Appendix B

Analysis Process

Mark Twain
National Forest

Cover image: Nodding ladies' tresses orchid on igneous glade

Photographer: Paul Nelson, Mark Twain National Forest

Appendix B

Analysis Process

Introduction

This appendix provides additional detail on the process used in the analysis that went into modeling timber harvest schedules and economic analysis. Timber harvest schedules were used to develop the Plan's alternatives and determine allowable sale quantity by alternative. This information supplements the vegetation affected environment and effects analysis found in Chapter 3 of this document. The other area described in this section is methodology used in the economic analysis, which complements social and economic affected environment and effects analyses, also found in Chapter 3.

This discussion includes basic assumptions, modeling components and inputs, rules, methods, and constraints. Additional information and documents used in the analysis process are contained in planning records. The planning record, in its entirety, is incorporated here by reference. Results from the modeling process are estimates of what is expected if alternatives are implemented, which facilitates comparison of alternatives.

This analysis fulfills requirements codified in the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 as amended by the National Forest Management Act (NFMA) of 1976. These Acts require that renewable resource programs are on a comprehensive assessment of present and anticipated uses. Demands for and supply of renewable resources must be determined through an analysis of environmental and economic impacts. This analysis was conducted in accordance with the planning regulations in effect before November 9, 2000 (See 36 CFR 219, revised as of July 1, 2000) as allowed under the 2005 planning regulations 36 CFR 219.14(e).

Timber Harvest Schedule Modeling

Scope of the Analysis

This environmental impact statement is being prepared in the context of revising the current Mark Twain National Forest Land and Resource Management Plan, approved in 1986. A significant part of the analysis effort in the 1986 Plan included modeling and evaluating various ways to allocate the land base to management prescriptions. The entire Forest was available for analysts and specialists at the time to evaluate different areas for their suitability and appropriateness to satisfy several possible multiple use objectives. This 'Zero based planning' process creates an initial Plan for an area that has never had a completed Plan. These uses included shortleaf pine emphasis (MP4.1), quality hardwood management (MP3.2) two categories of recreation emphasis (MPs 6.1 and 6.2), wildlife emphasis (MP 3.4) , natural vegetation emphasis (MP 3.1), grassland management (MP 3.3), cedar management (MP 4.2), Wilderness management (MP 5.1), Temporary Management (MP 6.3) and Special Area Designation (MP 8.1). Management prescriptions 71 (Developed Recreation Areas) and 3.5 Indiana Bat emphasis were later added to the plan by amendment.

The 2005 Plan changes management prescriptions of the Forest from specialty emphasis such as shortleaf pine emphasis (MP41), wildlife habitat emphasis (MP 3.4), etc. to ecosystem restoration (MP 1.1) and part of the semi-primitive motorized emphasis (MP 6.2) to

ecosystem restoration - semi primitive motorized (MP 1.2). The remaining areas are grouped into a general forest prescription (MP 2.1). Recreation emphases (MPs 6.1, 6.2 and 7.1), Wilderness (MP 5.1), Special Areas (MP 8.1) and Rivers (MP 6.3) have stayed the same or have added areas. Management Prescription 3.5 was dropped as a result of the new Ecosystem Restoration prescriptions and application of the MP 3.5 Standards and Guidelines to Forest-wide use.

While the new ecosystem management and general forest prescriptions merge many of the 1986 prescriptions, this is not a reallocation of the land base but a simplification of management prescriptions. This is not 'Zero based planning'. The scope of the analysis in this Plan revision effort focuses on outputs and conditions within various management areas while recognizing management emphasis changes presented in the alternatives.

The areas identified in the 1986 Forest Plan for timber management established a baseline for changes proposed in this revision effort. The most significant changes to lands that permit timber management resulted from better identification and mapping of special habitat conditions (i.e. old growth, caves, fens, etc).

Process Overview

Forest planning analysis problem is stated as follows:

- Given a fixed area of land, what activities should be allowed on each land unit over the next 150 years to achieve the desired future conditions and still meet all physical, operational and regulatory constraints?

To do this, Forest land area is divided into smaller homogeneous areas called analysis units. The planning horizon of 150 years is divided into fifteen 10-year periods. A computer program called SPRECTRUM analyzes forest-planning alternatives. SPRECTRUM is a decision support model, developed and supported by the USDA, Forest Service, which can simultaneously analyze trade offs between many goals, constraints, management activities, timing options and land types, which are necessary to manage a large forest. SPRECTRUM uses a linear program software program called C-Whiz, which in turn uses the Simplex method. Figure 1 provides a process flow diagram of the timber harvest schedule modeling process.

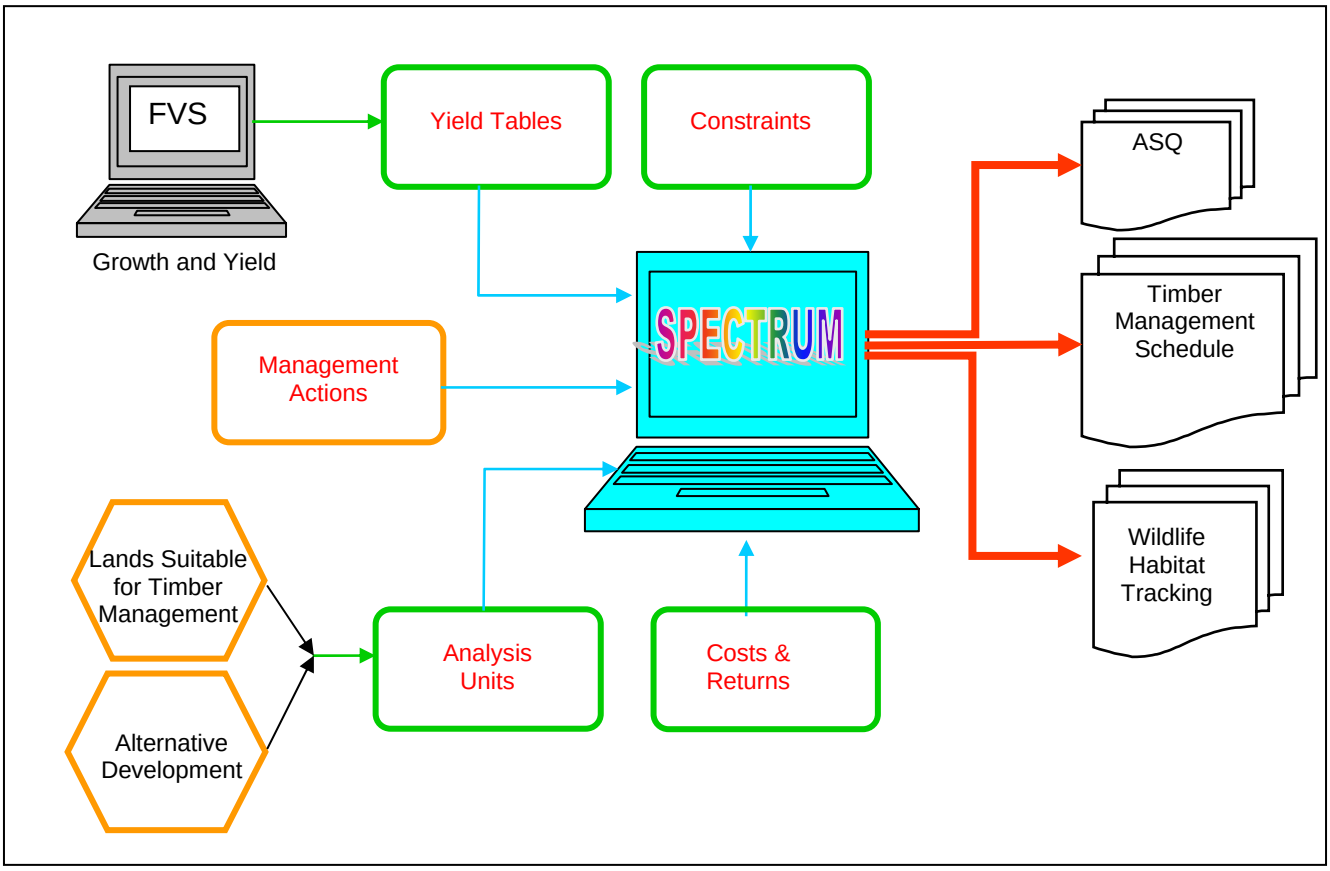
Prior to SPRECTRUM analysis considerable work was done to prepare data for input into the SPRECTRUM model. This work included the following:

- identification of lands tentatively suitable for timber harvest (per 36 CFR 219.14);
- analysis unit development;
- timber yield table development using the Forest Vegetation Simulator (FVS);
- economic information development;
- management prescription development; and
- determination of suitable acreage within each alternative.

The current and 2005 Forest Plan Standards and Guidelines (S&G) provides a framework for constraints, design of analysis units and development of possible timber management actions. Costs associated with various harvest activities and revenue from timber sales by product were additional inputs to the model. Outputs from the timber harvest schedule model included an allowable sale quantity (ASQ) for each alternative, timber management schedules to achieve each ASQ, and some indicators to track specific types of wildlife habitat. The

analysis uses acreage figures derived from Geographic Information System (GIS) data, which is + or – 2% difference from official land status acres.

Figure 1 - Timber Harvest Schedule Model - Process Overview



Common Assumptions Used

The model(s) were "built" based on several Assumptions:

- The Forest Land Management Plan (Plan) will be a strategic Plan that will guide broad land-based decisions to implement certain Goals and Objectives.
- "On-the-ground" decisions will utilize standards and guidelines of the Plan and implementation guides to meet goals and objectives of the strategic Forest Plan.
- Models used in this analysis are sufficient for strategic planning.
- Each alternative would use the same standards and guidelines and that only the area of land allocated to a Management Prescription would vary. Each alternative uses the same suitable timberlands for the Timber Harvest Scheduling analysis.
- As a rule, the ID Team would accept an "error" rate of plus (+) or minus (-) ten percent (10%) within any division of National Forest land, for any Activity, Output or Condition. Acre summaries will not always match and may be as large as 2 or 3 thousand acres. This is due to GIS analysis on large, detailed datasets and 'rounding off' methods used by different computer programs.
- Any policy guidance provided by the Region would be timely and pertinent.

Timber Suitability Analysis

Five standards determine whether a particular land area might be suitable for timber production (entire process is detailed in FSH 2409.13):

- Is the land forested? (36 CFR 219.9(a)(1))
- Is the land withdrawn from timber production? (36 CFR 219.14(a)(4))
- Is irreversible resource damage likely to occur? (36 CFR 219.14 (a)(2))
- Is there reasonable assurance that the technology and knowledge exists to adequately restock lands within 5 years after final harvest? (36 CFR 219.27(c)(3) and FSH 2409.13, 21.42)
- Is the land capable of producing industrial wood? (FSH 2409.13-21.3))

Those lands that remain after applying the five standards are termed tentatively suitable (Stage 1) timberlands, as shown in Table 1. Table 1 compares the timber suitability analysis from the Mark Twain Forest Plan of 1986 to the analysis for the 2005 Forest Plan.

In a 1995 analysis of land suitability, the Forest removed steep slopes, designated old growth, candidate areas, riparian areas and a reduction of acres in Management Prescription 6.3, 8.1 and 9.1. This reduced the suitable land base to 945,800 acres.

Table 1 - Draft Summary of Lands Suited for Timber Production

Classification	1986 Forest Plan [1]	Revision (2004 Analysis Acres)
Net National Forest System Land	1,461,600	1,495,747
Water	-3,500	-2,814
Non-Forest Land (Open Lands, Road and Utility Rights-of-Ways, glades, etc.) [2]	-23,200	-104,447
Sub-Total Non-Forest Lands	26,700	107,261
Forest Land	1,434,900	1,388,485
Not Available – Wilderness	-64,200	-57,015
Not Available --list any other areas withdrawn by Congress, the Sec., or the Chief ... (Eleven Point NS River, Greer Special Area, Irish Excluded Lands)	-0	-12,966
Not Capable of Producing Industrial Wood	-0	0
Potential for Irreversible Soil/Watershed Damage	-0	-0
Restocking in Five Years not Assured	-0	-0
Inadequate Response Information	-34,700	-1,964
Sub-Total Forest Land Withdrawn	98,900	71,945
Sub-Total Non Forest and Forest Land Withdrawn	125,600	179,206
Tentatively Suitable Lands (Stage1)	1,336,000	1,316,541
Not Suitable due to Minimum Management Requirements, and for other Resources. (i.e., riparian areas, Experimental Forest, habitat for Threatened, Endangered, or Sensitive Species, administrative and developed recreation sites, designated old growth, etc.) [3]	-53,500	-319,829
Lands Suitable and Appropriate for Timber Production (Stage2)	1,282,500	996,712

1 Data from the 1986 Forest Plan Table 4-2, IV6

2 Current open lands now include 44,000 acres of open and semi-open Glades.

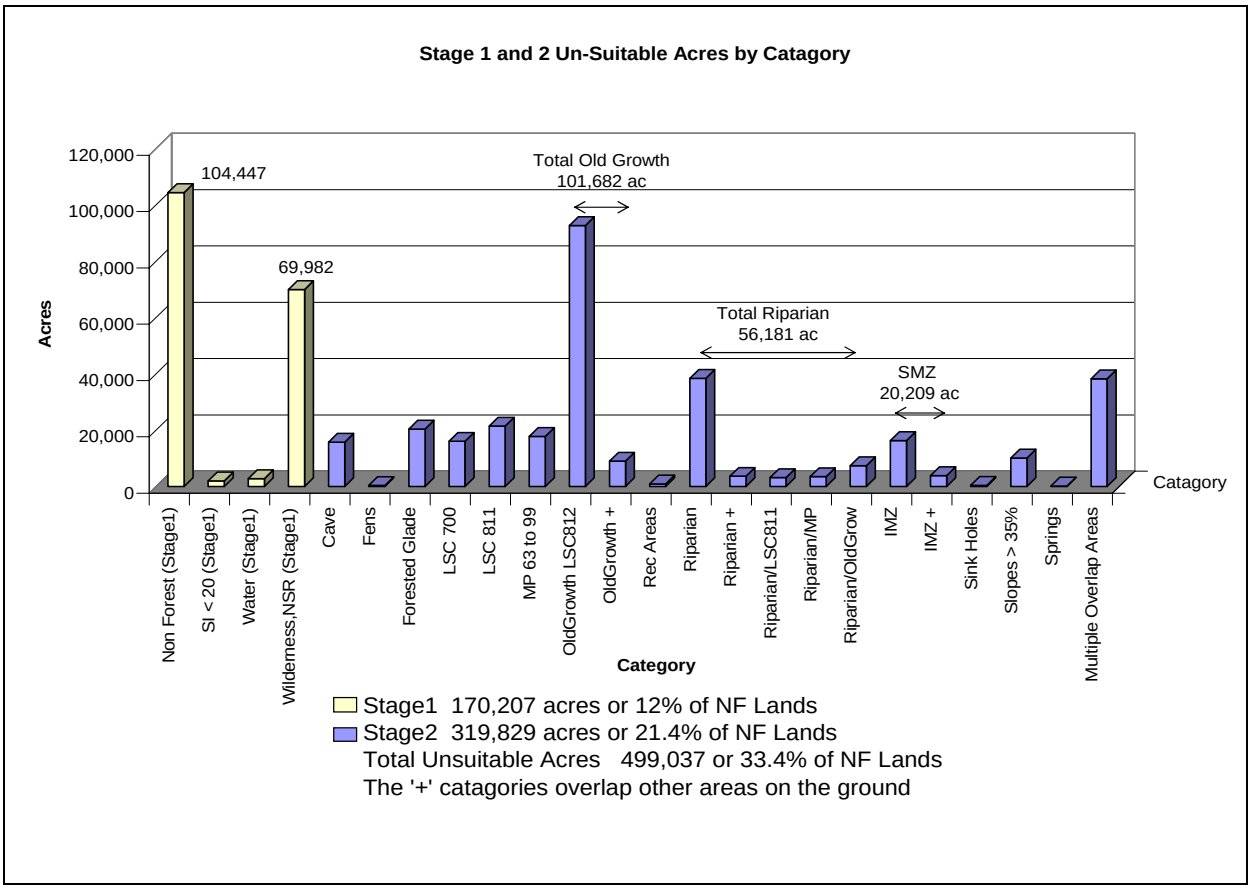
3 The 1986 Plan did not remove old growth areas from the suitable base.

4 Acres from this table in the FEIS have been rounded and will not match; some acres of Wilderness are withdrawn as open land.

Timber suitability is further refined (Stage 2) by removing lands that are not suitable due to minimum management requirements or for other resource needs. Examples are riparian areas, experimental forest, habitat for threatened, endangered, or sensitive species, administrative and developed recreation sites or designated old growth. Most of these lands are in the plan as a Specialized Habitat, Special Areas (MP 8.1) or as a Standard or Guideline (S&Gs). See Figures 2.

Geographic Information System (GIS) data layers reflect each of the management requirements, resource need, or S&G.

Figure 2 - Stage 1 and 2 Non-Suitable Lands for Mark Twain National Forest



Analysis Units

Land stratification is the process of splitting up suitable timber lands into units that respond similarly to management actions and have similar management requirements. Stratifications of suitable timber lands in SPRECTRUM are called levels. Each unique combination of selected attributes is referred to as a strata or analysis unit. The Forest Geographic Information System (GIS) was used to delineate analysis areas according to 4 attributes.

The term “Management Prescription” (MP) assigns management scenarios and S&Gs specific to that prescription.

Table 2 – Analysis Unit Level 1, Management Prescription

Class	Attribute Name
Ecosystem Restoration Emphasis	1.1
Ecosystem Restoration Semi-Primitive Motorized Emphasis	1.2
Ecosystem Enhancement Emphasis	2.1
1986 Plan = Natural Vegetation Communities Emphasis	3.1
1986 Plan = High Quality Hardwoods Emphasis	3.2
1986 Plan = Grassland Management Emphasis	3.3
1986 Plan = Wildlife Diversity Emphasis	3.4
1986 Plan = Indiana Bat Areas of Influence (AOI)	3.5
1986 Plan = Shortleaf Pine Emphasis	4.1
Semi Primitive Non-Motorized Recreation Emphasis	6.1
Semi Primitive Motorized Recreation Emphasis	6.2

Site index grouping assigns or limits management activities based on site productivity and or cost/investments.

Table 3 - Analysis Unit Level 2, Site Index Group

Class	Attribute Name
21-54 site index	Low
55 + site index	Med

Forest type grouping represents main forest types found on the Forest. These groups have distinct rotation ages and specific management activities associated with them.

Table 4 - Analysis Unit Level 3, Forest Type Working Group

Class	Attribute Name	CDS Forest Type Codes
Pine	Pine	3,32,33
Oak/Pine	OKPine	44
White/Post Oaks	WPOak	51,54
Red/Black Oaks	RBOak	53,55,56,57,58,59

Age class structure is derived from stand age. The Forest has management problems directly related to age and structure. Figure 3 shows the current Age Class distribution and B-4 shows the structure distribution for the Forest as a whole and lands suitable for timber management.

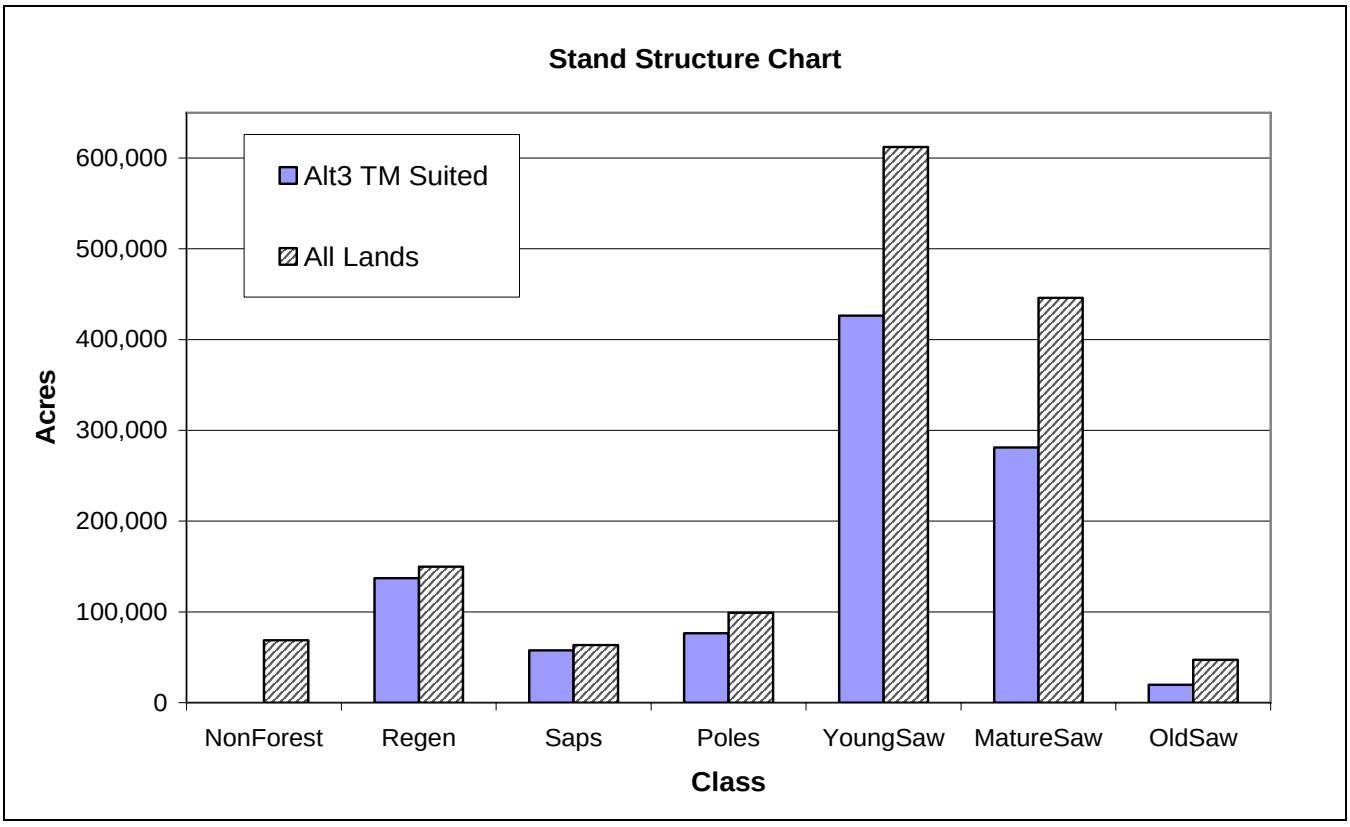
Table 5 - Analysis Unit Level 4, Age Class Structure Group

R9-CDS Age Class[1]	Attribute Name	SPRECTRUM Beginning Age
1	Regeneration	1
2	Saplings	2
3 or 4	Poles	4
5,6,7	Young Sawtimber	6
8,9,10,11	Mature Sawtimber	9
12,13,14,15,16	Old Sawtimber	12

1 CDS- Combined Data Systems database

Figure 3 - Current Age Class Distribution for Mark Twain National Forest

Figure 4 - Current Stand Structure Distribution for Mark Twain National Forest



Growth and Yield

Timber yields were developed using the Forest Vegetation Simulator (FVS), an individual-tree, distance-independent growth and yield model. Forest Inventory and Analysis (FIA) date from the Mark Twain National Forest and Missouri was pre-processed using the Pre-suppose program to meet analysis criteria, then processed with FVS to produce yields using several different scenarios or prescriptions. Tree data from the Region 9, Combined Data System (R9-CDS) was also summarized and used. Samples of yield tables were compared to yield from actual sales from the last 10 years to determine if the model was providing reasonable information. After formatting, yield tables representing Gross Volume were input into the SPRECTRUM model.

Plot data analyzed for non-commercial species and defect indicators helped create multipliers to adjust gross volumes. Wildlife reserve tree Guidelines could not be accounted for in a spatial context, so an additional 10% adjustment was made to all regeneration activities. Reductions to gross volumes were made to each species group by treatment type, using multipliers shown in Table 6.

Table 6 - Gross Volume Multipliers

Act/Output	Treatment Type[1]	Factor
Hardwood Pulp	All CC	0.75
Hardwood Pulp	All UEAM	0.70
Hardwood Pulp	- - - -	0.85
Hardwood Saw	All CC	0.73
Hardwood Saw	All UEAM	0.70
Hardwood Saw	- - - -	0.83
Pine Pulp	All CC	0.83
Pine Pulp	All UEAM	0.70
Pine Pulp	- - - -	0.93
Pine Saw	All CC	0.82
Pine Saw	All UEAM	0.70
Pine Saw	- - - -	0.92

1 CC- Clearcut, UEAM- Uneven aged management

Timber Harvest Schedule Modeling

The timber harvest scheduling analysis seeks to provide an optimum solution for how and when to harvest wood consistent with regulatory and user-defined constraints. In order to evaluate all possible management techniques, while seeking an optimal solution, the Forest employed computer-based modeling software. SPRECTRUM 2.6 is a software package developed by the Forest Service's Ecosystem Management staff in cooperation with the Rocky Mountain Forest and Range Experiment Station. The model optimizes management area prescriptions and allocations, and schedules activities and outputs. SPRECTRUM chooses among alternative solutions based on a set of constraints and an objective such as maximizing income or timber volume.

Regulations to implement the National Forest Management Act (NFMA) require that Forest Plans contain constraints on the timber flow over time and the forest structure at the end of

the planning horizon. The SPRECTRUM model contains special constraints to deal with timber flow, long-term sustained yield, and final forest structure.

The NFMA harvest policy constraints are:

- Non-declining Yield (NDY) - prevents the ASQ from decreasing period to period.
- Long-Term Sustained Yield Capacity (LTSYC) - controls the amount of estimated long-term sustained yield (LTSY).
- ASQ-LTSYC Link - controls the relationship between the ASQ and the LTSYC. Normally ASQ is Less than or equal to LTSY.
- Perpetual Timber Harvest – this ensures that the inventory in the last period is greater than or equal to the average inventory during the planning horizon.

A more detailed discussion on calculation of harvest policy constraints is in the SPRECTRUM documentation.

The Forest used SPRECTRUM as a timber harvest-scheduling tool that reports timber outputs, costs, and benefits. The model scheduled timber harvesting for 15 decades and provided an estimate of long-term sustained yield (LTSY) capacity for each of the alternatives.

SPRECTRUM is a linear programming model. It assumes that the relationship between outputs and the land base are linear, e.g., twice the number of similar acres yields twice the outputs. Other resource programs such as recreation are beyond SPRECTRUM capabilities because their relationship with the land base is not clearly defined in mathematical yield functions available at this time. SPRECTRUM builds a matrix of coefficients and transfers the file to a linear programming package for problem solution. The model then writes a report and produces a data file that contains results. Comparisons with information in other databases can help analyze the data files.

Model Assumptions

Assumptions made for modeling timber management area prescriptions, allocations, outputs, and scheduling activities are listed as follows:

- Only lands suitable for timber management are modeled. All S&Gs and Plan requirements that can be spatially modeled in GIS are met by removing the Stage 2 lands from the suitable timber base. The model only addresses timber scheduling and NFMA requirements. The model does not address other resource issues.
- Forest-wide and resource specific standards and guidelines are used for all even-aged and uneven-aged prescriptions.
- Modeling for forest type conversions and future oak decline is not included. Oak decline is not modeled specifically, but oak decline was active on the tree plot data used to build the yield tables, so it was implicitly modeled.
- The Combined Data System’s stand exam data is sufficiently accurate to use in determining average input stands used in modeling.
- Reserve tree guidelines are satisfied within the model with a 10 % reduction of volume for all regeneration harvest prescriptions.
- Regeneration, no action, and UEAM treatment options are available for all stands past rotation age.

- ASQ will not decrease between successive decades. All NFMA requirements are met by the models use of Non-Declining Yield (NDY), Long Term Sustained Yield (LTSY), Perpetual Harvest and ASQ<=LTSYC Link constraints.
- After lands are entered with a particular management strategy (uneven- vs. even-aged) and intensity (frequency of entry to harvest), strategy and intensity will continue indefinitely on those lands without interruption.
- Application of the SPRECTRUM model on this Forest has a very limited spatial component, which does not consider adjacency and sale layout considerations.
- Treatment schedules are constructed to allow for one or two decade extensions from optimally-designed treatment strategy in order to provide a set of modeling options consistent with maintaining non-declining yield. Alternative 1 is a timber schedule model that only cuts the timber but does not sell or remove the timber

Constraints

The major constraints used in the model for Alternatives 1 are:

- Total Harvest per decade in MP 61 must be <= 10 % of the MP 61 land area.
- Total Harvest per decade in MP 62 must be <= 20 % of the MP 62 land area.
- Total regeneration harvest per decade in MP 61 must be < 3 %
- Total regeneration harvest per decade in MP 62 must be < 5 %
- No thinning is allowed in MP 61 or mp 62 areas

The major constraints used in the model for Alternatives 2-4 are:

- Total Harvest per decade in MP 61 must be <= 10 % of the MP 61 land area.
- Total Harvest per decade in MP 62 must be <= 20 % of the MP 62 land area.
- Total regeneration harvest per decade in MP 21 must be >= 11 % and <= 16 %
- Total regeneration harvest per decade in MP 61 must be >= 3 % and <= 5 %
- Total regeneration harvest per decade in MP 62 must be >= 5 % and <= 10 %
- Total regeneration harvest per decade in MP 21 must be >= 11 % and <= 16 %
- Total regeneration harvest per decade in MP 21 must be >= 11 % and <= 16 %

The major constraints used in the model for Alternative 5 are:

- Total regeneration harvest per decade in MP 31 must be >= 7 % and <= 15 %
- Total regeneration harvest per decade in MP 32 must be >= 8 % and <= 15 %
- Total regeneration harvest per decade in MP 33 must be >= 3 % and <= 8 %
- Total regeneration harvest per decade in MP 34 must be >= 8 % and <= 15 %
- Total regeneration harvest per decade in MP 35 must be < 7 %
- Total regeneration harvest per decade in MP 41 must be >= 8 % and <= 15 %
- Total Harvest per decade in MP 61 must be <= 10 % of the MP 61 land area.
- Total Harvest per decade in MP 62 must be <= 20 % of the MP 62 land area.
- Total regeneration harvest per decade in MP 61 must be >= 3 % and <= 5 %
- Total regeneration harvest per decade in MP 62 must be >= 5 % and <= 10 %

An estimated budget constraint showed affects on the overall timber program given different levels of program costs. Each alternative ran without budget constraints. Then total dollars are constrained to $ 6.0 Million (MM), 5.5 MM, 5.0 MM, 4.2 MM (FY 2004 budget), 4.0 MM, 3.8 MM and 3.5 MM.

Program Costs and Stumpage Revenues

Stumpage prices (Table 7) for sawtimber came from the October-December 2003 Timber Harvest report from the Missouri Department of Conservation. Pulp prices we averaged for the 2nd quarter sale on National Forest Lands. Other costs use current FY 2004 prices.

Table 7 - SPECTRUM Revenues per MCF

Product	Revenue per MCF[1]
Hardwood Pulp	80.00
Hardwood Sawtimber	900.00
Pine Pulp	50.00
Pine Sawtimber	780.00

1 Thousand Cubic feet

Table 8 - SPECTRUM Costs per MCF

Work	Cost per MCF
Temporary Roads	
UEAM	4.00
Ecosystem Management	2.50
Timber Medium Level	1.75
Timber Minimum Level	1.00
No Harvest	0.50
System Road Work	18.93
Timber Sale Costs (NEPA to Close)	
UEAM	445.00
EAM Regeneration	270.00
EAM Thinning	392.00

Table 9 – SPECTRUM Costs per Acre

Work	Cost per Acre
Regeneration Work	80.00
Non-Commercial Tree Felling	595.00

Future costs and revenues are discounted at a rate of 4% per year to convert future values to present day dollars. Tables B7 and B8 show the current costs associated with conducting timber sales on the Forest, less overhead and cost pools.

Benchmarks

Benchmark analysis is specified in the NFMA regulations in 36 CFR 219.12(e) as part of the Analysis of the Management Situation. Selection of which benchmarks to develop is dependent upon revision topics. Benchmarks estimate the Forest's physical, biological, and technical capabilities to produce goods and services and assist in defining the range within which alternatives can be constructed. Benchmarks do not constitute alternatives because alternatives are designed to consider integrated management of all resources.

Seven benchmarks are relevant to the timber revision topic. They are:

1. Maximizing present net value of the timber program – no harvest constraints
2. Maximizing timber production in the first decade – no harvest constraints

3. Maximizing present net value of the timber program – with Non-Declining Yield harvest constraint
4. Maximizing timber production in the first decade – with Non-Declining Yield (NDY) harvest constraint
5. Maximizing present net value of the timber program – with NDY and LTSY harvest constraints
6. Maximizing timber production in the first decade – with NDY and LTSY harvest constraints
7. Minimizing costs of the timber program

Tentatively suited land base had benchmark scenarios applied to show the "maximum biological capability" of the Forest's timber resource. Suited timber base of 996,710 acres had the same scenarios applied. Comparisons, shown in Figure 5, show differences or "trade offs" of implementing constraints to meet minimum regulatory requirements as set in Forest Service direction. These constraints are coarse assumptions applied to maintain habitat for some Threatened, Endangered and Sensitive (TES) species, clean water requirements, etc.

Analysis on tentatively suited lands shows the effect of implementing the NFMA constraint of Non-Declining Yields. It creates a drop of 379 MMBF or 66 % reduction in the first decade outputs. Analysis shows that the Max PNV and ASQ may be possible, though not sustainable. What occurs is a massive "cut off" in the first 2 decades and then no harvesting for several decades. This is due in part to the Forest's age class distribution (Figure 3) and to economic considerations. The effect of adding the Long Term Sustained Yield constraint creates a further reduction of 13 MMBF or 7 %, but resulting yields for each decade are very similar to the first decade. Eliminating these large swings in decade outputs is the main reason for the required NFMA constraints.

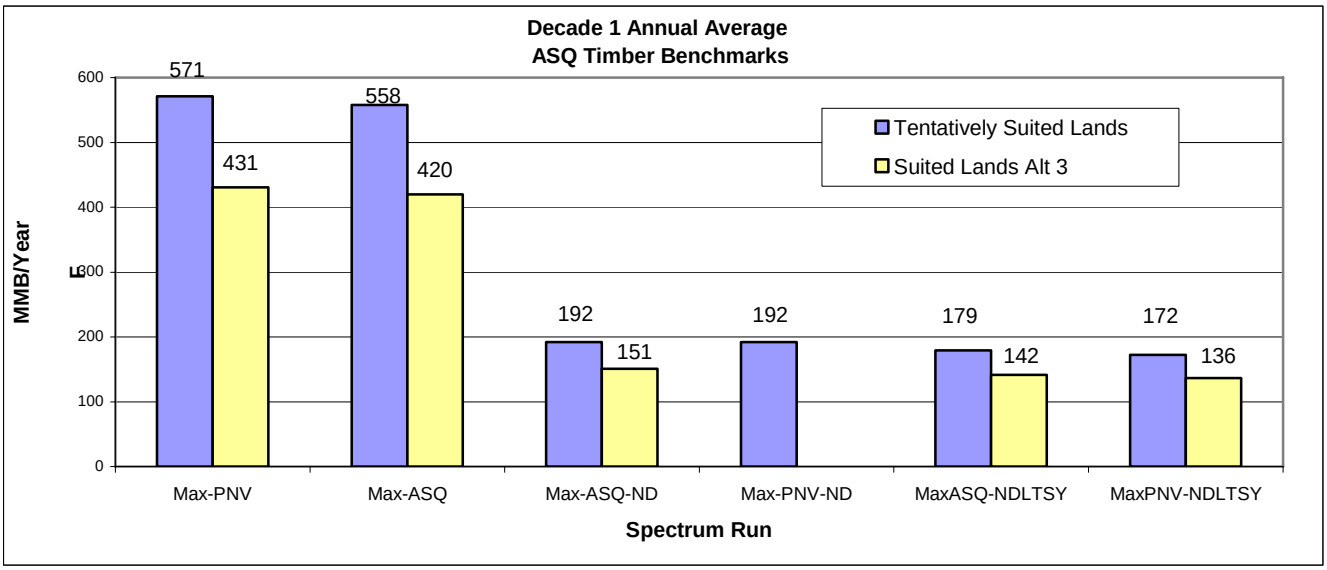
Analysis of the suited timber base show similar results as for the tentatively suited base. When applying the NFMA constraints, outputs for MaxASQ-NDLTSY are reduced 37 MMBF or 21 %

Maximizing the Present Net Value (PNV) produces negative numbers in all but one case – MaxASQ-ND.

The minimum level benchmark for timber would show no commercial timber production or an ASQ of zero. The PNV for timber is zero, since there would be no costs incurred (for timber) and no revenues generated.

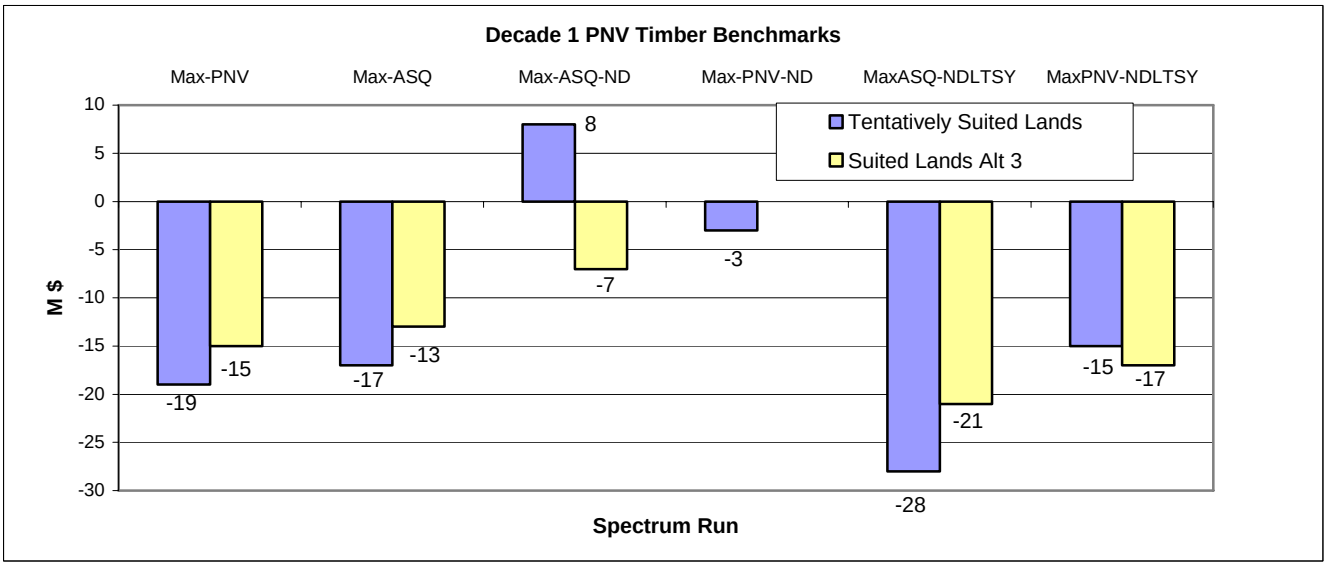
Figures 5, 6, 7 show allowable sale quantity (ASQ), present net value (PNV) and long-term sustained yield (LTSY) of all benchmarks. All PNV calculations share a common annual discount rate of 4% per year (Row, C. et al., 1981).

Figure 5 - First Decade Benchmark Comparison, Annual Average Allowable Sale Quantity



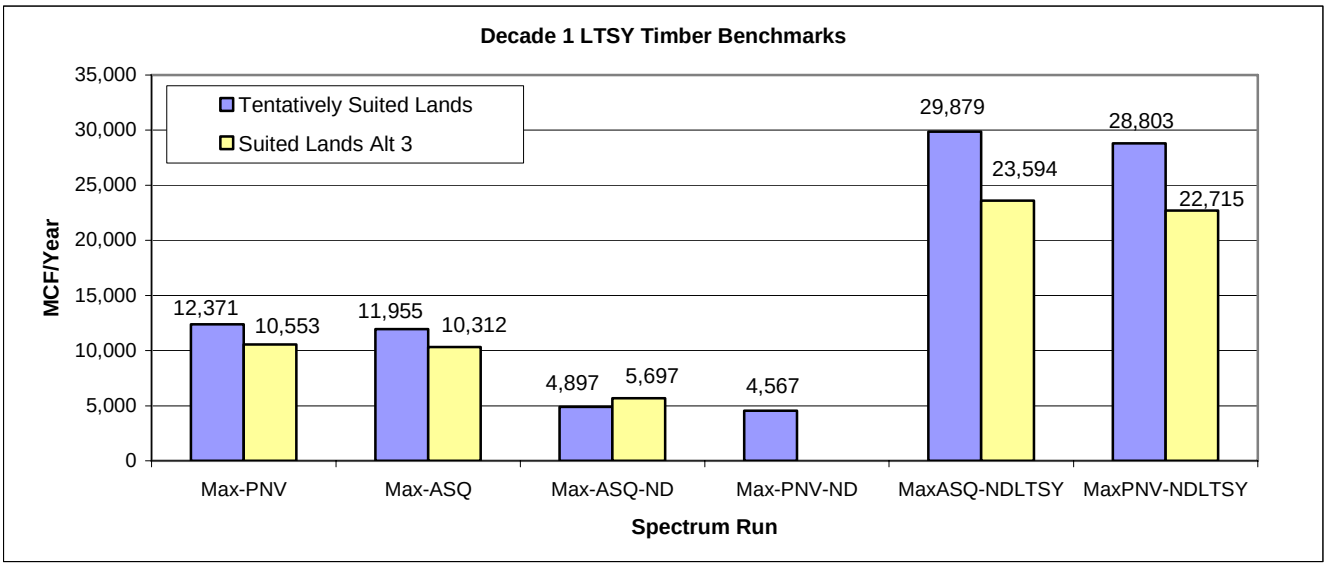
PNV = Present Net Value; ASQ = Allowable Sale Quantity; ND = Non-Declining Yield; LTSY = Long Term Sustained Yield

Figure 6 - First Decade Benchmark Comparison, Present Net Value



PNV = Present Net Value; ASQ = Allowable Sale Quantity; ND = Non-Declining Yield; LTSY = Long Term Sustained Yield

Figure 7 - First Decade Benchmark Comparison, Long Term Sustained Yield



PNV = Present Net Value; ASQ = Allowable Sale Quantity; ND = Non-Declining Yield; LTSY = Long Term Sustained Yield

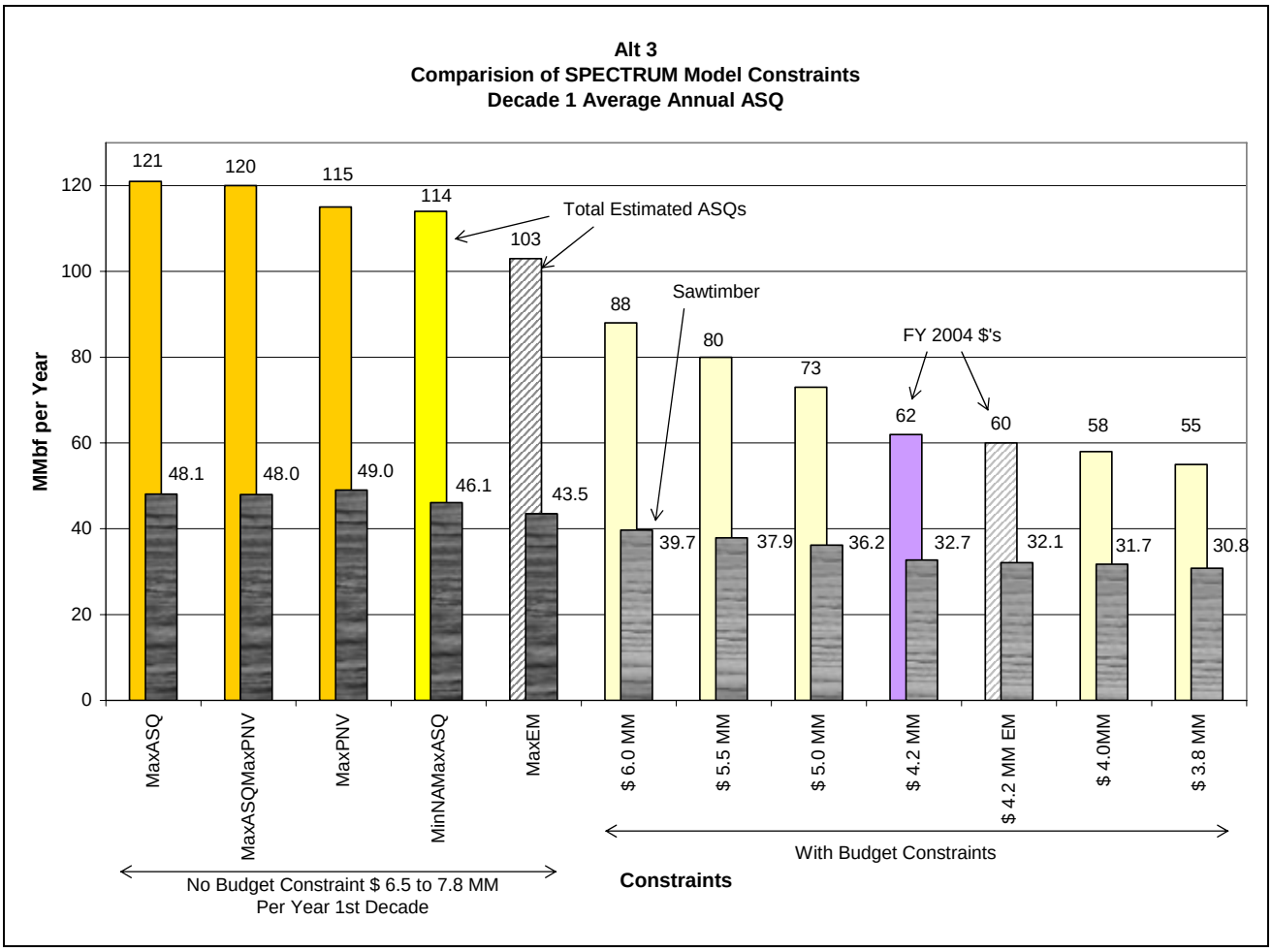
Results of Alternative Modeling

Five of the benchmark scenarios were used to model Alternatives 2 through 5 as a check of both the model and benchmark assumptions. Results and trends were similar to the first benchmark runs. Next, all Plan constraints were applied to the models and five scenarios run. Scenario 5 is the most representative of the intent of the 2005 Forest Plan; ASQ is set from this.

1. Max ASQ = Maximize Allowable Sale Quantity
2. Max ASQ Rollover to Max PVN = Maximize ASQ then use as a constraint to Maximize PNV
3. Max PNV = Maximize Present Net Value
4. MinNA Rollover to Max ASQ = Minimize No Action then use as a constraint to Maximize ASQ
5. Max EM = Maximize Ecosystem Management work

Seven budget constraining scenarios were run to test the effect or limits of budget, which compares to a current budget of $ 4.2 million dollars for Fiscal Year 2004. Figure 8 shows results for Alternative 3. The chart compares the total ASQ verses the sawtimber portion of the ASQ for each of the model runs. Results and trends for the other alternatives are very similar to Alternative 3.

Figure 8 - Comparison of Effects of SPECTRUM Modeling Constraints on Average Annual ASQ



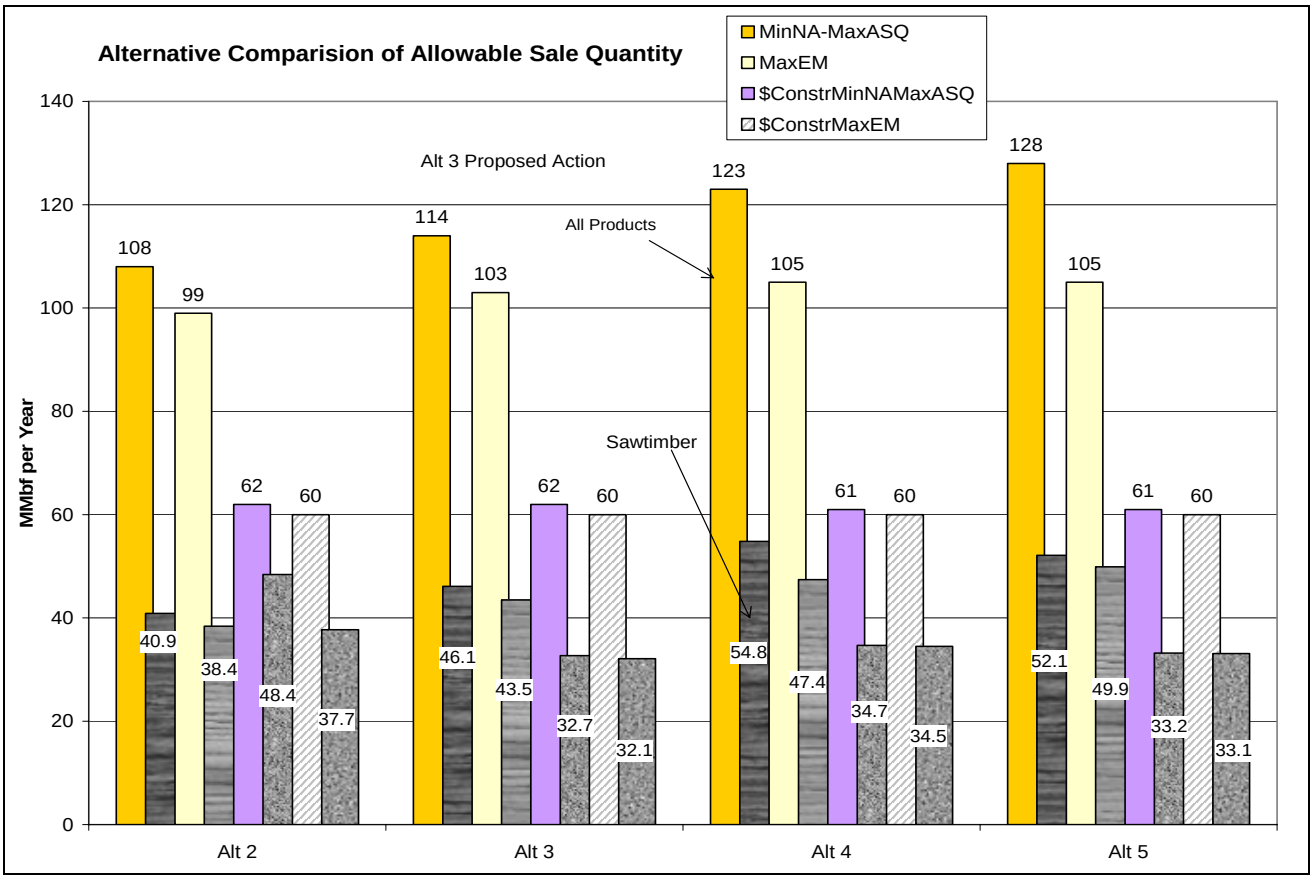
Analysis Results (See Table 10 and Figure 9):

- Alternative 1 is shown only for a comparison of what would be cut and left in the woods and the costs of implementation.
- Sawtimber volume in each alternative is less than 50 % of the ASQ
- Minimize No Action-Max ASQ costs $400, 000 to $750,000 over the cost of Max Ecosystem Management scenario in Alternatives 2-5.
- As budgets increase, ASQ increases, but the volume increase is 80% pulp, and program efficiency/ PNV goes down.
- The most cost efficient scenarios also have the most “No Action” acres selected.
- All alternatives become un-solvable when the budget drops below $ 3.0 Million/year.
- Under a constrained budget similar to FY2004, Alternatives 2-5 are virtually equal in ASQ; less than 6 MMBF difference.
- Alternative 4 has the “most efficient” timber program based on a timber program PNV analysis.
- Alternative 1 is the “most inefficient” as it pays to cut timber and leave it in the woods and does not show any revenue.

Table 10 – SPECTRUM Analysis Results

Alt 1 Volume Cut and Left	Budget Assumptions	Alt 2	Alt 3	Alt 4	Alt 5
	Unconstrained Budget				
24 MMBF	ASQ –Total (MMBF/Year)	99	103	105	105
	Sawtimber (MMBF/Year)	38.4	43.5	47.4	49.9
	Sawtimber % of ASQ	39%	42%	45%	48%
17 to 18	Budget Needs (MM$ Dollars/Year)	6.3 to 7.3	6.5 to 7.8	6.6 to 8.0	6.5 to 8.3
	Constrained Budget of $ 4.2 MM				
	ASQ Total (MMBF/Year)	62	62	61	61
	Sawtimber (MMBF/Year)	48.4	32.7	34.7	33.2
	Sawtimber % of ASQ	78 %	52%	56%	54%
	Timber PNV Range				
	Unconstrained Budget (M $/Decade)	0 to 1	0 to 2	0 to 2	-4 to 4
	Constrained Budget (M $/Decade)	0 to 3	5	6	5

Figure 9 - Alternative Comparisons



Social and Economic Resiliency Analysis

The purpose of this portion of Appendix B is to provide interested readers with additional details regarding the social and economic analyses of alternatives for management in the 2005 Forest Plan. This section will not provide sufficient information to replicate the analysis. For that level of detail, consult specialist reports contained in the administrative record-.

Economic sustainability was a significant issue in the Forest Plan revision and economic analysis is required to make informed decisions. Data used to display economic effects throughout the FEIS process were considered reliable or adjusted based on updates to data sources considered to be the most reliable at the time this analysis was completed.

36 CFR 219.12(g)(1) requires an analysis of expected outputs during the planning period. It suggests use of outputs, which include marketable goods and services as well as non-market items, such as recreation, and wilderness use, wildlife and fish, protection and enhancement of soil, water, and air, and preservation of aesthetic and heritage resource values. Based on these resources, the EIS set out to show a present net value (PNV) as required by 36 CFR 219.

A large number of rules and regulations designed to lessen negative impacts or otherwise protect resources govern Forest Service activities. In the planning process, benefits associated with regulations are seldom put in terms of dollars. The costs of achieving these benefits are increased operating costs and could result in reduced revenues.

The Forest has discussed only the foreseen environmental consequences of the proposed land management alternatives in the Final EIS. For resources that can be reasonably valued via market data (e.g. timber, minerals), and for those non-market resources that have estimated values based on Forest Service research, we have presented a present net value calculation. Resources that have no values such as wilderness use or heritage resources the value was estimated by generally accepted methods, and are discussed in assessing net public benefits.

During the revision process we specified dollar values of all market and non-market benefits in an accepted manner, as well as direct cost and revenues that could occur under a specific alternative. This was done to provide as much comparative information as possible to aid in making an informed decision among the alternatives.

Many “ecosystem services “ provided by forested land, such as flood control, purification of water, recycling of nutrients and wastes, production of soils, carbon sequestering, pollination, and natural control of pests are not given monetary values. Use of option values and existence values are not items suggested to be discussed under 36 CFR 219. These are highly controversial methodologies, which can be of a contentious nature with many publics. The Forest Service has chosen not to use values based on questionable and controversial methodologies and values not specifically required by agency directives. Externalized costs of resource extraction, such as increased rates of death, injury and property damage resulting from accidents involving heavy equipment, log trucks, ATVs and other dangers related to intensive resource use and development, are effects remote from resource management on the forest. Their unforeseen nature does not warrant a consideration in the efficiency analysis by 36 CFR 219.

The Forest Service does not use its social and economic analysis’ quantified measures and indexes as the only way of showing alternative impacts (FSM 1970.8(5)). These numbers are only one piece of information for the decision maker to use in making a selection among alternatives. Other resources biological or physical that are impacted are compared in a qualitative manner by comparing the environmental effects of each alternative. These effects

of forest land management are discussed along with financial outputs in arriving at an alternative that maximizes net public benefits. After comparing the effects of all alternatives and comments from public participation, a determination of the alternative which best maximizes public net benefits, is left to the judgment of the decision maker.

Forest Economic Impact Area

Due to the complex economic interactions between individuals, firms, and governments, no impact area can accurately represent the economic impact. An impact area includes a set of decisions that offer the best answers to questions that publics, decision-makers, and economists ask. Relevant questions for describing impact areas for forest planning include considerations for functional economies, state and local planning regions , Forest Service expenditures, and other factors.

Impact areas are defined using historic and anticipated effects of National Forest management in Missouri. However, there is no guarantee that they will provide the best fit for assessing future effects. Effects of future National Forest management should be monitored to see whether the criteria for impact area definition and their application are providing reliable and useful estimates of local economic impacts.

For recreation, timber and other impacts associated with Forest activities, we used the same 29-county impact area as was used for the 1986 Forest Plan. The counties are Barry, Bollinger, Butler, Carter, Christian, Crawford, Dent, Douglas, Howell, Iron, Laclede, Madison, Oregon, Ozark, Phelps, Pulaski, Reynolds, Ripley, Saint Francois, Sainte Genevieve, Shannon, Stone, Taney, Texas, Washington, Wayne, and Wright.

Even though the two counties that make up the Cedar Creek unit are not contiguous to the rest of the Forest, a decision was made to keep them in the economic impact area in order to have baseline data from the 1986 Plan. For the same reason, when analyzing the no-action alternative (the 1986 Forest Plan) data and analysis for comparison to other alternatives is already available.

Economic relationships generated within IMPLAN and timber data from Spectrum are used in the Forest Economic Analysis Spreadsheet Tool (FEAST) model. At the Forest-level the FEAST model analyzes impacts of each Forest Plan alternatives.

Broader, more diverse impact areas, such as the one mentioned previously, provide a truer picture of economic interactions within a regional economy. There is strong interest by local government units and others to look at the finest economic scale possible (e.g., the county level). However, this finer scale misrepresents interactions among many local areas and underestimates total impacts associated with the national forests. In addition, finer-scale impact areas require resource specialists to break down recreation and timber activities which are likely beyond the level of precision available in Forest Plan alternatives.

The Models

IMPLAN (Impact Analysis for Planning) is a software package for personal computers that uses the latest national input-output tables from the Bureau of Economic Analysis (BEA). Economic effects to local counties were estimated using an economic input-output model developed with IMPLAN Professional 2.0 The software was originally developed by the Forest Service and is now maintained by the Minnesota IMPLAN Group, Inc (MIG). Data used for the impact analysis was from secondary data for those counties considered to be in the Forest economic impact area. The assumption used in this modeling process was that the impact area comprised the counties within the Forests' designated boundaries. The data

source used in developing models for impact purposes was the most recent county data available from MIG (2000). County data is used in the model to develop one impact response coefficient for each resource or activity in the analysis area.

Input-output analysis gives estimates of employment and income whether an increase or decrease in final demand on certain sectors or industries within an economy. For Forest Service timber, for example, we have looked at the logging camps where timber is used in the first processing step in manufacturing. Impacts include all those industries initially impacted as well as those industries linked with supplies that support production, as well as, workers in those industries who spend wages (known as direct, indirect and induces effects, respectively). Thus, the impact assumes a new demand is made on the economy and estimates what this new increase in final demand will mean in employment and income to that economy. Input-output modeling is an efficiency analysis, which tells how income and jobs are distributed throughout and economy for a given economic impact. Input-output modeling has nothing to do with benefit-cost, which is an efficiency analysis that estimates how efficiently monies are spent on investment activities.

Someone who is unfamiliar with IMPLAN cannot readily perform input-output analysis with it. A detailed explanation of every step in building the model and i resource activity is not included in this appendix.

Important assumptions have been documented in the FEAST electronic spreadsheet, which links IMPLAN response coefficients with resource outputs, as part of the Process Records. Data sources have been described in the EIS.

Economic relationships generated within IMPLAN have been extracted and used in the Forest Economic Analysis Spreadsheet Tool (FEAST) models. The FEAST/IMPLAN information has traditionally been the professionally accepted means of analyzing effects of Forest Plan alternatives. It provides for an area-wide view of relative differences in employment, income and revenue. This model and spreadsheet analyze only the first decade of the planning horizon. The IMPLAN model, utilizing FEAST, helped analyze the economic variation of forest management based on each alternative's proposed management emphasis. The Present Net Value (PNV) analysis provided from IMPLAN estimates PNV over the 100 year planning horizon.

Information used in IMPLAN is specific to Missouri from the year 2000, as later data are NAICS* based and the FEAST model uses SIC† data. Employment and income data was derived from the US Department of Commerce, Bureau of Economic Analysis (BEA) regional economic projections from 2000. Cross tabulations of personal income by major source of earnings by industry, and total full and part time recreation employment by industry projections were included.

Definitions of terms used in the IMPLAN model followed those provided by the BEA and are standards in economic reporting. The "agricultural sector" includes agriculture, forestry, and fishing as a classification of economic data provided by the BEA and Census Bureau.

Basic assumptions of IMPLAN do not include restructuring the economy, nor does it predict the specific future of industry related to the opening or closing of businesses. IMPLAN estimates jobs and income related only to National Forest resources and subsequent changes in proposed management of those resources.

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* *North American Industry Classification System*

† *Standard Industrial Classifications*

IMPLAN does analyze direct, indirect and induced effects by sector based on timber volume by product, and specific measurable recreation, wildlife, fisheries and mineral related resources values.

Data Sources

The IMPLAN model for the forest economic impact area was used to determine total effects of dollar, employment, and income changes in selected industry sectors. Because input-output models are linear, multipliers or response coefficients are calculated once per model and applied to the direct change in final demand. A Forest Service-developed spreadsheet known as "FEAST" (Forest Economic Analysis Spreadsheet Tool) imported IMPLAN impact results, or response coefficients, to each alternative, expressed in units of output. FEAST transforms the dollar impact for a given industry from IMPLAN to resource output units, obtained from SPECTRUM this is the name of the model, not an acronym model (e.g. ccf for timber) or other sources such as NVUM‡ for recreation and wildlife use. Multiplication of resource outputs and the IMPLAN response coefficients within FEAST yields a specific employment and dollar output for each resource or activity. Specifications for developing IMPLAN response coefficients and levels of dollar activity are stated below.

Timber

Sales Data

Sales data was determined by using timber values multiplied by estimated production levels for each alternative.

Use of the Model

Hardwood and softwood sawtimber were processed through the sawmill industry. In the absence of a pulp mill in the local economy, we assumed round wood is exported out of the analysis area. Impacts represent the economic activity occurring in all backward linking sectors associated with the final demand output of the timber industries described above.

IMPLAN showed, that for every $1 million of total timber production in the forest impact area, a given level of dollar value of logs going into the mill result in this impact. Some output may be exported and generate new money for the local economy.

Other Recreation and Wildlife/Fish

Expenditure Data

Recreation, wildlife, and hunting trips were derived from the National Visitor Use and Monitoring survey, (NVUM 2002) done for one-quarter of national forests each year. These results were entered into FEAST to link with IMPLAN impact response coefficients to yield an impact for recreation and wildlife resources.

Federal Expenditures and Employment

Expenditure Data

A Forest budget was estimated for each alternative, and these estimates were used for forest expenditures, some of which have local economic effects. Total Forest obligations by budget object code for FY 2002 were obtained from the National Finance Center and used to identify

‡ *National Visitor Use Monitoring*

expenditures. The proportion of funds spent by program area varied by alternative. The Forest staff examined historical Forest Service obligations to estimate Forest Service employment.

Use of the Model

To obtain an estimate of total impacts from the Mark Twain National Forest spending, salary and non-salary portions of these impacts were handled separately. Non-salary expenditures were determined by using the budget object code information noted above. This profile was run through the model for non-salary expenditures per one million dollars, and the results multiplied by total Forest non-salary expenditures. FEAST was used to make calculations. Local sales to the federal government are treated in the same manner as exports. Salary impacts result from Forest employees spending a portion of their salaries locally.

County Revenue via Payments to States

There are three payments or revenue sources provided to counties via payments to States from the Federal government that are based on the amount of National Forest System land within the county. These payments are a source of revenue for counties and local school districts, and are meant to offset the loss of potential land, goods, and services related tax revenue.

Twenty-five Percent Fund Payment

The first county payment or revenue is the 25 percent fund payment. The 25 percent fund payment is based on gross National Forest receipts within a National Forest, and is allocated to counties by the proportion of total National Forest acreage within each. For example, if a National Forest had $1,000,000 in gross receipts, and County A included 20 percent of National Forest acreage, County B, 50 percent, and County C, 30 percent; then $250,000 (25 percent of gross receipts) would be split $50,000 to County A, $125,000 to County B, and $75,000 to County C.

The Secure Rural Schools and Community Self-Determination Act of 2000 (SRSCS)

The Secure Rural Schools and Community Self-Determination Act of 2000 (SRSCS) signed in October 2000, became a new option to counties to replace the 25 percent fund. It is designed to stabilize annual payments to States and counties over five years, beginning in 2001. The new formula for computing annual payments is based on averaging a State's three highest payments between 1986 and through 1999 to arrive at a compensation allotment or "full payment amount".

Counties could choose to continue to receive payments under the 25 percent fund or to receive the county's proportionate share of the State's full payment amount under SRSCS. All but one county (Boone) within the Mark Twain National Forest are receiving payments under the SRSCS Act, therefore payments to these counties will not be affected by changes in the 2005 Forest Plan. Therefore, this analysis will not address "payments to counties" as a stand-alone indicator.

Payment in Lieu of Taxes (PILT)

Payment in Lieu of Taxes (PILT) is another federal payment to counties. It is based on the number of federal entitlement acres within a county, with adjustments based on the population of the county; a schedule of maximum and minimum per acre payments, which are adjusted annually by the Consumer Price Index; decreased by the previous year's other federal payments, including 25 percent fund payments; and the amount actually appropriated by Congress. Because of this the PILT fluctuates year to year. In recent years, Congress has appropriated approximately one-half to two-thirds of a full PILT payment would be. It is not

possible to predict PILT payments because the major factor in determining financial allocation is Congressional appropriation.

Financial and Economic Efficiency Analysis

Financial efficiency is defined as how well the dollars invested in each alternative produce revenues to the agency. Economic efficiency is defined as how well the dollars invested in each alternative produce benefits to society. Present Net Value (PNV) is used as an indicator of financial and economic efficiency.

The Mark Twain National Forest used a Microsoft Office Excel electronic spreadsheet to calculate PNV for each alternative over a 50-year period. A 4 percent real discount rate, prescribed by Forest Service Handbook (FSH) 1909.17, was used. Decadal and 50 year cumulative present values for program benefits and costs as well as present net values are the product of this spreadsheet. For each decade, an average annual resource value was estimated, multiplied by 10 years, and discounted from the mid-point of each decade.

Financial values for timber came from average 2002 stumpage prices and prices for recreation and wildlife came from RPA, updated to 2004 dollars and transformed to NVUM unit measurements. All values are in 2004 constant dollars. For recreation and wildlife values, a spreadsheet was used to convert from RVDs to “Visits.”

Limitations on Minerals Market Analysis

A number of factors go into analyzing mineral commodity markets. Most operations go through three very costly phases: exploration, development and production. Once discovered, further activity and expense must occur to determine if the deposit is valuable and can be successfully recovered at a reasonable profit. Ore is considered an economically valuable deposit. Value of the mineral commodity and its future anticipated demand are two factors used to evaluate potential for exploration, development, or continued production of a given mined material. However, this is further complicated by a variety of less stable or predictable factors: Discovery of a new mineral source, a decrease in demand, and political instability in critical mineral-producing countries all have direct effects on market value and feasibility of successfully producing a given mineral.

A small fluctuation in price for a mineral commodity, such as a change of 15 cents per pound in the price of lead, as has occurred since 1978, can quickly translate into millions of dollars of gain or loss for the lead industry in Missouri (OOHA 1999).

The introduction of a mineral commodity subsidized by another government often results in an artificially undervalued and under-priced product.

Looking at the last 15 years of revenue, there are seem to be cycles, with the last year reported at an all time low, though exploration and development of lead resources is expected to continue as long as there is a demand for these ores and it is profitable.

Table 11 - Revenue from Lead Leases, Percent of Forest Revenue, and 25 Percent Distribution to Counties, 1988 - 2001

FY	Total Revenue from Lead Leases ($)	Percent of Forest Revenue	25 % Distribution to Counties
1988	6,208,913	73	1,552,228
1989	7,438,174	71	1,859,543
1990	7,314,062	71	1,828,515
1991	5,312,950	66	1,328,237
1992	2,571,270	47	642,817
1993	2,276,734	41	569,183
1994	2,527,117	34	631,779
1995	4,150,597	47	1,037,649
1996	4,955,000	50	1,238,750
1997	5,226,631	53	1,306,657
1998	3,561,499	42	890,374
1999	4,405,516	48	1,101,379
2000	3,631,000	55	907,750
2001	3,089,439	39	600,000
2002	2,750,132	*	790,847
2003	1,822,585	*	331,638

Source: USDA Forest Service, Mark Twain National Forest, 1988–2001, Annual Report; USDI Bureau of Land Management, 2001 - 2003.

** no longer reported by Forest in Annual Report*

Historically, world demand for lead and zinc has increased 2–3 percent per year; however, in 2002, demand remained about the same as in previous years. The transportation industry is the principal consumer of lead with 76 percent used for batteries, fuel tanks, solder seals, bearings, and wheel weights. The remaining lead uses are for electronics, communications (including batteries), ammunition, television glass, protective coatings, ceramics, crystal glass, foil, wire, and specialized chemicals. With the continued industrialization, it is anticipated that demand will continue to increase. However, a continued decrease in value may inhibit traditional increases in demand. In addition, increased recycling of existing lead products will also influence the demand for mining.

For these reasons the minerals program is not included in the IMPLAN and FEAST model as a constant due to lack of decadal data and the volatility of lead prices.