay price. Output above the estimated demand was not valued.

Grazing values are the average amount that National Forest permittees are willing to pay for grazing on the Forests as estimated from the 1990 RPA.

Recreation Visitor Day values are the estimated average amount that recreationists are willing to pay to participate in a recreation activity associated with a developed site and/or a dispersed recreation opportunity. These values are based on a survey of travel cost and contingent value recreation studies conducted by the Forest Service for the Forest and Rangeland Renewable RPA evaluations for 1990.

Timber value estimates are complicated by local circumstances. Recent historical volumes and values (before 1990) reflect land bases prior to the ISC report on the northern spotted owl. Timber sold after the 1987 fire siege was mostly fire salvage. Green sale values are subject to supply and demand situations influenced by the injunction in the Ninth Circuit Court of Appeals on all suitable owl habitat on northern spotted owl forests.

Timber values are average actual timber receipts (including purchaser road credits) divided by harvest volume reported on cut and sold reports for 1991 adjusted to 1987 dollars. Values were prorated by strata based on the cut and sold report. Values were adjusted for brush disposal, KV and other revenues based upon Timber Sale Program Information Reporting System 1991 data. Values were also adjusted for economic effects due to the northern spotted owl based upon an analysis conducted by Mike Skinner, Regional economist.

Water values. The 1990 RPA recommended water value of $69.23 per acre-foot was used. Only 26% of this water yield is diverted and used for agriculture, hydroelectric power or domestic use resulting in an $18 per acre-foot value.

Wildlife and Fish User Day values are based on studies conducted for the Forest Service which were used in the RPA evaluations for 1990.

A demand curve was developed for WFUDs for 50 years. WUD demand is approximately 1% per year. The FUD demand, also around 1% per year, is based on "The Fishery Resources of the National Forests: Extent, Uses and Economic Benefits--1988" by Lisa Tripp and Dr. David B. Rockland, Sport Fishing Institute, Washington, D.C. for USDA Forest Service, April 1990.

Table B-9. Benefit Values Used in Analysis

Priced Output	Unit	Average Actual Cash Receipts per Unit of Output ($)	Average Willingness-to-Pay Value Used in this Analysis ($)
Timber			
(Average all species)	MBF	200.49	200.49
Westside Mixed Conifer		176.92	176.92
Eastside Mixed Conifer		245.75	245.75
Ponderosa Pine Type		276.92	276.92
Douglas-fir Type		150.16	150.16
Red Fir Type		171.33	171.33
Lodgepole Pine Type		91.25	91.25
Range	AUM	1.86	5.98
Recreation			
Dispersed (standard)	RVD	0	14.88
Dispersed (low)	RVD	0	7.89
Developed (standard)	RVD	0	11.97
Developed (low)	RVD	0.20	6.34
Wilderness	RVD	0	12.98
Wildlife & Fish			
Wildlife	WUD	0	45.50
Fisheries	FUD	0	60.14
Commercial Anadromous	Lb.	0	1.61

Values for Outputs that Exceed Demand

Benefit values are applied only where there is a demand for the output by the Forest's users. Outputs that exceed demand are given a benefit value of zero, while those that are produced at or below the quantity demanded by consumers are assigned the benefit value described in the previous section. This is handled with the use of a demand cut-off. A demand cut-off was used for dispersed and developed RVDs. For this resource output, demand is less than the potential capacity of the Forests (refer to Table B-10).

Table B-10. Recreation Wildlife and Fish Demand Curves Used in Analysis.
(Recreation, wildlife and fish visitor days)

Decade	Developed Recreation	Wilderness Recreation	Dispersed Recreation	Wildlife	Fisheries
1	165,000	78,000	480,900	59,300	96,832
2	181,000	87,000	529,000	65,200	116,198
3	199,000	96,000	581,900	71,700	130,142
4	219,600	106,000	640,100	78,900	149,663
5	241,600	116,600	704,100	86,800	163,133

Refer to Chapter 2 for a discussion on how costs and benefits interact to determine the PNV for each alternative and how non-valued benefits have trade-offs and opportunity costs.

H. Constraints

Constraints are quantifiable limits placed on the FORPLAN model to assure that only realistic and reasonable amounts of resources are used, that outputs are produced and that prescription allocations are made.

In a linear programming analysis, constraints supersede the objective function. Thus, where a predetermined level of output, minimum physical condition or allocation is entered as a constraint, it is always achieved (or no feasible solution is found). Output levels and other desired effects, entered as constraints, are implicitly assumed to contribute more to public benefits than their cost of production plus the foregone public benefits of any outputs or other effects they replace in the solution.

Five different categories of constraints were used:

- **Management Requirements (MRs) -** These are constraints needed to meet MRs or management standards. Procedures for defining the MRs were specified by Region 5. MRs are applied to all benchmarks and alternatives, but they are not applied to the unconstrained Maximum PNV assigned with Flow and Long-term Sustained Yield constraints (FLW) or the Minimum Level of Management (MLV) FORPLAN runs. The MRs are taken from 36 CFR 219.27 and generally represent requirements that are outside of Forest Service authority to change. They are based on statutes and regulations in contrast to manual direction or agency policy.
- **Implementation Requirements (IRs) -** These are constraints needed to assure that alternatives are minimally acceptable and implementable on the ground. Procedures for defining IRs were specified by Region 5. They are within agency control, but there is little discretionary control regarding their application at the Forest level. IRs do not apply to benchmarks, but they are applied to all alternatives.
- **Timber Policy Constraints -** These are needed to ensure that timber harvesting meets sustained yield, rotation length and dispersion requirements. These constraints are applied in all benchmarks and alternatives, except for the non-declining yield constraint.
- **Forest Constraints Common to All Alternatives -** These constraints are needed to assure implementability at the local level. They are based on local (rather than Regional) conditions and issues. These constraints are not applied to benchmarks, but are applied to all alternatives except the Constrained Economically Efficient (CEE) FORPLAN Alternative. Opportunity costs associated with these constraints were depicted in FORPLAN Alternative CEF.
- **Forest Constraints That Vary Between Alternatives -** These constraints are unique to individual alternatives. They are applied to meet the theme of individual alternatives. Land base constraints caused most of the difference between the alternatives. (Refer to the Economic Comparisons section of Chapter 2 for a discussion of the opportunity costs associated with each of the above constraints.)

I. Management Requirements

Included in the following discussion of the MRs is the rationale of how they were modeled in FORPLAN. All MRs were modeled either directly or indirectly. That is, in some cases a constraint was used in the model which was intended to recognize more than one MR.

Capable, Available and Tentatively Suitable Timber Lands

The following criteria were used in identifying tentatively suitable timber lands in the Forest's data base:

- The land is forested and is producing or is capable of producing crops of industrial wood. This includes land which is at least 10% occupied by forest trees and/or land which has the biological growth potential of at least 20 cubic feet per acre per year.

- The land has not been withdrawn from timber production by Congress, the Secretary of Agriculture or the Chief of the Forest Service. On the Forest, the Marble Mountain, Red Butte, Russian, Trinity Alps and Siskiyou Wildernesses, as well as the Butte Valley National Grassland, have been withdrawn from timber production.
- Technology and knowledge exists and is available to ensure that timber is produced without irreversible damage to soil productivity, water quality or watershed condition. Lands which are most prone to sediment production through mass wasting, such as inner gorges and recently active landslides, are identified, and classified, as unsuitable.
- Existing technology and knowledge, as reflected in current research and experience, provides reasonable assurance that adequate restocking can be attained within 5 years after final harvest.
- Significant cultural resource sites have been removed from the suitable timber land base.

This MR was modeled in FORPLAN by allocating Inam, Cottimein and Helkau, existing wilderness, non-forest, non-regenerable, non-capable and geologically highly unstable areas as unsuitable for timber management.

Threatened and Endangered (T&E) Species

Approved or current recovery, territory and species management plans for population and habitat requirements were used.

- *Bald Eagles*: A target population level was assigned from the USFWS Recovery Plan of 5 pair.
- *Peregrine Falcon*: The Forest set a recovery objective of 14 pair.
- *Northern spotted owl*: Habitat areas (HCAs) identified in the ISC Report will be maintained. Forest matrix lands will be managed for dispersal in accordance with the 50-11-40 rule. For the Final Preferred Alternative, HCAs and the 50-11-40 rule were replaced by LSRs and RRs to provide for late-successional species habitat and viability. For Alternative G (SOHA), SOHAs were modelled instead of HCAs and the 50-11-40 rule.

Sensitive species.

- *Goshawk*: The Forest determined that 72 territories, 200 acres in size, were necessary for viability. This MR was modeled in FORPLAN by allocating all currently identified and potential territories or habitat as unsuitable for timber management. For the Final Preferred Alternative, goshawk territories were not a land allocation, but zones would be established through standards and guidelines. For Alternative G (SOHA), 72 territories, 50 acres in size, were modelled.

Direction for Snag-Dependent Species

To the extent possible within each timber compartment, manage for an average of 1.5 snags per acre. This MR was modeled in FORPLAN by foregoing the timber yields from every other thinning in regenerated stands.

Diversity of Plant and Animal Communities

- Diversity consists of richness, evenness and pattern, each element of which is considered in the diversity MR.
- Diversity of plant and animal communities is achieved by providing a threshold level of vegetation types and seral stages found within the Forest.
- In the Draft EIS, this MR was to provide and maintain a minimum of 5% of each vegetative-timber type/seral stage combination on the Forest as a whole. The total existing area in each type in forested lands was used as the base for this calculation.
- Both suitable and unsuitable timber lands were used to meet the diversity requirements as long as habitat characteristics for management indicator species (MIS) were fully met.
- Vegetative types and seral stages (total acres) would be distributed in proportion to their current acres in a given management area.

This MR was modeled in FORPLAN by accounting for 7 seral stages ranging from seed/saplings to older over-mature habitat for each decade. Eastside mixed conifer is deficit the 5% minimum requirement for the oldest seral stage category on a Forest-wide basis until the fourth decade, and eastside pine is deficit until the ninth decade. This situation requires a constraint to hold the best candidate stands to meet the requirement as soon as possible. Douglas-fir, red fir and westside mixed conifer maintained the 5% minimum throughout the planning horizon. For the Final Preferred Alternative, this constraint was removed.

Riparian Area Management - Perennial Streams, Lakes and Reservoirs

- No practices or prescriptions that cause detrimental changes to water quality, aquatic flora and fauna and hydrophytic vegetation would be applied to perennial riparian areas.
- Emphasis would be given to riparian-dependent resources. Other activities would be allowed to occur when compatible with dependent resources.

This MR was incorporated in FORPLAN by allocating a 200-foot corridor along all perennial streams to minimal timber. Inner gorge areas, which coincide with geologically unstable lands covered in the suitable land classification, have already been removed from the timber suitable land base. In the Final Preferred Alternative, intermittent stream buffers were modelled by

removing an additional percentage of land from the timber suitable land base.

Soils and Water

- Soil and water resources would be conserved. No significant or permanent impairment of the productivity of the land would be allowed.
- Existing or potential watershed conditions that would influence soil productivity, water yield, water pollution or hazardous events, such as landslides and stream channel destabilization, would be evaluated.
- The amount of land disturbance on sensitive watershed lands would be limited in order to avoid soil loss, activation of mass land failures and degradation of water quality through sedimentation.

This MR relates to cumulative watershed impacts and was modeled in FORPLAN by estimating ERAs. The Forest-wide ERAs are lower than the Forest-wide TOC constraint. Thus, no constraint was needed in the FORPLAN model. This occurs because other factors are more constraining than the TOC constraint.

Designated Wild, Scenic and Recreation Rivers

- These rivers are managed according to guidelines contained within the National Wild and Scenic Rivers Act. Management direction is focused on the maintenance and enhancement of these rivers for their recreation and scenic values.
- Lands adjacent to wild segments of the Wild and Scenic Rivers System are unavailable for timber production. However, timber management activities can take place along the Scenic and Recreation River segments.

This MR was modeled in FORPLAN by allocating 1/2-mile corridors along Wild Rivers to timber unsuitable, Scenic Rivers to minimal yields, and recreation rivers to modified timber yields.

J. Implementation Requirements

Following is a listing of the IRs, including a discussion of how they were modeled in FORPLAN. IRs would be applied in the implementation of all alternatives.

Sensitive Plant Species

Sensitive plants would be managed to ensure that these species do not become listed as T&E because of management actions.

Vegetation management practices would be planned to protect or enhance Sensitive plant species.

Approximately 100 acres were allocated to unsuitable for timber production for *C. persistens*.

Sensitive Animal Species

Critical furbearer habitat was allocated to minimal timber yields to maintain population viability.

In the Final Preferred Alternative, this constraint was removed; LSRs and RRs provided for population viability.

Visual Quality

Foregrounds and middlegrounds of the following scenic corridor travel routes would be maintained to partial retention visual objectives: officially designated California State and County scenic highways and proposed California State Scenic Highway system routes.

The foreground portions and middleground portions of the following corridors would be managed to an adopted visual quality objective (VQO) of partial retention:

(1) U.S. Highway 97;
(2) State Highway 3;
(3) State Highway 96
(4) State Highway 263

This IR was modeled by allocating the foreground and middleground areas to modified timber yields.

K. Timber Policy Constraints

Listed below are the detailed descriptions of the constraints used in the FORPLAN model in response to sustained yield, harvest flow, rotation length and dispersion requirements.

Rotation Length and Culmination of Mean Annual Increment Requirements for Timber Harvest Scheduling

Mean annual increment was:

(1) Based on regenerated yields;
(2) Calculated for each applicable FORPLAN prescription; and
(3) Determined for sawlog products measured in cubic feet.

For benchmarks and alternatives, minimum rotations were based on culmination of mean annual increment (CMAI) in utilized cubic feet of merchantable size trees. Regenerated timber stands are regarded as generally culminated in growth at the age that corresponds to 95% of the apparent culmination calculated from the managed yield projections used in FORPLAN. Culmination is always later than or equal to the age of merchantability.

On the Forests, the age at CMAI is equal to the age of merchantability on over 80% of the suitable timber

tability are the same as rotation ages based on CMAI for FORPLAN modeling purposes.

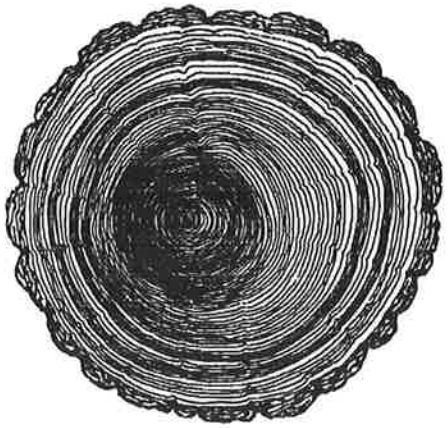
Merchantability occurs when the average projected diameter at breast height is 13 inches with an average projected tree height of 50 feet for stands maintained within the range of desired to optimum stocking. This is to insure that nearly all trees in the projected stand would be minimally merchantable and larger at first harvest.

Table B-11 shows the minimum age for attainment of 13-inch diameter at breast height, 50-feet height and 90% maximum basal area (for standard even-aged management).

Table B-11. Minimum Age for Attainment of 13-inch Diameter at Breast Height, 50-foot Height and 90% Maximum Basal Area.

Forest Type	FORPLAN Period	Age
Douglas-fir	4	35
Mixed conifer - eastside	5	45
Mixed conifer - westside	6	55
Ponderosa pine	7	65
Red fir	6	55
Lodgepole pine	6	55

The rotations included in FORPLAN matrices represent the range from CMAI to the end of the planning horizon. This is for regenerated timber projected for harvest starting in any period that corresponds to a mean stratum age equal to that of CMAI for regenerated stands. To the extent possible, each regeneration class in the FORPLAN matrix included one timing choice that corresponded to minimum CMAI defined for the class. Table B-12 shows the defined FORPLAN minimum rotation lengths.



B-12. Defined FORPLAN Minimum Rotation Length

Forest Type	Without Thinning 95% CMAI	With Thinning 95% CMAI
Mixed conifer - westside	100 years	100 years
Mixed conifer - eastside	90 years	90 years
Douglas-fir	60 years	80 years
Red fir	90 years	100 years
Ponderosa pine	90 years	110 years
Lodgepole pine	90 years	90 years

Sustained Yield Requirements

FORPLAN Modeling Rules. To ensure that the Forest can sustain the timber harvest level past the end of the planning horizon, a FORPLAN constraint was applied that states timber harvest cannot exceed 95% of the long-term sustained yield in Decade 16.

Harvest Flow Requirements.

FORPLAN Modeling Rules. Timber output after the first decade is not allowed to fluctuate more than 15% from the previous decade. This prevents wide fluctuations from one decade to the next. The 15% limit is based on the portion of the current timber sale quantity required to support an average sawmill.

Dispersion

The intent of the dispersion rule is to prevent regeneration units, which are still "openings," from being adjacent to each other. The intent is also to disperse units in such a way as to leave logical harvest units between openings for future management. This requirement applies only to regeneration harvest based on even-aged management. An opening created by even-aged timber management would no longer be considered an opening once the number of trees, defined below, have reached 4.5 feet in height and are generally free to grow.

FORPLAN Modeling Rules. The dispersion requirement is modeled in FORPLAN by limiting the number of acres which can be altered in any one decade. Separate constraints were used for each Forest and for each of the major forest types with significant acreages. The constraint for modified timber lands was a harvest limit of not more than 24% of the inventory in a decade.

L. Additional Forest Direction and Constraints

Forest Supplementation of Regional MRs

Forest Constraints Common to All Alternatives

Special Interest Areas (SIAs) - Four botanical areas (approximately 1,200 acres) are proposed for SIA consideration.

Research Natural Areas (RNAs) - Nine RNAs (approximately 12,500 acres) are proposed for RNAs.

This requirement was modeled in FORPLAN by allocating the areas to unsuitable for timber.

Harvest requirement for poorly stocked stands. Well-stocked stands can be harvested up to a maximum of their proportion in the available land base. The remainder of stands harvested must be poorly stocked.

Dispersion constraint for acres burned in 1987. An additional constraint was applied for dispersion due to the large contiguous areas burned during the fire siege. It was assumed that these areas would mature and become available for timber production at the same time. This constraint was intended to prevent spatial implementation infeasibilities.

M. Benchmarks

FLW - Maximum Present Net Value (PNV) with Flow and Long-Term Sustained Yield (LTSY) Constraints Benchmark

Description and Purpose:

- Used to evaluate the appropriateness of harvest flow constraints.
- Used to provide the economically efficient level of valued resources with fewest constraints.
- Forms a base run used in evaluating MRs.

Specifications:

- *Objective Function:* Maximize PNV for 12 periods (decades).
- *Timber Policies:*
  - *Minimum rotation:* Merchantability (same as the CMAI);
  - Includes sustained yield requirements;
  - Includes harvest flow requirements;
  - No dispersion was included.
- *Land Base:* Includes all tentatively suitable lands.
- *Economic Assumptions:* Used assigned values with trends and demand cut-offs for RVDs.

MLV - Minimum Level of Management Benchmark

Description and Purpose:

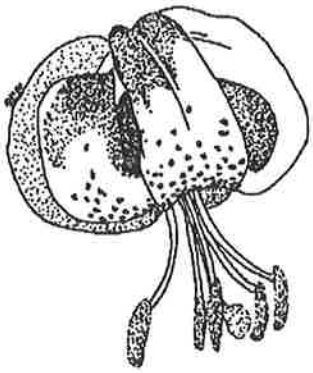
Used to estimate outputs and cost of the backgrounds or residuals. Minimum level is an accounting analysis to determine the background outputs and fixed costs associated with maintaining the Forests. It was used as a base to compare other alternatives. It is not stewardship or custodial management.

Specifications:

- *Objective Function:* Minimize cost for the planning horizon (16 decades).
- *Output Constraints:*
  - Only background or incidental outputs were allowed;
  - Timber, range and developed recreation outputs were set at zero.

Other Assumptions:

- Vegetation would follow natural succession.
- Only maintenance of those facilities that are needed to support the basic ownership activities would be allowed. All other facilities would be allowed to deteriorate.
  - State and County roads would remain open but most Forest roads would be closed.
  - All public and private sector recreation facilities on NFS lands would be closed, with no provisions for maintaining such assets.
- The fire organization would be greatly reduced. Forests would assume costs for detection and initial attack (engines) only; no other fire management and/or cooperator resources were considered.
- Recreation use assumptions - Dispersed recreation use that cannot be discouraged or controlled would occur.



MR - Management Requirements Benchmark

Description and Purpose:

- Used to define and evaluate MRs.
- Used to show the opportunity cost of MRs taken collectively.
- Used to form the basis for evaluating constraints.
- Used to estimate the mix of resource uses and a schedule of outputs and costs which would maximize the PNV of those outputs that are assigned a monetary value. Dollar values were based on actual or simulated market prices (willingness to pay) for timber, recreation, range, water, wildlife and fish.

Specifications:

- *Objective Function:* Maximum PNV for 12 periods (decades).
- *Timber Policies:*
  - *Minimum rotation:* Used the full set of rotation ages greater than or equal to 95% of CMAI;
  - Includes sustained yield requirements;
  - Includes nondeclining yield requirements;
  - Includes dispersion.
- *Land Base:* Includes all tentatively suitable land.
- *Economic Assumptions:* Used assigned values with trends and demand cut-offs for RVDs.
- All MRs were applied.

TBD - Maximize Timber Outputs for One Decade-Departure Benchmark

Description and Purpose:

Used to define the maximum timber output possible for the first decade with nondeclining yield policy removed and CMAI and MMRs retained.

Specifications:

- Same as TBR run below, except for removal of nondeclining yield.
- *Land Base:* Includes all tentatively suitable land.
- *Economic Assumptions:* Same as TBR.
- All MRs were applied.
- An economic rollover was performed as was the case for TBR. Rollover specifications were the same as TBR.

TBR - Maximize Timber Outputs Benchmark

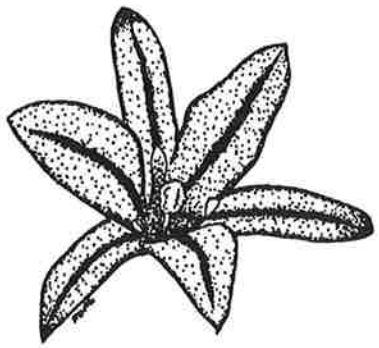
Description and Purpose:

Used to define the maximum timber output possible for the first decade under current policy and MRs.

Specifications:

- *Objective Function:* Maximum timber for one period (decade).
- *Timber Policies:*
  - *Minimum rotation:* Used the full set of rotation ages greater than or equal to 95% of CMAI;
  - Includes sustained yield requirements;
  - Includes nondeclining yield requirements;
  - Includes dispersion.
- *Land Base:* Includes all tentatively suitable land.
- *Economic Assumptions:* Used assigned values with trends and demand cut-offs for RVDs.
- All MRs were applied.
- An economic rollover was performed to determine the most economically efficient allocation and schedule which corresponded to the harvest levels for each of the five periods defined in the maximum timber run.

  The specifications for this rollover were the following:
  - *Objective Function:* Maximize PNV for 12 periods;
  - Timber policies were the same as above;
  - Land base was the same as above;
  - Economic assumptions were the same as above;
  - All MRs were applied as above;
  - *Output Constraint:* Meet timber outputs from each of the 5 periods as defined by the maximum timber run.



N. Alternatives

This section lists only those constraints that were modeled in FORPLAN; it also describes how they were modeled. For a more complete discussion about the displays and results of all the alternatives refer to Chapter 2. Chapter 2 describes each alternative in detail and Chapter 4 discusses how those constraints change the environmental consequences.

Alternatives Eliminated From Detailed Study

Alternative CEE - Constrained Economically Efficient Alternative

Description and Purpose:

- Used to portray the most economically efficient mix of allocations and schedules, subject to meeting MRs and IRs.
- Used to specifically define and evaluate IRs.
- Used to demonstrate the opportunity cost of the IRs taken collectively.
- Used to form a base run used in evaluating the Forest's constraints common to all alternatives.

Specifications:

- *Objective Function:* Maximize PNV for 12 periods (decades).
- *Timber Policies:*
  - *Minimum rotation:* Used the full set of rotation ages greater than or equal to 95% of CMAI;
  - Includes sustained yield requirements;
  - Includes nondeclining yield requirements;
  - Includes dispersion.
- All MRs and IRs were applied. No additional Forest defined constraints were added.
- *Land Base:* Includes all tentatively suitable land.

  This alternative has a relatively small land allocation change from MR benchmark due to California State Scenic Highways agreements and sensitive species constraints. For this reason CEE was an accounting analysis. Outputs were prorated based upon MR outputs.
- *Economic Assumptions:* Used assigned values with trends and demand cut-offs for RVDs.

Alternative LBU

Description and Purpose:

Used to estimate the expected outputs and services that could be provided in the future if the current budget was reduced by 25% or more.

Assumptions:

Held as constant for the planning horizon, a 45% reduction in the normalized 1987 budget (see Alternative CUR direction). This 45% reduction applied to the total dollars.

Specifications:

This alternative was drawn from the Basic Program Level submitted to the Regional Office for 1995. Resource management requirements are met with no investment programs. The timber program consists of 20 MMBF of salvage.

Alternative PFD/D - Preferred Alternative/Departure

Description and Purpose:

Used to determine whether multiple-use objectives could be better met by regulating timber harvest volumes in a manner which deviates from the principle of Nondeclining Yield.

Specifications:

Same specifications as Alternative PFD except for the following:

- *Objective Function:* Maximize PNV for 12 decades.
- *Nondeclining Yield:* Applied only after the fifth decade.
- Required to return to the Base Sale Schedule of Alternative PFD by the fifth decade.

Alternatives Considered in Detail

Alternative PFD - Preferred Alternative

Description and Purpose:

Alternative PFD provides for multiple use with an emphasis on ecosystem health. Providing habitat for aquatic and late-successional species to recover at-risk populations is emphasized. Salvage and restoration after catastrophic events is a priority. Stand and landscape patterns would be designed to mimic "natural" patterns. Existing visual quality objectives are applied. Late-successional species habitat is provided for by a reserve system, including LSRs and RRs.

Specifications:

- All MRs and IRs were applied to this alternative except owl, goshawk and furbearer habitat; and seral stage requirements which are provided for by LSRs, RRs and associated standards and guidelines in the Final EIS.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative:
  - Retention of 15% of the volume on all lands with modified yields.
  - Group selection prescriptions are confined to low or moderate slope areas.
  - Several allocations of land were made under this alternative beyond the MRs and IRs in order to respond to local Forest issues.

Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

- Riparian Reserves.
- Backcountry Management Area--2 areas, 29,000 acres.
- Stands which are infeasible to manage due to harsh sites.
- Wild River foreground--101.1 miles proposed.
- SIAs 45 areas consisting of 22,000 acres are proposed or existing.
- Winter Range Management Area--83,000 acres.

A total of about 1,327,000 acres of the Forest were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Forage Management Area--55,000 acres.
- Scenic River foreground--10.6 miles proposed.
- Managed Wildlife Area--7,000 acres.
- Wild River middleground viewsheds.

A total of 58,000 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Geologically sensitive lands.
- Recreational Rivers foreground and middleground viewsheds--59.6 miles proposed.
- Scenic Rivers middleground viewsheds.

A total of 296,000 acres of Forest were allocated to this prescription.

Alternative CUR/RPA - Current No Action/No Change and 1990 RPA Program Emphasis

Description and Purpose:

Alternative CUR is the No Action/No Change Alternative required by National Forest Management Act (NFMA) regulations. This alternative represents a continuation of the current resource management direction based on the Forest Multiple-Use Plan. It also represents a continuation of current land allocations and policies.

Under Alternative RPA, the primary objective is to provide products and services at levels expected to help satisfy current and future demands (as stated in the 1990 Forest and Rangeland Renewable program).

These alternatives were considered similar enough to be modeled together. Existing visual quality objectives are applied. Northern spotted owl habitat is provided by HCAs and 50-11-40, consistent with the ISC strategy.

Specifications:

- All MRs and IRs were applied to this alternative.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative:
  - RPA has a limit on new road construction in the first decade of 3%.
  - Several allocations of land were made under this alternative beyond the MRs and IRs in order to respond to local Forest issues.

Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

- Cultural sites which require a determination of significance are protected.
- Forage Management Areas--22,500 acres.
- Existing Wild River foreground viewsheds--0 miles proposed.
- SIAs 5 areas consisting of 1,930 acres are proposed or existing.

A total of about 1,000,000 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Riparian habitat.
- Existing Scenic River foreground viewsheds--0 miles proposed.
- Existing Recreational River foreground viewsheds--0 miles proposed.

A total of 118,300 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Geologically sensitive lands.
- Big game habitat management--128,000 acres.

A total of 348,300 acres of Forest were allocated to this prescription.

Allocation of the remaining land base (213,600 acres) was to timber emphasis (TF) prescriptions.

Alternative A

Description and Purpose:

Alternative A provides for multiple use with an emphasis on timber management. There is a high priority for prompt salvage and reforestation after catastrophic damage. Visual quality objectives were assigned by management area consistent with management intensity. Northern spotted owl habitat is provided by HCAs and 50-11-40, consistent with the ISC strategy.

Specifications:

- All MRs and IRs were applied to this alternative.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative:
  - 1-4% of the inventory is left after harvest to provide green tree recruitment for wildlife habitat.
  - Several allocations of land were made under this alternative beyond the MRs and IRs in order to respond to local Forest issues.

Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

- Cultural sites which require a determination of significance are protected.
- Backcountry Management--3 areas, 33,000 acres.
- Wild River foreground viewsheds--128.8 miles proposed.
- SIAs--26 areas consisting of 14,280 acres are proposed or existing.

A total of about 969,300 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Riparian habitat.
- Scenic River foreground viewsheds--1.0 mile proposed.
- Recreational River foreground viewsheds--50.8 miles proposed.
- Stands which are infeasible to manage due to harsh sites, economics or access problems.

A total of 236,800 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Geologically sensitive lands.
- Big game habitat management--500,000 acres.
- Forage Management Areas--44,000 acres.
- Additional scenic highways.

A total of 201,000 acres of Forest were allocated to this prescription.

Allocation of the remaining land base (273,200 acres) was to timber emphasis (TF) prescriptions.

Alternative B/B'

Description and Purpose:

These alternatives provide for multiple use with an emphasis on visual quality and developed recreation. Inventoried visual quality objectives apply. No lands are allocated to timber emphasis. Alternatives B and B' are identical except for the management of northern spotted owl habitat. Alternative B' provides for owl habitat with HCAs and 50-11-40, consistent with the ISC strategy. Alternative B allocates HCAs to minimal timber yields and does not apply the 50-11-40 rule.

Specifications:

- All MRs and IRs were applied to Alternative B' only.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative
  - The major prescription for harvest is group selection. Other harvest prescriptions leave 2-25% of the inventory after harvest for green tree recruitment for wildlife habitat.
  - No lands are allocated to timber emphasis prescriptions.

Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

- Cultural sites which require a determination of significance are protected.
- Riparian habitat.
- Wild River foreground viewsheds--93.7 miles proposed.
- SIAs--20 areas consisting of 27,560 acres are proposed or existing.

A total of about 803,000 acres for Alt B and 1,050,000 acres for Alt B' were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Geologically sensitive lands.
- Wild River middleground viewsheds.
- Scenic River foreground and middleground viewsheds--15.2 miles proposed.

A total of 511,600 acres for Alt B and 264,400 acres for Alt B' were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Big game habitat management--336,000 acres.
- Recreational River foreground and middleground--52.8 miles proposed.

A total of 365,700 acres for Alt B and Alt B' are allocated to this prescription.

Alternative C

Description and Purpose:

Alternative C provides for multiple use with an emphasis on maintaining a high degree of stand, ecosystem and forest diversity. Inventoried visual quality objectives are applied.

Northern spotted owl habitat is provided by HCAs and 50-11-40, consistent with the ISC strategy.

Specifications:

- All MRs and IRs were applied to this alternative.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative:
  - 3-6% of the inventory is left after harvest to provide green tree recruitment for wildlife habitat.
  - Several allocations of land were made under this alternative beyond the MRs and IRs in order to respond to local Forest issues.

  Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

  - Riparian habitat.
  - Forage Management Areas--21,000 acres.
  - Wild River foreground and middleground viewsheds--112.2 miles proposed.
  - SIAs--41 areas consisting of 21,610 acres are proposed or existing.

  A total of about 1,035,100 acres of Forest were allocated to this prescription.

  Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

  - Cultural sites which require a determination of significance.
  - Habitat linkage--79,900 acres.
  - Scenic River foreground viewsheds--5.2 miles proposed.
  - Recreational River foreground viewsheds--14.0 miles proposed.

  A total of 152,900 acres of Forest were allocated to this prescription.

  Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

  - Geologically sensitive lands.
  - Big game habitat management--128,000 acres.
  - Scenic River middleground viewsheds.
  - Recreational River middleground viewsheds

  A total of 367,100 acres of Forest were allocated. to this prescription.

  Allocation of the remaining land base (125,200 acres) was to timber emphasis (TF) prescriptions.

Alternative D/D'

Description and Purpose:

These alternatives provide for multiple use with an emphasis on providing a balance of commodity and amenity products. Water quality, soil productivity, geologic stability and fish habitat objectives are emphasized. Alt D and D' are identical except for the management of northern spotted owl habitat. Alternative D' provides for owl habitat with HCAs and 50-11-40, consistent with the ISC strategy. Alternative D allocates smaller size class and immature stands in HCAs to minimal timber yields.

Specifications:

- All MRs and IRs were applied to Alternative D' only.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative:

- 2% of the inventory is left after harvest for green tree recruitment for wildlife habitat.

Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

- Riparian areas.
- Wild River foreground viewsheds--102.7 miles proposed.
- SIAs--46 areas consisting of 34,880 acres are proposed or existing.

A total of about 938,800 acres for Alt D and 1,045,800 acres for Alt D' were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Geologically sensitive lands plus lands with a high geological hazard rating.
- Other riparian areas.
- Scenic River foreground viewsheds--12.9 miles proposed.
- Recreational River foreground viewsheds--31.9 miles proposed.
- Forage management areas.

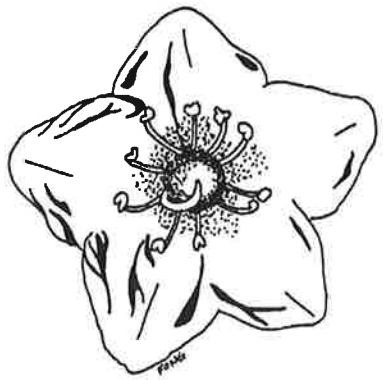
A total of 264,700 acres for Alt D and 157,700 acres for Alt D' were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Geologically sensitive lands.
- Scenic River middleground viewsheds.
- Recreational River middleground viewsheds.
- Big game habitat management--51,000 acres.

A total of 303,500 acres for Alt D and Alt D' are allocated to this prescription.

Allocation of the remaining land base (173,300 acres) in both alternatives was to timber emphasis (TF) prescriptions.



Alternative E

Description and Purpose

Alternative E provides for multiple use with an emphasis on amenity values and maintaining future options. Emphasis is on maintenance of late seral stage habitat. Timber management intensity is limited in order to maintain a continuous forest canopy and a visually pleasing Forest. No lands are allocated to timber emphasis. Existing visual objectives apply. Northern spotted owl habitat is provided for with HCAs and 50-11-40, consistent with the ISC strategy.

Specifications

- All MRs and IRs were applied to this alternative.
- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Constraints unique to this alternative:
  - Most harvest prescriptions leave 20% of the inventory for green tree recruitment for wildlife habitat.
  - No lands are allocated to timber emphasis prescriptions.

  Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:
  - Cultural sites which require a determination of significance are protected.
  - Riparian habitat.
  - Wild River foreground viewsheds--126.6 miles proposed.
  - SIAs--46 areas consisting of 34,880 acres are proposed or existing.
  - Backcountry Management Area--241,000 acres.
  - Forage Management Area--16,100 acres.
  - "Old growth"--4G size and density classes.
  - Critical habitat areas for the northern spotted owl.

- Stands which are infeasible to manage due to harsh sites, economics or access problems.
- Sensitive species habitat for furbearers.

A total of about 1,298,700 acres were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Scenic River foreground and middleground viewsheds--26.3 miles proposed.

A total of 52,500 acres were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Big game habitat management--128,000 acres.
- Recreational River foreground and middleground--33.4 miles proposed.
- Geologically sensitive lands.

A total of 332,800 acres are allocated to this prescription.

Alternative G (SOHA)

Description and Purpose

Alternative G (SOHA) represents management practices on the Forest prior to 1987. It provides for multiple use with an emphasis on the production of timber and other commodities. Northern spotted owl habitat is provided for by SOHAs. It is not consistent with current direction and would not be implementable without a change in the laws, policy or regulations.

Specifications

- The following timber policies were applied:
  - Sustained yield requirements;
  - Harvest flow requirements;
  - Nondeclining yield;
  - Dispersion rules; and
  - Minimum rotations.
- The objective function was to maximize timber for 10 years. An economic rollover was performed to determine the most economically efficient allocation and schedule for this timber harvest level.
- Several allocations of land were made under this alternative beyond the MRs and IRs in order to respond to local Forest issues.

Allocations of specified analysis areas to timber unsuitable (TU) prescriptions include primarily the following areas:

- Cultural sites which require a determination of significance are protected.
- Forage management areas--16,100 acres.
- Existing Wild River foreground viewsheds--0 miles proposed.
- SIAs--5 areas consisting of 1,930 acres are proposed or existing.

A total of about 833,900 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to minimal timber (TM) prescriptions include primarily the following areas:

- Riparian habitat.
- Existing Scenic River foreground viewsheds--0 miles proposed.
- Existing Recreational River foreground viewsheds--0 miles proposed.

A total of 143,200 acres of Forest were allocated to this prescription.

Allocations of specified analysis areas to modified timber (TR) prescriptions include primarily the following areas:

- Geologically sensitive lands.
- Big game habitat management--128,000 acres.

A total of 440,400 acres of Forest were allocated to this prescription.

Allocation of the remaining land base (262,800 acres) was to timber emphasis (TF) prescriptions.