Appendix B

Description of the Analysis Process

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Table of Contents

List of Tables

List of Figures

APPENDIX B Description of the Analysis

Introduction

Appendix B describes the analysis processes used in the development of the Final Environmental Impact Statement (FEIS). The appendix consists of the following major sections:

- A discussion of the analysis of land tentatively suitable for timber production.
- A description of how the land area of the forest was stratified into various forest types and yields for vegetation and timber characteristics were estimated.
- A description of the SPECTRUM decision support model, including a discussion of constraints applied to the model and some results from the benchmark and alternative analyses.
- A description of the analysis of other resources, including estimation of trail mileages for all-terrain vehicles (ATVs) and off-highway motorcycles (OHMs), scenery integrity levels, and the disposition of management indicator species in the 1986 Forest Plan.
- A description of the economic efficiency analysis, including the calculations of present net value (PNV) with market and non-market values.
- An analysis of economic suitability that examines the discounted costs and revenues of the different silvicultural regimes modeled in SPECTRUM.
- Some added detail describing the processes used in the economic impact analysis contained in Chapter 3 of the FEIS.

Suitability for Timber Production

One of the decisions to be made during plan revision is an identification of lands considered suitable or not suitable for resource uses, such as timber production. The first step in identifying land suitable for timber production is to identify the forested and non-forested lands. The following categories of lands are then subtracted from the forested lands to determine those lands considered tentatively suitable for timber production: (1) forested lands withdrawn from timber production by Congress, the Secretary of Agriculture, or the Chief of the Forest Service; (2) forested lands not capable of producing industrial wood; (3) forested lands that cannot be regenerated with new trees within 5 years; (4) forested lands where technology is not available to ensure timber production without irreversible resource damage to soils productivity or watershed conditions; and (5) forested lands for which there is insufficient information to make a determination. These categories are summarized in Table B-1. Forested lands cover 442,672 acres on the ANF. A total of 34,423 acres have been withdrawn, with 408,249 remaining as available for timber production. Of the land available for timber production, 19,962 acres are not suitable for timber production based on categories 2 through 5 listed above, resulting in a total of 388,287 acres tentatively suitable for timber production.

Table B-1. Timber land suitability classes

Category	Sub-category	Acres
Total ANF Land		516,843
Water	Water	11,169
Non-forested Land	Shrub or Grass Openings	16,056
	Developed for Other Uses	26,135
Total Non-forested Land		53,360
Total Forested Land		463,483
Forested Land Withdrawn from Timber Production	Hickory Creek and Allegheny Island Wilderness (MA 5.1)	8,641
	Allegheny National Recreation Area (MAs 6.4 and 8.2)	20,192
	Tionesta Scenic Area (MAs 8.0 and 8.3)	1,894
	Tionesta Research Natural Area (MAs 8.0 and 8.5)	2,080
	Hearts Content Scenic Area (MAs 8.0 and 8.3)	107
	Kane Experimental Forest (MAs 8.0 and 8.6)	1,622
Total Forested Land Withdrawn		34,536
Forested Land Available		428,947
Forest Landed Not Capable of Producing Crops of Industrial Wood	n/a	0
Forested Land Physically Not Suitable	Irreversible damage likely to occur	0
	Not restockable within 5 years	20,520
Forested Land Inadequate Information	n/a	0
Forested Land Not Physically Suitable		20,520
Tentatively Suitable Forested Land		408,427

The following is a more detailed breakdown of the unsuitable lands.

1. Water (11,169 acres)
    a. Water (includes the following)
        i. Allegheny Reservoir and Allegheny River.
        ii. Cartographic Feature Files Double line streams and rivers located within the ANF proclaimed boundary and surrounded by National Forest System (NFS) lands.
        iii. All water bodies (lakes, ponds other reservoirs) identified in the geographic information systems (GIS) coverage where the water body is surrounded by NFS lands.
2. Non-forested
    a. Non-forested (16,056 acres)
        i. Opening–this includes areas classified as forest type 99 (open) in the timber stand database.

ii. Upland brush–this includes areas classified as forest type 98 (upland shrub) in the timber stand database.

iii. Lowland brush–this includes areas classified as forest type 97 (lowland shrub) in the timber stand database.

iv. NLCD wetland–National Land Cover Dataset augmented existing information for large wetland inclusion.

v. NLCD opening–National Land Cover Dataset used in conjunction with the timber stand database to identify stands that were greater that 40 percent open.

vi. Islands–islands within the major two-line stream that were predominantly void of forest.

b. Developed Areas (26,135 acres)

i. Roads–road centerlines from the GIS coverage were buffered to estimate the area not forested to support the road right-of-way (ROW). The buffer distances varied according to road system type and road cartographic feature file (CFF) class. The forest engineer in charge of road management provided buffer widths for each road class. The following chart outlines the buffer distances used.

System Type	CFF/RDGEO* code	Width
Municipal	100	100
Forest System	FR262	100
Municipal	101	60
Municipal	102	60
Municipal	103	50
Forest System	FR454	50
Forest System	FR492	50
Municipal	105	45
Forest System	518	35
Forest System	515	30
Forest System	517	30
Forest System	519	30
Unknown Non-system	105	30
Unknown Non-system	106	30
Unknown Non-system	107	20

* RDGEO indicates the identifier for each road in the GIS travel_route layer.

ii. Utility Corridors–utility corridors were identified using Digital Orthophoto Quads (DOQs) that combine the image characteristics of a photograph with the geometric qualities of a map. The DOQs used were at a 1-meter ground resolution, quarter-quadrangle (3.75-minutes of latitude by 3.75-minutes of longitude) image. The utility locations were captured at a scale of approximately 1:6,000. Only corridors that created a measurable break in forest canopy were digitized at this scale.

iii. Oil, gas and mineral (OGM) development–oil and gas roads located on NFS lands were included in the road portion of the developed area analysis. Items included in this portion are the following:

1. OGM well sites–the well locations were buffered to occupy approximately 0.25 acres per well site.
2. Tank farms–tank farms located on NFS lands were included if they where not already included as openings in the non-forest coverage. Areas were digitized from DOQs.
3. Warehouse and equipment storage sites–OGM warehouse and equipment storage areas were digitized if they were not already included in the non-forested coverage from above. Source for the digitizing is the 1 meter DOQs.

iv. Developed recreation and administrative sites–developed recreation sites and administrative sites, such as recreation sites, trailheads, overlooks, campgrounds, offices, and other points of interest on the Allegheny National Forest (ANF), were obtained from the GIS coverage. This category also includes the 5 Recreational Residence areas (Camp Run, Camp Nine, Hoffman Farm, Seldom Seen A and Seldom Seen B), Camp Olmstead Boy Scout site, and Birdsall Eddy Girl Scout Camp. Several additional non-recreational administrative sites, such as warehouse, sewage waste processing facility, and work sites, were digitized from DOQs.

v. Stone borrow pits–Data was obtained from digitized coverage of known borrow pits. DOQs were used as the source for digitizing the polygons. Several known pits were either developed after the effective date of the DOQs or were too small to locate on these photos. For these areas an average size of 2 acres is used.

3. Forested Lands Physically Not Suitable (20,520 acres)
   a. Irreversible Damage Likely to Occur
      i. Steep Slopes–Areas with slopes greater the 40 percent. The steep slope sites were located by using 10 meter digital elevation model (DEMs). Areas with calculated percent slope greater that 40 were classified as areas where irreversible damage may occur.
   b. Regeneration Difficulty
      i. Low stocked with site limits–Sites that were identified as low stocking during the previous planning cycle and continue to be low stocking were selected from TM stand database. In addition, a spatial relationship was conducted between these areas and the areas where soils were classified as having severe equipment limitation as identified in Use and Management of Soils in the county soil survey. Soils listed as having severe equipment limitation are: Armagh, Atkins, Brinkerton, Cavode, Cookport, Gilpin, Hartleton, Hazelton, Leck Kill, Nolo, Palms Muck, Rexford, and Wayland. These areas were tagged as low stocking with site limits.
      ii. Low stocked with no site limits–Sites that were not identified as low stocking during the previous planning cycle and are now classified as low stocking were selected from the TM stand data base. These areas were tagged as low stocking with no site limits.
   c. Inadequate Information
      i. Moderately stocked with site limits–Sites that were identified as moderate stocked now and were also classed as being moderately stocked in the previous planning cycle were selected from TM stand data base. The spatial relationship was conducted between these areas and the areas where soils were classified as having severe equipment limitation. These areas were tagged as being moderately stocked with site limits.

The process is exclusionary. That is, once an acre of land is classified into one of the excluded classes, it is no longer carried forward. Therefore no acre of land is double counted in the unsuitable land base.

The second part of this process is to determine which lands are appropriate for scheduled timber production, based on management area designations and land use allocations that further refine land use. The alternatives provide a range of intensities across resource allocations. They were formulated to provide a diverse mix for analysis and review.

The table that follows does not show management area allocations. Total Forested Land Not Appropriate for Timber Production acreages are removed from the suitable timber base with each alternative.

Table B-2. Suitable Land for Timber Production

Category	Sub-category	Acres			
Tentatively Suitable Forested Land		**408,427**			
Forested Land Not Appropriate for Timber Production by Alternative [1]		**Alt. A**	**Alt. B**	**Alt. Cm**	**Alt. D**
Forested Land Not Appropriate for Timber Production	MA 5.2 Wilderness Study Areas	0	0	11,577	13,641
	MA 6.3 Buzzard Swamp Wildlife Management Area	479	479	479	479
	MA 7.1 Developed Recreation Areas	300	280	280	31
	MA 7.2 Remote Recreation Areas	0	4,310	8,417	27,493
	MA 7.3 Interpretive Recreation Area	0	3,077	0	0
	MA 8.1 Wild and Scenic River Corridor	0	5,662	5,662	5,640
	MA 8.4 Historic Area	172	172	172	172
	MA 8.6 Kane Experimental Forest Expansion	0	1,530	1,530	1,530
	MA 9.1 Managed with Minimal Investment	871	0	0	0
	Corridor along Wilderness, Remote, and Class A Wild Trout Streams [2]	0	1,255	1,255	1,255
Total Forested Land Not Appropriate for Timber Production		**1,822**	**16,765**	**29,372**	**50,241**
Unsuitable Forested Land		**110,238**	**125,181**	**137,788**	**158,657**
Total Suitable Forested Land (MAs 1.0, 2.1, 2.2, 3.0, and 6.1) [3]		**406,605**	**391,662**	**379,055**	**358,186**

[1] The acreages displayed do not include acreages previously removed as being non-forested, withdrawn, or physically not suitable for timber management. These acreages are the net increase by acreage in areas considered inappropriate for timber management.

[2] Includes the area within 200 feet of Wilderness Trout Streams, Remote Trout Streams, and Class A Wild Trout Streams as defined in the forestwide Soil and Water standards and guidelines.

[3] Suitable lands within these MAs are limited to those that have been identified as tentatively suitable for timber production (forested land that is not withdrawn, able to regenerate seedlings within 5 years of final harvest, will not result in irreversible resource damage to soil productivity or watershed conditions, and is cost efficient in meeting multiple use objectives).

Analysis Unit Mapping and Assigned Characteristics

The ANF is partitioned into areas of like vegetation called stands. Areas with no vegetative cover are also partitioned. The ANF maintains a tabular listing of these areas and their characteristics in a database called Combined Data System (CDS). The STAND table in this database lists stand characteristics. The ANF also maintains a GIS map coverage of the geographic locations of these stands. The analysis units used in the plan revision process are derived in part from these sources.

The stand characteristics in CDS are maintained over time by district personnel. As new field inventories are taken, vegetative treatments are applied, or other ground disturbing events occur, updates are made to the mapping and information assigned to each. This data becomes outdated in areas where a long time has passed since the last inventory or in areas of management inactivity. Updating this data is part of the actions taken in preparation for plan revision.

Updating Percent Stocking

There are additional acreages that lack either a current enough inventory to be useful or have had some significant event to warrant such inventory obsolete. As they grow, the interaction of living trees favors some and they get larger, while others can stagnate or die. Insects or diseases can also affect stand dynamics, causing reduced growth or increased mortality.

A measure of how tightly trees are packed into a stand, percent stocking, is an important characteristic used in the analysis of tree interactions. An update to percent stocking was applied where needed to account for both recent growth and mortality. All analysis units were assigned low, medium, high or all stocking. The all category was used in cases where stocking could not be determined or guaranteed.

Adjustments for Normal Growth

FIA plot data collected on the ANF was used to model the effects of normal growth on relative density. The new reference year (survey year) for these stands after adjustment is 2001. Using the most current data available at the time, growth effects on relative density were calculated by looking at differences in the 1979 and 1989 FIA measurements. These effects were modeled using Forest Type, Age and Initial Relative Density as predictive variables. Stand characteristic were updated by using a multi-variable equation model. Following are the criteria used to select stands for update:

- Areas outside of those with major mortality and a survey year prior to 1999.
- Within the major mortality areas, survey year prior to 1999 and a cut treatment has occurred since 1988.
- Within the major mortality areas, survey year prior to 1989 and where no cut treatment has occurred since 1988.

Adjustments for Mortality

Inventories collected on the ANF were used to model the effects of recent major mortality events on relative density. Inventories collected in 2003 expressly for this purpose and others collected since 1989 were evaluated to find paired surveys from the same stand. Paired surveys used for this modeling exercise were selected where one survey occurred before the mortality (1989 to 1995) and another after the mortality (1999 to 2003).

Growth and mortality effects on relative density were calculated and modeled using Forest Type, Age, Initial Relative Density, Total Basal Area and proportion of the stand in each of five landform classes (bottom, foot slope, shoulder slope, side slope and plateau top) as predictive variables. Stand characteristic were updated by using a multi-variable equation model. Stands selected for update were within the areas of major mortality, had not been surveyed since the mortality (prior to 1989) and had no cut treatment since 1988. The new reference year (survey year) for these stands after adjustment is 2001.

Filling in Special Management Areas

Prior to 2002, areas designated under the 1986 Forest Plan for special management had not been partitioned on a map into individual forest stands. There were few, if any, recent vegetative inventories taken in these areas. These areas are: the National Recreation Areas, Wilderness Areas, Tionesta Research Natural Area, Tionesta Scenic Area and Kane Experimental Forest.

In 2002 the National Recreation Areas and Wilderness were stratified using aerial photo interpretation, landform, aspect and satellite imagery. A subset of stands was then inventoried. Stands not inventoried were assigned stand level characteristic using the Most Similar Neighbor Program methodology[1].

Inventories collected by the Northern Research Station were obtained for the Tionesta Research Natural Area, Tionesta Scenic Area and Kane Experimental Forest. Stands not inventoried directly were assigned characteristics using photo interpretation and professional judgment.

Estimating Yields

One aspect of forest management planning involves forecasting vegetation development over time. The development of yield estimates for the ANF plan revision includes simulation models. The SPECTRUM decision support model utilizes these yield profiles. The SPECTRUM model allocates resources defined in the yield profiles to best address management issues.

Stored in files called Yield Tables, vegetation yield profiles often specify stand metrics, such as the number of trees per acre, stand basal area, average tree diameter and height, and merchantable volume. Classification variables taken from the yield tables describe forest health conditions and stand structure dynamics.

Modeling Software

Yield Table Development incorporates the use of The USDA Forest Service Forest Vegetation Simulator (FVS) suite of computer programs. The Forest Management Service Center located in Fort Collins, Colorado developed and maintains the FVS programs.

FVS requires plot and tree level data. Important variables include site species and site index for the plot, and tree species and diameter breast height (DBH) for the individual trees. Ten year intervals define the projected cycle length.

The FVS model contains modules for growing trees, predicting mortality, establishing regeneration, simulating damage reductions due to insects and disease, performing management activities, calculating tree volumes, and producing reports.

Yield tables relate time in decades and area in acres. These tables typically include timber volumes and stand condition values. Output values take the form of either averages or most common condition in the strata being analyzed at that point in time. Examples of the values used in this exercise are:

- Stratum Code
- Planning Decade
- Age
- Net Timber Volume per Acre

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[1] Crookston, Nicholas L.; Moeur, Melinda; Renner, David 2002. Users guide to the Most Similar Neighbor Imputation Program Version 2 Gen. Tech. Rep. RMRS-GTR-96. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 35 p.

- Basal Area per Acre
- Trees per Acre
- Average Diameter
- Average Canopy Cover
- Most Common Dominant Layer

The ANF worked directly with the Management Service Center to modify and calibrate the FVS Variant for the Northeastern United States, to more closely represent conditions and stand dynamics observed on the ANF. The following list contains species specific information that the ANF provided and the Service Center used in this effort:

- seedling height growth projections
- diameter growth projections
- diameter/height relationships
- site index curves
- relative shade tolerance
- species average bud widths

Data Sources

Forested stand inventories extracted from the ANF's Combined Data System (CDS) database make up the major source of tree measurement data used in the timber yield analysis. Northern Research Station publications and data sets, Forest Inventory and Analysis (FIA) data and Forest Health Monitoring (FHM) program data from the ANF provide a way to fill gaps in the information available from CDS. For example, an analysis of 168 Forest Health Monitoring plots on the ANF collected between 2000 and 2001 provides estimates of forestwide average Site Indexes by Forest Type Groups.

The collection and preparation of supplemental stand inventories for use in plan revision started as far back as 1998. A series of tree mortality events occurred across the ANF just prior to this time. A post mortality inventory project collected data on 5,655 acres spread across the ANF. Inventories focused on stands where inventories collected prior to the mortality provide comparison. An analysis of stands comparing conditions before and after mortality data provides a way to predict current conditions in other stands that have no recent surveys.

Few surveys existed for young stands on the ANF. An inventory, in 1999 and 2000, on 4,097 acres focused on stands between 10 and 40 years of age.

Several large blocks of the ANF totaling about 30,000 acres have not been inventoried within the last few decades. An inventory, in 2002, focus on these blocks by randomly selected stands totaling 6,531 acres. These areas are: the National Recreation Areas and Wilderness Areas. Other surveys collected by the Forestry Science Laboratory provide an opportunity to characterize the Tionesta Research Natural and Scenic Areas. This project used the Most Similar Neighbor Program methodology to assign stand level characteristic to stands not inventoried.

During the period leading up to the Notice of Intent, data checks and corrections fixed missing values and errors in the data stored in the CDS database. Evaluation of stand inventories insured overall quality. This evaluation looked for missing critical information and illogical relationships between two or more items.

A separate electronic storage location, created in May of 2004, contains the data used for the plan revision analysis. This data derives from information copied from the ANF's production CDS database, operationally frozen-in-time. This information includes stand level characteristics for all stands identified on the ANF and any associated stand level inventories.

Population Stratification

Stratification of stand inventories follows that used to classify all forested areas across the ANF. This approach allows yield results to be assigned to corresponding analysis area acres used in the SPECTRUM model. This stratification segments the population of inventories based on Forest Type, Age Class and Stocking Class. It does not use Suitability Class, Management Area or Riparian Class.

Forest Type Groups

A string of five characters makes up the Coding of each stratum. The first two characters of the strata's code indicate the forest type group. The forest type, calculated directly from a stand's tree list, determines the forest type group assignment. The table that follows lists the Forest Type Groups and their codes.

Table B-3. Forest Type Group Codes

Forest Type Group	YT-Code Characters 1 + 2
Allegheny Hardwood	AL
Aspen	AS
Conifer	CF
Hemlock	HM
Northern Hardwood	NR
Oak	OK
Upland Hardwood	UP

Age Groups

The third character of the strata's code indicates the assigned Age Group (in years). The Age Group includes a range of stand effective ages. The Northern Research Station in their SILVAH stand analysis system (Marquis et al. 1992) provides the methodology to calculated effective age. The calculation of a tree's effective age uses diameters from a stand's tree list and estimates the years for a tree to grow to its current diameter. The calculation of a stand's effective age is the average of the effective age of all trees in the stand. The table that follows lists the Age Groups and their codes.

Table B-4. Age Group Codes

Age Groups (Years)	Description	YT-Code Character 3
00-50	young to 3rd growth	Y
51-180	established to 2nd growth	E
181+	old to 1st growth	O

Stocking Groups

The fourth character of the strata's code indicates the assigned stocking group. Calculated directly from the stand's tree list, relative density provides an estimate of how close a stand is to an average maximum density (100 percent), regardless of tree size or species composition. SILVAH provides the methodology for calculating relative density. The table that follows lists the Stocking Groups and their codes.

Table B-5. Stocking Group Codes

Stocking Group	Description	YT-Code Character 4
00-16	Low	L
17-44	Low	L
45-60	Moderate	M
61-74	Moderate	M
75+	High	H

Stocking Stagnation Issues

The fifth character of the strata's code indicates a stand's Stocking Stagnation designation. This designation depends on whether a stand's low to moderate stocking is due to its location on unsuitable lands. The table that follows lists the Stocking Stagnation codes.

Table B-6. Stocking Stagnation Codes

Stocking Stagnation	Description	YT-Code Character 5
low to moderately stocked on unsuitable lands	Yes	Y
not the above	No	N

Tree List Selection

Selection of an inventory for use in yield table development depends on the initial strata assignment. The target of selecting 15 inventories randomly from within distinct 10-year age class groups promotes an even distribution of samples. Selection of all stands in an age group occurs if there are less than 15 inventories in that 10-year age class. Due to an unintended quirk in the program used to select stands, the selection resulted in 16 stands in some categories.

Yield Table Strata Collapse

The collapse of initial strata into larger populations reduces the number of strata to analyze. The symbol "+" replacing one or more characters of the final coding indicates more than one original sub-population being collapsed to make up the new strata. An "A" replacing a character of the final coding indicates all sub-populations are collapsed to make up the new strata. The table that follows documents how strata are collapsed.

Table B-7. Collapsed Strata Codes

Final YT Coding	Initial YT Coding	Forest Type Groups	Age Range	Stocking Range	Stagnation Values
No Change	ALEHN	AL	051_180	75+	N
No Change	ALELN	AL	051_180	00_44	N
No Change	ALYAN	AL	000_050	ALL	N
No Change	NRYAN	NR	000_050	ALL	N
No Change	OKYAN	OK	000_050	ALL	N
No Change	UPYAN	UP	000_050	ALL	N
++ELN	OKELN	NR, OK, UP	051_180	00_44	N
++ELN	NRELN	NR, OK, UP	051_180	00_44	N
++ELN	UPELN	NR, OK, UP	051_180	00_44	N
++ELY	ALELY	AL, NR, OK, UP	051_180	00_44	Y
++ELY	NRELY	AL, NR, OK, UP	051_180	00_44	Y
++ELY	OKELY	AL, NR, OK, UP	051_180	00_44	Y
++ELY	UPELY	AL, NR, OK, UP	051_180	00_44	Y
ASAAN	ASEHN	AS	ALL	ALL	N
ASAAN	ASELN	AS	ALL	ALL	N
ASAAN	ASEMN	AS	ALL	ALL	N
ASAAN	ASYAN	AS	ALL	ALL	N
CFAAN	CFEHN	CF	ALL	ALL	N
CFAAN	CFELN	CF	ALL	ALL	N
CFAAN	CFEMN	CF	ALL	ALL	N
CFAAN	CFYAN	CF	ALL	ALL	N
HMAAN	HMEHN	HM	ALL	ALL	N
HMAAN	HMELN	HM	ALL	ALL	N
HMAAN	HMEMN	HM	ALL	ALL	N
HMAAN	HMOHN	HM	ALL	ALL	N
HMAAN	HMYAN	HM	ALL	ALL	N
NR+HN	NREHN	NR	51+	75+	N
NR+HN	NROHN	NR	51+	75+	N

Final YT Coding	Initial YT Coding	Forest Type Groups	Age Range	Stocking Range	Stagnation Values
UP+HN	UPEHN	UP	51+	75+	N
UP+HN	UPOHN	UP	51+	75+	N
OKE+N	OKEHN	OK	051_180	45+	N
OKE+N	OKEMN	OK	051_180	45+	N
OKE+N	OKEMY	OK	051_180	45+	N
ALEMA	ALEMN	AL	051_180	45_74	ALL
ALEMA	ALEMY	AL	051_180	45_74	ALL
NREMA	NREMN	NR	051_180	45_74	ALL
NREMA	NREMY	NR	051_180	45_74	ALL
UPEMA	UPEMN	UP	051_180	45_74	ALL
UPEMA	UPEMY	UP	051_180	45_74	ALL

Controlling Stand Dynamics

In FVS simulations, software commands control interactions between trees. These commands adjust FVS outputs to reflect a range of stand conditions observed locally. The following list shows the factors incorporated into this modeling:

- Site Index and Site Species by Forest Type Group
- Maximum diameter and height by tree species
- Maximum basal area by Forest Type Group
- Diameter Distribution Control
- Mortality rates by diameter and species
- Ingrowth of small diameter trees by Forest Type Group
- Mortality and sprouting patterns expected from American beech trees responding to beech bark disease

Utilization, Product, and Value Class Assignments

The Eastern Region of the Forest Service uses the cubic foot as its official unit of measure for the volume of wood. A cubic foot constitutes a block of wood 12 by 12 inches on each side. Loading of volumes into SPECTRUM include only thousands of cubic feet (MCF).

Total net merchantable MCF of wood that exists at a given moment of time defines the standing inventory. Rates of defect used in the simulation come from those observed on ANF timber sales. During harvest, not all trees are cut; the total net MCF of wood for trees cut makes up the harvest volume.

The net merchantable MCF varies based on utilization standards. Utilization standards built into the simulations are simplified from the actual ANF standards.

The value class assignment for each species depends on several levels of classifications. The first level is commercial versus non-commercial. If commercial, then can the species produce pulpwood only, or produce both sawtimber and pulpwood?

The final classification assigns a value group. Value groups break down by historic bid prices. They differ by their averaged selling price over several years. Volume outputs are calculated by these categories and included in the yield tables.

Defects Assignments

An analysis of timber sale cruise tree measurements provide defect values by 5-inch diameter class. Cruise tree defects are measured by 8-foot log segments. A conversion of these defect measurements provides values in terms of whole tree defects.

Computed Variables

Canopy Cover

The assignment of habitat structural stages in SPECTRUM depends on the relationship of two dependant variables (canopy cover and dominant layer). Stand percent canopy cover relates the percentage of the ground area that is directly covered with tree crowns. Tree diameter provides a basis for estimating crown radius. Crown area calculations use the formula for a circle. In each model decade, for each simulated stand, canopy closure estimates are calculated for all trees and for five ranges of tree diameter. These calculations take into account the expected overlap of crowns in a forest canopy.

Calculated Canopy Covers characterize each stand. Canopy layers disaggregate into five inch diameter classes. Canopy cover is calculated for each layer. Each decade of a simulation has its own calculated average total and average per layer canopy cover for all stands modeled in that decade. The table that follows lists the tree diameter ranges for each layer.

Table B-8. Canopy Layer Tree Diameter Ranges

Layer	Minimum Diameter	Maximum Diameter
1	0	5
2	6	10
3	11	15
4	16	20
5	21	99

Dominant Layer

The assignment of habitat structural stage in SPECTRUM requires a second dependant variable called Dominant Layer. The Dominant Layer class assignment for each simulated stand, in each modeling decade, reflects the layer with the greatest canopy cover. Each decade of a simulation receives its designation based on the most common Dominant Layer observed for all stands modeled in a decade.

Prescription Design

Not all prescriptions proposed for use in an alternative considered as part of the plan revision process get modeled. Modeling selection include both even-aged (IH and RH) and uneven-aged prescriptions (R2). The following list shows the prescriptions simulated to develop yield tables:

- Measured Condition (MC)
- Natural Growth (NG)
- Regeneration Harvest (RH)
- Intermediate Harvest (IH) followed by regeneration

- Accelerate/Restore Understory Mature Forest Condition (R2)

The MC simulations include only one 10-year cycle. Their results provide estimates of existing stand conditions. The MC simulations, when compared against other local sources of information, confirm that FVS simulation outputs are reasonable. Comparison of differences provides adjustment factors used in the SPECTRUM model to modify yields.

The NG simulations include 15 10-year cycles. These simulations estimate stand growth but, unlike the rest of the simulations, do not include harvesting. These simulations calculate stand conditions over the entire planning horizon for stands with no cutting.

The RH, IH and R2 simulations also include 15 10-year cycles. Different management intensities for each prescription vary by the number of intermediate harvests (thinnings). The table that follows lists of the base simulations conducted.

Table B-9. Base Simulations

Rx Type	Silvicultural System	Thinnings	Applicable Forest Type Groups	Description
MC	n/a	0	All	Measured Condition
NG	n/a	0	All	Natural Growth
IH	Even-aged	1	AL,NR,OK,UP	Intermediate Harvest, Regeneration Harvests follow 1 thinning
IH	Even-aged	2	AL,HM,NR,OK,UP	Intermediate Harvest, Regeneration Harvests follow 2 thinnings
IH	Even-aged	4	CF	Intermediate Harvest, Regeneration Harvests follow 4 thinnings
RH	Even-aged	0	AL,NR,OK,UP	Regeneration Harvest, Regeneration Harvests with no thinning
R2	Uneven-aged	1	AL,NR,OK,UP	Restore Mature Character, Group Selection follow 1 thinning
R2	Uneven-aged	0	AL,NR,OK,UP	Restore Mature Character, Group Selection with no thinning

Variations on the base simulation differ by increasing the age at which treatments are implemented. Each variant changes the treatment age in increments of 10 years. These changes affect all commercial harvest treatments. The base simulation receives a timing option with the label 00. The subsequent timing option labels indicate the number of 10-year increments added to the base simulation ages. For example, timing option 02 adds 20 years to the age at which each treatment initiates. The table that follows lists Timing Options used by Prescription Type.

Table B-10. Timing Options by Prescription Type

Rx Type	Thinnings	Timing Options
MC	0	n/a
NG	0	n/a
IH	1	00, 01
IH	2	00, 01
IH	4	00, 01
RH	0	00, 03, 06, 09
R2	1	00, 01, 02, 03
R2	0	00, 01, 02, 03, 04

Setting various software command variables determines the harvest sequences within a simulation. The list that follows contains examples of these variables.

- Stand age after which a treatment may occur.
- Stand Density Index that indicated the need for a treatment.
- Target Stand Density Index as the result of a treatment.
- Maximum Stand Density Index reduction allowed through a treatment.
- Percent of the stand affected by the treatment.
- Retention or cutting preference for individual species during treatment.
- Species, amount and size of seedlings added after mortality or treatment.

Agency Direction Related to Culmination of Mean Annual Increment

The analysis of the NG simulation by strata indicates the age at which culmination of mean annual increment (CMAI) of growth is reached. For a tree or stand of trees, the average annual increment reaches its maximum at the CMAI. CMAI coincides precisely with the age at which the current annual increment equals the mean annual increment of the stand and thereby defines the rotation of a fully stocked stand that yields the maximum volume growth. Basing minimum rotation age on when volume production is equivalent to at least 95 percent of the CMAI meets current manual direction.

Forest Service Manual direction (FSM1921.17f) states:

> "NFMA requires that even-aged stands of trees scheduled for regeneration harvest during the planning period have generally reached culmination of mean annual increment of growth (16 U.S.C. 1604 (m)(1)). This requirement applies to regeneration harvest of even-aged stands on areas identified as generally suitable for timber harvest. The culmination of mean annual increment of growth requirement does not apply to:
>
> 1. Cutting for experimental or research purposes.
> 2. Non-regeneration harvests, such as thinning or other stand improvement measures.
> 3. Management of uneven-aged stands or to stands under uneven-aged silvicultural systems.
> 4. Salvage or sanitation harvesting of timber stands.

A plan must identify categories of activities that are exceptions to the culmination of mean annual increment if necessary to meet resource objectives, such as wildlife habitat enhancement, visual enhancement, or riparian area improvement. Exceptions to the culmination of mean annual increment requirement and the reasons for these exceptions must be specifically disclosed during the public collaboration and participation process when developing, amending, or revising plans."

Forest Service Handbook direction (FSH2409.13, 32.1) states:

"Rotation ages must meet the requirement that all even-aged stands scheduled for harvest generally will have reached the culmination of mean annual increment (CMAI) of growth. Permit the harvest of trees or stands before CMAI for:

1. Sound silvicultural practices, such as thinnings or other stand improvement measures.
2. Salvage or sanitation harvesting of stands substantially damaged by fire, windthrow, or other catastrophes, or stands that are in imminent danger from insect or disease attack.
3. Experimental and research purposes.
4. Removal of particular species of trees, after consideration of the multiple-use objectives of the forest plan alternative.

Base the determination of CMAI on the yield from regeneration harvest and any additional yields from intermediate harvests, consistent with the selected management prescription. In general, base minimum rotation age on the length of time required to achieve volume production equivalent to at least 95 percent of CMAI as expressed in cubic measure."

Generally, final even-aged regeneration occurs after the indicated minimum rotation age. CMAI requirements do not apply in some situations. Regenerating of low stocked stands returns suitable land to full stocking through salvage harvests. Regenerating aspen stands meets other Forest Plan objectives. Uneven-aged prescriptions have an explicit exemption. The table that follows summarizes the pattern of identified minimum rotation ages for each Forest Type Group for different strata and different harvest intensities.

Table B-11. Minimum Rotation Ages for Even-aged Prescriptions

Forest Type Group	Not Thinned		Thinned[1]	
	Age Group E	Age Group Y	Age Group E	Age Group Y
AL	60	60	70	80
AS[2]	n/a	n/a	n/a	n/a
CF	50	n/a	90[3]	n/a
HM	60	n/a	70[4]	n/a
NH	60	60	80	80
OK	70	60	80	80
UP	70	50	70	80

[1]More than one thinning pushes final harvest age out by 10 years for existing, 20 years for regenerated and northern hardwood stands.

[2]The listed rotation ages for aspen stands accomplish landscape wildlife habitat objectives for a young aspen component.

[3]Conifer assumes four thinnings occur.

[4]Hemlock assumes two thinnings occur.

Stand Density Index

The publication by Reineke, L. H. 1933. Perfecting a stand density index for even-aged forests. Journal of Agricultural Research 46(7):627-638 introduced the concept of Stand Density Index (SDI). SDI conveys a measure of stand stocking, in terms of an equivalent number of 10 inch diameter trees per acre. SDI calculates transform individual tree measurements, no matter what their diameters are, to a measure that is used to compare one stand to another.

Interpolating trees per acre values from appropriate stocking charts determines the assignment of upper and lower stocking levels (in terms of SDI) by Forest Type Group. The SDI used to trigger a commercial thinning corresponds to the A-level on a given chart. The SDI used as the target stocking for partial cuts corresponds to the B-level.

Table B-12. SDI Cutting Targets by Forest Type Group

Forest Type Group	A-level SDI	B-level SDI	Stock Chart/Guide Reference
AL[1]	310	180	Roach, Benjamin A. 1977. A stocking guide for Allegheny hardwoods and its use in controlling intermediate cuttings. USDA For. Serv. Res. Pap. NE-373, 30 p. Northeast. For. Exp. Stn., Broomall, Pa.
CF	350	160	Benzie, John W. 1977. Manager's handbook for red pine in the north-central states. General Technical Report NC-33. St. Paul, MN: U.S. Dept. of Agriculture, Forest Service, North Central Forest Experiment Station.
HM	305	200	Solomon, Dale S.; Leak, William B. 1999. Growth and Stocking of Eastern Hemlock (Tsuga canadensis) in New England. In: Proceedings: Symposium on Sustainable Management of Hemlock Ecosystems in Eastern North America. Ed. McManus, Katherine A.; Shields, Kathleen S.; Souto, Dennis R. Gen. Tech. Rep. NE-267. Durham, NH: U.S. Department of Agriculture, Forest Service, Northeast Research Station. 1999.
NR	225	120	Leak, William B.; Solomon, Dale S.; DeBald, Paul S. 1987. Silvicultural guide for northern hardwood types in the Northeast (revised). Res. Pap. NE-603. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.
OK	215	120	Roach, B.A.; Gingrich, S.F. 1968. Even-aged silviculture for upland central hardwoods. Agric. Handbook 355. Upper Darby, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station.
UP[2]	270	160	Roach, Benjamin A. 1977. A stocking guide for Allegheny hardwoods and its use in controlling intermediate cuttings. USDA For. Serv. Res. Pap. NE-373, 30 p. Northeast. For. Exp. Stn., Broomall, Pa.

1 Stocking on average includes 60% cherry-ash-poplar

[2] Stocking on average includes 30% cherry-ash-poplar

Maximum Thinning Percent

In the case of overstocked stands, thinning down to the identified target SDI may be too severe. The practical application of thinning limits cutting to no more than 35 percent of the standing live stocking, as measured by relative density. Simulations limit thinning to no more than 35 percent of the standing live stocking, as measured by SDI.

Species Retention

In certain Forest Type Groups, the stocking of critical tree species should not decrease during even-aged treatments (IH and RH prescriptions) to a point that would change the Forest Type of the stand. Simulations conducted on the AL, NR and UP Forest Type Groups control Black Cherry stocking. Simulations on the HM group control eastern hemlock stocking. Simulations on the OK group control the total stocking of all oaks. And, simulations on the CF group control the total stocking of all conifers.

Cutting Preference by Species

Each simulation includes removal preference for certain species. These preferences affect the order in which trees are selected for removal during harvest. Trees records with the highest removal priority go first, followed by those of lower priority, until the objectives of the cutting are reached. If a preference is not explicitly set, the default value is zero. A positive value increases the chance for tree removal and a negative value increases the chance for tree retention.

Seedling Response in Groups for the R2 Prescription

The R2 is the only uneven-aged prescription simulated. Even-aged simulations end at the point of regenerated, and therefore do not add seedlings. In contrast, uneven-aged simulations include the introduction of seedlings.

Regeneration in uneven-aged simulations does not occur all at once. After each group selection cut, seedlings are added to the simulation.

Using Simulation Output in SPECTRUM

For the IH and RH prescriptions, the initial yield tables generated during the base simulations do not go directly into SPECTRUM. An analysis of their results provides the proportion of the standing inventory volume harvested in each step of an even-aged regeneration harvest sequence.

The tables actually used in SPECTRUM for these prescriptions are called run-out yield tables. Run-out yield tables contain standing inventory and thin volumes where appropriate, but not final harvest volumes. SPECTRUM uses these tables to provide flexibility in selecting final harvest times. When the minimum allowable age is reached, SPECTRUM can then calculate yields for the final harvest for any decade by applying the proportion to the standing inventory volume.

Copies of the NG simulation tables for each Forest Type Group are used as run-out tables for the even-aged prescription without thins (RH). Customized simulations that include only the thinning treatment(s) provide run-out tables for the other even-age prescriptions (IH).

The base and timing option simulations for the R2 prescription load directly into SPECTRUM. Standing inventory volumes and harvest volumes are listed separately and used were applicable.

Comparing FVS Volume Output to Other Sources

The table that follows lists the standing cubic feet per acre at age 100 for some of the major stratum taken from the MC simulations as loaded into the SPECTRUM model.

Table B-13. Standing Inventory Volumes at Age 100 from FVS Simulations

Stratum Code	Cubic feet at Age 100
ALEHN	4558
CFAAN	3984
HMAAN	3784
NR+HN	3639
OKE+N	3893
UP+HN	4130

An analysis of MC simulations provides an estimate of how well FVS calculates timber volumes. The ANF has extensive experience analyzing its stand inventories with the SILVAH software program and feels comfortable with its ability to predict volumes. The same stand inventories simulated in FVS are run through the SILVAH software. A comparison of the two sets of simulations shows similar relationships between stand age and live volume. The table that follows lists the average fractional difference between calculated cubic volume from FVS and SILVAH. The SPECTRUM model uses these values as volume modifiers for each forest type group.

Table B-14. Differences between FVS Simulations and SILVAH Simulations

Forest Type Group	Average Fractional Difference
AL	1.04
CF	1.45
HM	1.04
NR	0.95
OK	0.88
UP	0.91

The table that follows lists recent volumes (cubic feet per acre) from ANF non-salvage timber sales, broken out by treatment type.

Table B-15. Harvest Volumes by Average Stand Diameter from Timber Sales

Stand Average Diameter	Cutting Type			Total of All Cut Types
	Overstory Removal	Shelterwood Seed Cut	Thinning	
14	n/a	700	500	1200
15	3100	681	900	4681
16	2100	751	880	3731
17	2317	876	700	3893
18	2013	767	n/a	2780
19	1673	n/a	n/a	1673
20	1150	n/a	n/a	1150

Recent cut volumes do not directly compare to the standing volume figures taken from the MC simulation. If you add the harvest volumes from a standard sequence of treatments (thinning, seed cut then removal cut), then it is reasonable to conclude that these harvest volumes can result from treating stands with the listed initial standing volumes. This fact adds credence to the stand volumes generated by the FVS simulations.

Yield Table Substitutions, Modifications and Adjustments

An evaluation of FVS-generated yield tables determined if their results look reasonable. Comparison on simulations run for the entire planning horizon (150 years) with the MC simulations other provides one measure. This comparison shows reasonable stand characteristics are maintained over time.

In some cases, the ANF modified FVS-generated yield tables to adjust dependent variables that do not look reasonable. Modifications include the removed asymmetrical variates by normalization of the relationship between dependant and independent variables. Modifications made to some dependent variables act to maintain their relationship with another variable after modification of that variable.

Sometimes the application of simple factors adjusts yield table values. In other cases where little or no data is available for the stratum, one stratum’s yield table substitutes for another. For some cases, substitution of a table is followed by an adjustment to reflect reasonable stand characteristics for the new population. Modifications of both standing inventory and harvest values for dependent variables like cubic volume, board foot sawtimber volume, canopy cover and dominant layer are included as part of these changes. Several examples of these changes to yield tables are:

- Since there is almost no inventory data available for the analysis of aspen stands, a yield table developed for the upland hardwood forest type group act as surrogate. A run-out table for the upland hardwood young growth stratum (UPYAN), based on the NG simulation yield table, is substituted for the aspen clearcut prescription.
- The NG simulations for Moderately Stocked (45 to 74%) stands do not adequately portray local conditions. Therefore, High Stocked (75+%) tables from the same Forest Type Group substitute for Moderately Stocked (45 to 74%) yield tables, after being adjusted downward using a factor to account for the lower stocking.
- Canopy Cover and Dominant Layer values in the R2 Prescription simulations do not reflect the midstory and overstory canopy dynamics of interest when trying to evaluate habitat structural stages. Manual changes to these yield tables eliminate the unwanted influence of seedling canopy cover on these variables.

FVS Simulation Board Foot of Sawtimber to Cubic Foot Relationships

To simplify the complex process of setting up the SPECTRUM model, the ANF only loads MCF wood volume values directly into the SPECTRUM model. The local timber industry uses thousands of board feet (MBF) as another measure of volume. The ANF estimates MBF of sawtimber within SPECTRUM by converting total MCF. An analysis of MC simulations provides a set of conversion factors. The analysis also provides factors for each combination of Dominant Layer and Forest Type Group combination. The table that follows lists the results.

Table B-16. Calculated MCF to MBF Conversion Factors

Dom Layer	AL	CF	HM	NR	OK	UP	++
1 (0-5")	No Data	No Data	No Data	No Data	No Data	No Data	No Data
2 (6-10")	1.312	1.644	No Data	1.299	1.994	1.691	No Data
3 (11-15")	3.124	3.981	3.520	3.087	2.843	3.215	3.686
4 (16-20")	4.305	No Data	No Data	No Data	No Data	No Data	4.294
5 (>20")	4.897	5.555	5.521	5.019	4.471	4.909	No Data

SPECTRUM needs a complete set of conversion factors. Certain combinations of Dominant Layer and Forest Type Groups do not occur in the data representing the measured condition. The table that follows lists values for the missing combinations (No Data) based on interpolation and professional judgment for use in SPECTRUM.

Table B-17. Assigned MCF to MBF Conversion Factors

Dom Layer	AL	CF	HM	NR	OK	UP	++
1 (0-5")	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2 (6-10")	n/a	n/a	1.600	n/a	n/a	n/a	1.500
3 (11-15")	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4 (16-20")	n/a	5.000	5.000	4.300	4.000	4.300	n/a
5 (>20")	n/a	n/a	n/a	n/a	n/a	n/a	5.000

The table that follows lists recent ANF sawtimber board feet to total merchantable cubic feet ratios from non-salvage timber sales.

Table B-18. MCF to MBF Ratios from Timber Sales

Stand Average Diameter	Forest Type Group				
	AL	CF	NR	OK	UP
16	3.599	3.676	2.753	3.507	3.361
17	4.197	n/a	4.482	4.701	4.263
18	4.782	n/a	4.426	4.820	4.368
19	4.772	n/a	4.849	n/a	4.735
20	n/a	n/a	n/a	n/a	5.119

Recent cut sawtimber board feet to total cubic feet ratios compare well to the proposed conversion factors calculated from the FVS simulations. This too adds credence to the stand volumes generated by the FVS simulations.

FVS Simulation Board Foot Equivalents to Cubic Foot Relationships

Normally, measures of MBF do not include pulpwood volume since lumber can not be cut from it. When discussing Allowable Sale Quantity (ASQ) for planning purposes, it can be misleading to talk only of sawtimber MBF volumes. This value does not account for the pulpwood volume in the same way that MCF does.

Board feet equivalents displays merchantable volume using one number, as does MCF. To calculate MBF-equivalents from MCF, the ANF uses an average ratio observed between MBF and the MCF of sawtimber. An analysis of the MC simulations indicates a ratio across all Forest Type Groups of approximately 6.3 MBF equivalents for each MCF. The table that follows lists Total Board Foot Equivalents to Cubic Foot Ratios from recent ANF non-salvage timber sales.

Table B-19. MBF to MCF Ratios from Non-salvage Timber Sales

Forest Type Groups	Ratio
AL	6.50
CF	6.27
NR	6.57
OK	6.56
UP	6.46

The Board Foot Equivalents to Cubic Foot Ratios from ANF sales are higher than those observed in the FVS simulations. If the FVS ratio is used to predict MBF equivalents, it will be a conservative estimate.

Shelterwood Seed Cut and Removal Proportions

Base on an analysis of post harvest leave tree surveys, 10 percent of initial standing volume prior to the Shelterwood Seed Cut remains as residual volume after the Shelterwood Removal. This assumption is based on five percent of an average cut unit remaining in reserve areas. The basal area stays unchanged in these reserve areas. However, re-calculating this basal area in terms of the total area in the cut unit results in 6.8 square feet per acre. Outside of reserve areas, the basal area of individual reserve trees left in the cut unit averages 11.6 square feet. When adding the two types of reserve trees together, there is about 15 trees/acre left across the entire cut unit. Reserve areas contain 37 percent of that total.

Analyzing outputs from full RH simulations show approximately 11 percent of the initial live cubic volume left in reserve trees prior to regeneration treatments. Proportions used in SPECTRUM for Shelterwood Seed and Removal cuts assume 90 percent of the live volume removed by the two entries together.

RH simulations of fully stocked stands show a 30/70 percent split of the total harvested volume between the Shelterwood Seed and Shelterwood Removal cut harvest volumes. Distributing these harvest volume percents by the percent volume removed generates a 27/63 percent split. Shelterwood Seed Cuts take 27 percent of the initial standing volume. Removal Cuts take another 63 percent. This leaves 10 percent in reserve trees.

SPECTRUM Model 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, forested land area is divided into smaller homogeneous areas called analysis units. The planning horizon of 150 years is divided into fifteen decades. A computer program called SPECTRUM analyzes forest planning alternatives.

SPECTRUM is a decision support model, developed and supported by the USDA Forest Service that can simultaneously analyze trade-offs between the many goals, constraints, management activities, timing options and land types that are necessary to manage a large forest. SPECTRUM uses a linear program software package to generate a matrix, and another software program called C-Whiz solves the matrix. Output files are created and those output files are used to generate the reports. Figure B-1 provides a process flow diagram of the timber harvest schedule modeling process.

The ANF utilized a Model 2 configuration of SPECTRUM. The primary difference between a typical Model 1 configuration and a Model 2 configuration is the ability to transfer acreages to new decision variables with different attributes. In a Model 1 configuration, an acre of land retains the attributes (with the exception of age) it starts with throughout the planning horizon; however, in a Model 2 configuration, the original or existing acreage with the original attributes lasts only for the life of the stand, and then it is transferred to a new transfer class with new defined attributes.

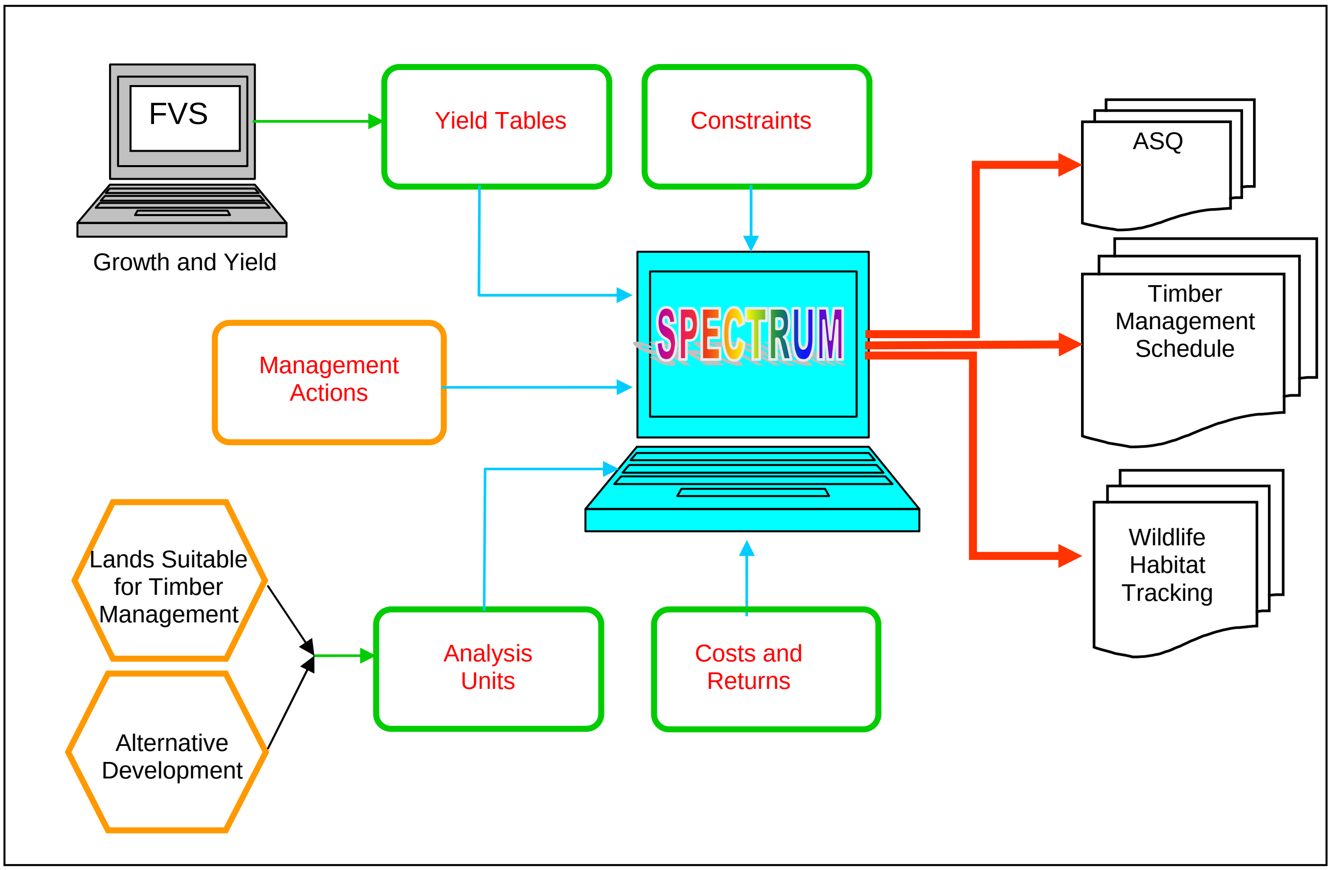
Prior to SPECTRUM analysis considerable work was done to prepare data for input into the SPECTRUM model. This work included the following:

- 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);
- schedule of timber harvest;
- reforestation activities;

- economic information development;
- management prescription development; and
- determination of suitable acreage within each alternative.

Standards and guidelines from both the 1986 and the new Land and Resource Management Plan (LRMP) provide 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 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 GIS data.

Figure B-1. Timber Harvest Schedule Model–Process Overview



Common Assumptions Used

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

- The ANF LRMP will be a strategic plan that will guide broad land-based decisions to achieve certain goals and objectives.
- On-the-ground decisions will utilize standards and guidelines of the LRMP and implementation guides to meet goals and objectives of the strategic LRMP.
- 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.

Model Layers

Model layers were dictated by the GIS analysis units and yield tables, and the associated attributes were developed for the model to provide consistency with the GIS and yield table data. Six layers were used in each model alternative as well as the Benchmark SPECTRUM Runs. Layer 1 is the forest or land type, Layer 2 is the Age Class, Layer 3 is the Stocking Class, Layer 4 is Suitability Class, Layer 5 is the management area, and Layer 6 is the Riparian Class. Any unique combination of these layers defines an analysis unit. The layers and important attributes used in the Benchmark and Alternatives are tabulated in Tables B-20 through B-25. Although groups of the attributes were often used within the model, they are not specified here.

The following tables and acreages list the model inputs. They include all suitable timber land (totals may not be exact due to rounding errors). The actual land base is adjusted based on management area designations in the model. This is reflected in model outputs, not here.

Suitable timber land has been grouped into eight forest type groups. They are defined as having greater than 50 percent of basal area in the major species of that group. The mixed group includes those that don't fall into any other category.

Table B-20. Layer 1, acres of suitable forest by forest type

Class	Attribute	Acres	Major Species
Allegheny Hardwoods	AL	123,336	Black cherry, yellow-poplar, white ash
Aspen	AS	2,382	Bigtooth and quaking aspen
Conifer	CF	10,059	All conifers except hemlock
Hemlock	HM	6,297	Eastern hemlock
Mixed (NR, OK, UP)	MIX	5,903	All others
Northern Hardwoods	NR	62,090	Sugar maple, beech, yellow birch, hemlock
Oak	OK	55,206	All oak species
Upland Hardwoods	UP	143,149	Red maple, black cherry, yellow-poplar, white ash, Basswood, cucumber tree, black birch

Further, these lands were categorized by age class into 10-year increments. Where available data represented other than the base year, age was adjusted to reflect the current condition. The model will continue to grow each stand until a final harvest resets it to zero. Age Classes were expanded to 310+ in 10-year increments.

Table B-21. Layer 2, acres of suitable forest by age class

Age	Attribute 1	Attribute 2	Acres
0-10	0-10	AC1	11,196
11-20	11-20	AC2	23,936
21-30	21-30	AC3	10,939
31-40	31-40	AC4	13,853
41-50	41-50	AC5	2,906
51-60	51-60	AC6	6,138
61-70	61-70	AC7	26,341
71-80	71-80	AC8	67,593
81-90	81-90	AC9	99,260
91-100	91-100	AC10	94,332
101-110	110	AC11	40,552
111-120	120	AC12	7,958
121-130	130	AC13	2,803
131-140	140	AC14	616

Stocking levels are assigned to one of four categories (all, low, moderate and high).

Table B-22. Layer 3

Layer 3 Stocking Class	Attribute	Acres
All	0-75+%	79,405
Low	0-44%	10,880
Moderate	45-74%	105,203
High	75+%	212,933

Each analysis unit was further delineated by existing suitability. Non-forested areas include water, developed recreation sites, etc. The non-suitable category includes those areas currently withdrawn by Congress, the Secretary of Agriculture or the Chief of the Forest Service and those acres not physically suitable. Everything else is deemed to be tentatively suitable forested land.

Table B-23. Layer 4

Layer 4 Suitability	Attribute	Acres
Non-forested	NF	53,360
Non-suitable Forested	NSF	55,056
Suitable Forested	SF	408,427

Table B-24. Layer 5

Layer 5 Management Area	Attribute
1.0	MA 1.0
2.1	MA 2.1
2.2	MA 2.2
3.0	MA 3.0
6.1	MA 6.1
6.2	MA 6.2

Other management areas are carried in the models; however, since they are not part of the suitable land base, they are assigned to a minimum prescription. Acres are not displayed, since they change by alternative.

The riparian-no harvest category removes a corridor along wilderness, remote and Class A wild trout streams from timber management actions. The rest of the riparian areas (33,526 acres) are available subject to the applicable standards and guidelines. The non-riparian acres are not constrained by this attribute.

A second level indicator to identify stands that have already received a shelterwood seed cut and are scheduled for an overstory removal in the first decade or the second decade (oak stands) are designated with an OR in Layer 6.

Table B-25. Layer 6

Layer 6 Riparian Class	Attribute	Acres
Riparian, no harvest	RNC	1,278
Riparian, allocated to harvest	RC	34,543
Non-Riparian	NR	419,435
Overstory Removal	OR	8,197

Activities

Activities in the models generally fall into two categories, reforestation and tracking. Reforestation activities that were scheduled and accounted for in the model included: site preparation, sale administration, sale preparation, controlled burning, herbicide treatment, fencing, pre-commercial thinning, scarification, stocking surveys and fertilization. Reforestation activities in all cases had specific economic cost information associated with them that varied by forest type and harvest treatment prescriptions. Tracking activities were used to identify age classes and harvested acres. The activities and model attributes used in the Benchmark and Alternatives are tabulated in Tables B-26 through B-29.

Table B-26. Age Class

Age Class	Attribute
age class 0	AC0
age class 0-10	AC1
age class 11-20	AC2
age class 21-30	AC3
age class 31-40	AC4
age class 41-50	AC5
age class 51-60	AC6
age class 61-70	AC7
age class 71-80	AC8
age class 81-90	AC9
age class 91-100	AC10
age class 101-110	AC11
age class 111-120	AC12
age class 121-130	AC13
age class 131-140	AC14
age class 141-150	AC15
age class 151+	AC16

The reforestation activities table lists all available activities for areas that need to be regenerated. The model utilizes various combinations of these activities based on prescription, forest type and the desired future condition.

Table B-27. Reforestation Activities

Reforestation Activity	Attribute
Controlled Burning	BURN1
Fencing	FENCE
Fertilization	FERTILIZE
Herbicide Treatment	HERBICIDE
Planting	PLANT
Pre-Commercial Thinning	PRETHIN
Release	RELEASE
Sale Planning	SALEPLAN
Sale Preparation	SALEPREP
Sale Administration	SALE_ADM
Scarification	SCARIFY
Site Preparation	SITE PREP
Stocking Surveys	STOCKSURVEY

Outputs

Outputs from the ANF models generally fall into these three categories: timber oriented, Indiana bat habitat, and tracking. Components of commodity oriented outputs (Table B-28) are Timber Volumes, Inventory, Annual Sale Quantity, Stand Average Volume, and Long Term Sustained Yield (LTSY). Timber volumes were analyzed using Harvest Board Foot Equivalents, Harvest Board Foot-Saw Timber, and Millions of Cubic Feet.

Table B-28. Commodity Outputs

Commodity Outputs	Attribute
Harvest Board Foot Equivalents (MBF)	HBd-Eq
Harvest Board Foot Saw TIMBER (MBF)	HBd-St
Inventory	INV
Live Board Foot	LBd
Long Term Sustained Yield	LTSY
Stand Average Volume	SAV
Annual Sale Quantity	ASQ
Timber (MCF)	ALL

Acres of Indiana bat habitat (Table B-29) for Non-suitable, Optimal, and Satisfactory habitat are effects that were also tracked. Optimum Indiana Bat Habitat is specified in the models as having a 50 to 80 percent canopy closure and a dominant layer of 2-5. Suitable plus Optimal Indiana Bat Habitat is specified in the models as having 20 to 100 percent canopy closure and a dominant layer of 2-5. Non-Suitable Indiana Bat Habitat was specified in the model as having a Canopy Closure of less than 20 percent and a dominant layer of 0-1.

Table B-29. Wildlife Outputs

Wildlife Outputs	Attribute
Optimum Indiana Bat Habitat	O-IBAT
Optimum+ Satisfactory Indiana Bat Habitat	S+O_IBAT
Non-suitable Indiana Bat Habitat	NOT_IBAT

Conditions

Structural stages are used to track vegetative conditions in the model. In the table that follows, these structural stages are defined and grouped together for summarization.

Table B-30. Structural Stages

ATTRIBUTE (Stage)	Canopy Closure	Dominant Layer	Structural Stage Group
0	0-40%	0-5	Early
1	40-100%	0	Early
2	40-100%	1	Early
3S	40-69%	2	Mid
3O	70-100%	2	Mid
4	40-100%	3	Mid
5	40-100%	4	Mid
6S	40-59%	5	Late
6O	60-100%	5	Late

Treatment types

Treatment types are used in the model to describe the different types of vegetation manipulation that can occur. Several different types of treatments dependent on forest type were used in the models. Clearcutting was used for aspen. Shelterwoods were used for all other forest types. Allegheny hardwoods and hemlock were modeled as a one-step shelterwood that has the seed cut and the overstory removal occurring in the same decade. All other forest types use a two-step shelterwood with the seed cut occurring in one decade followed by the overstory removal in the next decade. Three two-step shelterwood options are available by forest type: a no-thin option, which consists of a seed cut followed by overstory removal, a one-thin option followed by a seed cut followed by the overstory removal, a two-thin option that is followed by a seed cut and overstory removal, and a four-thin option followed by the seed cut and subsequent overstory removal. The four-thin option is only used for the conifer (red pine) forest type. Regeneration occurs following the overstory removal. Clearcutting, one-step shelterwoods, and two-step shelterwoods access even-age dependent yield tables. Time dependent uneven-aged yield table are accessed by the two other uneven-aged treatments. Two options are available for uneven-aged management treatments. The first is the uneven-aged transition cut followed by a group selection cut, and the second is a one-thin option of the first. The treatments and model attributes used in the Benchmarks and Alternatives are tabulated in Table B-31.

Table B-31. Treatments

Treatment	Attribute
Clearcut the existing stands	CC-EX
Clearcut the regenerated stand	CC-Rgn
Overstory removal of the existing stand, two-step shelterwood, final harvest	OverE2
Overstory removal of the regenerated stand, two-step shelterwood, final harvest	OverR2
Prep-cut of the existing stand, two-step shelterwood	PrepE2
Prep-cut of the existing stand, two-step shelterwood	PrepR2
The first entry of selection cuts	Sel-F
Latter entries of selection cuts	Sel-L
Thinning in the existing stand	ThnEst
Thinning in the regenerated stand	ThnReg
Prep-cut and overstory removal of the existing stand, one-step shelterwood	ICutE1
Prep-cut and overstory removal of the regenerated stand, one- step shelterwood	ICutR1
Overstory removal of the existing stand	OR
Removal of understory and overstory as a result of OGM activity, n o regeneration	OGM
Group of all commercial treatment types	ALLHAR
Group consisting of clearcut existing and clearcut regenerated stands	CCEXRG
Group consisting of CC-EX, CC-Reg, PO-Est, ICutE1, PrepE2, PrepR2 and Sel-F	Econ1
Group consisting of CC-ex, CC-Reg, overE2, OverR2, and Sel-L	Econ2
Group consisting of OverE2, OverR2, PO-Est, and PO-Reg	F_Har
Group consisting of CC-EX, CC-Reg, PO-Est, PO-Reg, PrepE2, PrepR2, and Sel-F	Har1
Group consisting of 1CutE1, and 1CutR1	PrepOV
Group consisting of CC-EX, CC-Reg, OverE2, OverR2, 1CutE1, and 1CutR1	Regen

Transfer Classes

Model 2 Transfer Classes are defined as forest stands that an existing forest type converts to upon regeneration harvest. The Mixed Forest type composed of low stocked northern hardwoods, oak, and upland hardwoods is expected to convert to 25 percent Allegheny hardwoods, 25 percent northern hardwoods, 25 percent oak, and 25 percent upland hardwoods. Allegheny hardwoods are expected to convert to 90 percent Allegheny hardwoods and 10 percent upland hardwoods. Northern hardwoods are expected to convert to 10 percent northern hardwoods, 70 percent upland hardwoods, and 20 percent Allegheny hardwoods. Oak is expected to convert to 90 percent oak, 5 percent upland hardwoods, and 5 percent Allegheny hardwoods. Upland hardwoods are expected to convert to 80 percent upland hardwoods and 20 percent Allegheny hardwoods. Hemlock is expected to convert to 20 percent hemlock and 80 percent upland hardwoods. Conifers and aspen are not expected to convert.

Table B-32. Model 2 Transfers

Existing	Transfer Class	Proportion
MIX	AL	0.25
	NR	0.25
	OK	0.25
	UP	0.25
AL	AL	0.9
	UP	0.1
NR	NR	0.1
	UP	0.7
	AL	0.2
OK	OK	0.9
	UP	0.05
	AL	0.05
UP	UP	0.8
	AL	0.2
HM	HM	0.2
	UP	0.8
AS	AS	1.0
CF	CF	1.0

Management Action Definitions

Management actions definitions are composed of two components. The first is the management emphasis, and in the ANF models the emphasis corresponds to the management areas definitions as specified in Layer 5 of the models. The second component is the intensities or the levels of activities undertaken to accomplish the management emphasis. The emphasis used in the models are a MIN that is a minimum intensity, or more specifically natural growth without a harvest, an RH intensity that is the two-step shelterwood seed cut followed by overstory removal, a CC or clearcut intensity, an IH or one thin two-step shelterwood, an IH2 or two thin two-step shelterwood, an IH4 or four thin two-step shelterwood, an R2 that is an uneven-aged transition cut followed by group selection, and a UT emphasis that is a thinning followed by an uneven-aged transition cut followed by group selection. Forest types and Management Emphasis were assigned intensities in the model as specified in Table B-33.

Table B-33. Management Actions

Management Emphasis	Forest Type	Intensity
MA 1.0	Allegheny Hardwoods	MIN, RH
	Aspen	MIN, CC
	Conifer	MIN, IH4
	Hemlock	MIN, IH2
	Mixed	MIN, RH
	Northern Hardwoods	MIN, RH
	Oak	MIN, RH
	Upland Hardwoods	MIN, RH
MA 2.1	Allegheny Hardwoods	MIN, R2, UT
	Aspen	MIN, CC
	Conifer	MIN, IH4
	Hemlock	MIN, IH2
	Mixed	MIN, RH
	Northern Hardwoods	MIN, R2, UT
	Oak	MIN, RH, IH, IH2
	Upland Hardwoods	MIN, R2, UT
MA 2.2	Allegheny Hardwoods	MIN, R2, UT
	Aspen	MIN, CC
	Conifer	MIN, IH4
	Hemlock	MIN, IH2
	Mixed	MIN, R2, UT
	Northern Hardwoods	MIN, R2, UT
	Oak	MIN, RH, IH, IH2
	Upland Hardwoods	MIN, R2, UT
MA 3.0	Allegheny Hardwoods	MIN, RH, IH, IH2
	Aspen	MIN, CC
	Conifer	MIN, IH4
	Hemlock	MIN, IH2
	Mixed	MIN, RH
	Northern Hardwoods	MIN, RH, IH, IH2
	Oak	MIN, RH, IH, IH2
	Upland Hardwoods	MIN, RH, IH, IH2

Management Emphasis	Forest Type	Intensity
MA 6.1	Allegheny Hardwoods	MIN, RH, IH, IH2
	Aspen	MIN, CC
	Conifer	MIN, IH4
	Hemlock	MIN, IH2
	Mixed	MIN, RH
	Northern Hardwoods	MIN, RH, IH, IH2
	Oak	MIN, RH, IH, IH2
	Upland Hardwoods	MIN, RH, IH, IH2
MA 6.2	Allegheny Hardwoods	MIN, RH, IH
	Aspen	MIN, CC
	Conifer	MIN, IH4
	Hemlock	MIN, IH2
	Mixed	MIN, RH
	Northern Hardwoods	MIN, RH, IH
	Oak	MIN, RH, IH
	Upland Hardwoods	MIN, RH, IH

Constraints

Constraints are placed in SPECTRUM to establish minimum or maximum levels of acres, harvest activity, age classes or other model variables for either a particular decade or all decades.

The ANF SPECTRUM model has two major types of explicit constraints to structure the model of the forest. The first type of allocation constraints sets minimum, maximum or specific level prescription intensity to a give land type. It is common to set a minimum acreage constraint to the Minimum (No Cut) prescription and set a minimum or maximum acreage constraint to a given harvest prescription.

The second type of explicit constraints are scheduling constraints that establish a minimum or maximum amount of harvest activity or environmental conditions (e.g. Age Class) expected in one or more specified decades of the alternative. Most often these are used to set minimum or maximum amounts of specific harvest activity, usually HAR1, that initiates the regeneration sequence for both even-aged and uneven-aged treatments. In Alternative D, scheduling constraints are used to control the level of early age classes. Often these constraints are specified as a proportion or percent of a specified land area (e.g. limit the acres of HAR1 to a percentage of the amount of suitable forested land in Allegheny hardwoods in MA 3.0).

Since the model uses an objective function of maximizing PNV, constraints are often used to counter selection tendencies of the model that may be undesirable. This includes limiting the amount of an activity or condition preferred by the model but otherwise undesirable (e.g. harvesting all of the old timber of one forest type in the first decade) or forcing a specified level of an activity or condition that would not otherwise be selected by the model (e.g. harvesting a low PNV forest type, such as oak).

In addition, the fundamental structure of the model contains a number of implicit land accounting constraints to ensure that each acre of land in the model is assigned to a management emphasis and intensity.

Most of the constraints do not vary by alternative but apply specific controls to either the allocation of intensities by management area (Allocation Constraints) or scheduling of timber harvest (Schedule Constraints).

General Constraints That Apply to All Alternatives

OGM Allocation Constraints

One set of allocation constraints represents the conversion of the ANF land surface to OGM development. These constraints allocate 6,660 total acres (2,220 acres of non-suitable and 4,440 acres of suitable) in decades 1 thru 4 to OGM activity. This activity results in the removal of existing timber and elimination of these acres from regeneration as they are converted into roads and well pads. The constraints were based on percentage of forest type, percentage of age distribution and on percentage of management area of lands where OGM activity currently occurs on the ANF. These initial harvests contribute to the ASQ for suitable land, but not on unsuitable land.

Harvest Volume Scheduling Constraints

Harvest volume constraints generally require a non-declining flow of timber harvest volume in thousands of cubic feet. This means that the amount of scheduled harvest volume in a later decade cannot be less than the amount of harvest volume assigned to an earlier decade. A departure analysis was conducted by relaxing this constraint on Alternative B to determine the affect of boosting harvest volumes in the second and third decade.

Overstory Removal Scheduling Constraints

A set of scheduling constraints force stands that have already received a shelterwood seed cut to harvest the overstory in decade 1 for stands other than oak or in decade 2 for oak stands. This is to remove the ability of the model to unrealistically prepare the overstory removals in later decades. This constraint is applied to all applicable stands in a management area that would allow regeneration harvest. It is not applied in other management areas.

Low Stocking Scheduling Constraints

A set of scheduling constraints force at least 1,000 acres of low stocked stands to have regeneration harvest treatments in decades 1 thru 3 (Not applied to alternative D).

Management Area Constraints That Generally Do Not Vary By Alternative

MA 1.0

Allocation Constraints

1. At least 15 percent (10% Alternative A) of all suitable forested land is assigned to minimum (No Cut) intensity to account for springs, seeps, and other areas of deferred harvest.

Schedule Constraints

1. HAR1 must be greater than or equal to 7 percent of the suitable forest acres in MA 1.0 in each decade to force creation of early structural conditions.
2. HAR1 must be less than or equal to 20 percent of the suitable forest acres in MA 1.0 in each decade. This is a limit for harvest dispersion requirements.
3. HAR1 in suitable riparian forest must be less than or equal to 3 percent of the suitable riparian forest acres in MA 1.0 in each decade. This is to prevent excess activity in riparian areas.

MA 2.1

Allocation Constraints

1. The acres assigned to Minimum (No Cut) intensity must be greater than or equal to half of the suitable riparian acres in MA 2.1. This is to prevent excess activity in riparian areas.
2. At least 15 percent (10% Alternative A) of all suitable forested land is assigned to minimum (No Cut) intensity to account for springs, seeps, and other areas of deferred harvest.

Schedule Constraints

1. HAR1 (SEL-F) treatment must be less than or equal to 25 percent of the suitable forest acres in MA 2.1 in each decade. This is an upper limit on decadal initiation of uneven-aged harvests.

MA 2.2

Allocation Constraints

1. For each of these forest types: AL, NR, and UP, the acres assigned to Minimum (No Cut) intensity must be greater than or equal to half of the suitable riparian acres in MA 2.2. This retains approximately half of these forest types as undisturbed areas within MA 2.2.
2. For each of these forest types: AL, NR, and UP, the acres of suitable riparian forest area assigned to Minimum (No Cut) intensity must be greater than or equal to 75 percent of the acres of suitable riparian forest area. Most of riparian areas in MA 2.2 will have no disturbance.

Schedule Constraints

1. For each of these forest types: AL, NR, and UP, the HAR1 amount of SEL-F must be less than or equal to 13 percent of the suitable forest acres in each type in each decade from 1 thru 4. This is an upper limit on decadal initiation of uneven-aged harvests.
2. For oak forest types only: the HAR1 amount (Shelterwood Prep) must be greater than 2 percent and less than 4 percent of the suitable forested land in oak type in MA 2.2 in each decade. This both forces some regeneration of oak and limits the amount of oak regeneration.
3. For CF and HM forest types only: the HAR1 amount (Shelterwood Prep) must be less than or equal to 4 percent of the suitable forested land in each type in MA 2.2 in each decade. This limits harvest of these types for their conservation. (Note later exception for alternative Cm).
4. The HAR1 amount of SEL-F must be greater than or equal to 2,500 acres in each decade 1-4, broken down by 750 acres each in AL and NR forest types and 1,000 acres in UP types. This is to force some amount of uneven-aged harvest activity for these three forest types.

MA 3.0

Allocation Constraints

1. Each alternative has a set of specific acres assigned to Minimum (No Cut) intensity based on mapped potential old growth areas of deferred harvest.
2. At least 15 percent (10% alternative A) of all suitable forested land is assigned to minimum (No Cut) intensity to account for springs, seeps, and other areas of deferred harvest.

Schedule Constraints

1. HAR1 must be less than or equal to 17 percent of the suitable forest acres in MA 3.0 in each decade to account for dispersion requirements for harvest units.
2. No more than 20 percent of the suitable forest in any one forest type may be harvested (HAR1) in a single decade to account for dispersion requirements for harvest units.
3. HAR1 in suitable riparian forest must be less than or equal to 3 percent of the suitable riparian forest acres in MA 3.0 in each decade.

MA 6.1 (No Allocation Constraints)

Schedule Constraints

1. For each of these forest types: AL, CF, HM, NR, OK, and UP, the amount of HAR1 in that type must be less than or equal 3 percent of suitable forest acres in that type in each decade from 1 to 15.
2. HAR1 in suitable riparian forest must be less than or equal to 3 percent of the suitable riparian forest acres in MA 3.0 in each decade from 1 to 15.

MA 6.2 (No Allocation Constraints, MA 6.2 Is In Alternative A Only)

Schedule Constraints

1. For each of these forest types AL, CF, HM, NR, OK, and UP, the amount of HAR1 must be less than or equal to 6 percent of the suitable forest acres in MA 6.1 in each decade (160 year rotation).
2. HAR1 in suitable riparian forest must be less than or equal to 3 percent of the suitable riparian forest acres in MA 6.2 in each decade. This is to prevent excess activity in riparian areas.

Constraints That Vary By Alternative

Alternative A

Allocation Constraints

1. For each of these forest types in age classes 61 to 150: AL, NR, OK, and UP in MA 3.0, the acres in these age classes in these types assigned to Min (No Cut) intensity must be greater than or equal to 5 percent of the total suitable forest in each of these types in MA 3.0. This in addition to other constraints requiring min intensity. This is to provide for the 5 percent potential old growth areas of the existing plan.
2. The acres of suitable riparian forest in age classes 61 to 150 assigned to the Min (No Cut) intensity in MA 3.0 must be less than or equal to 15 percent of the total suitable riparian acres in MA 3.0. This combines the old growth and spring/seep requirements into a single constraint.
3. The riparian area for this alternative does not assign Wilderness Trout Streams, Class A Trout Streams and Remote Trout Streams to minimum (No Cut) prescription.

Schedule Constraints

1. In MA 3.0, the amount of HAR1 occurring in oak types must be greater than or equal to the 7 percent of the total amount of HAR1. This is to force some regeneration of oak types.

Alternative B

Allocation Constraints

1. The riparian area for this alternative assigns Wilderness Trout Streams, Class A Trout Streams and Remote Trout Streams to minimum (No Cut) prescription.

Schedule Constraints

2. In MA 3.0, the amount of HAR1 occurring in oak types must be greater than or equal to the 9 percent of the total amount of HAR1. This is to force some regeneration of oak types.

Alternative Cm

Allocation Constraints

1. The riparian area for this alternative assigns Wilderness Trout Streams, Class A Trout Streams and Remote Trout Streams to minimum (No Cut) prescription.

Schedule Constraints

2. In MA 3.0, the proportion of HAR1 occurring in different forest types is limited to foster active management of all forest types. These constraints limit the proportion of Allegheny hardwoods to 60

percent of the total acres of HAR1, while requiring that at least 10 percent of HAR1 acres occur in oak and northern hardwoods forest types.

3. To insure some uneven-aged management in MA 2.1, at least 500 acres of SEL-F are forced in decades 1 and 2 in this MA.
4. To provide for more thinning activity, at least 1,000 acres of thinning must occur in decades 1 and 2.
5. To conserve hemlock and conifer stands, no scheduled harvest of these forest types occurs in alternative Cm.

Alternative D

Allocation Constraints

1. In MA 2.1, 40 percent or greater of the suitable forested land must be assigned to the R2 intensity. This is to force harvest activity consistent with MA 2.1 uneven-aged prescription.

Schedule Constraints

1. The amount of AC1 (acres in age class 0-10) must be greater than 4,635 acres in each decade from 2 to 15 (this is based on 1 percent of the entire forested area on the ANF: 463,483). This is the minimum amount of younger age classes to replicate estimated historic levels.
2. The amount of AC1 (acres in age class 0-10) must be less than 13,905 acres in each decade from 2 to 15 (this is based on 3 percent of the entire forested area on the ANF: 463,483). This is the maximum amount of younger age classes to replicate estimated historic levels.

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 ANF'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. Benchmarks were constructed with OGM and riparian constraints.

Benchmarks relevant to the timber revision topic:

1. Maximizing PNV of the timber program, no harvest constraints.
2. Maximizing PNV of the timber program, with NDY and LTSY harvest constraints.
3. Maximizing timber production, no harvest constraints.
4. Maximizing timber production, with NDY and LTSY harvest constraints.
5. Minimizing timber production.

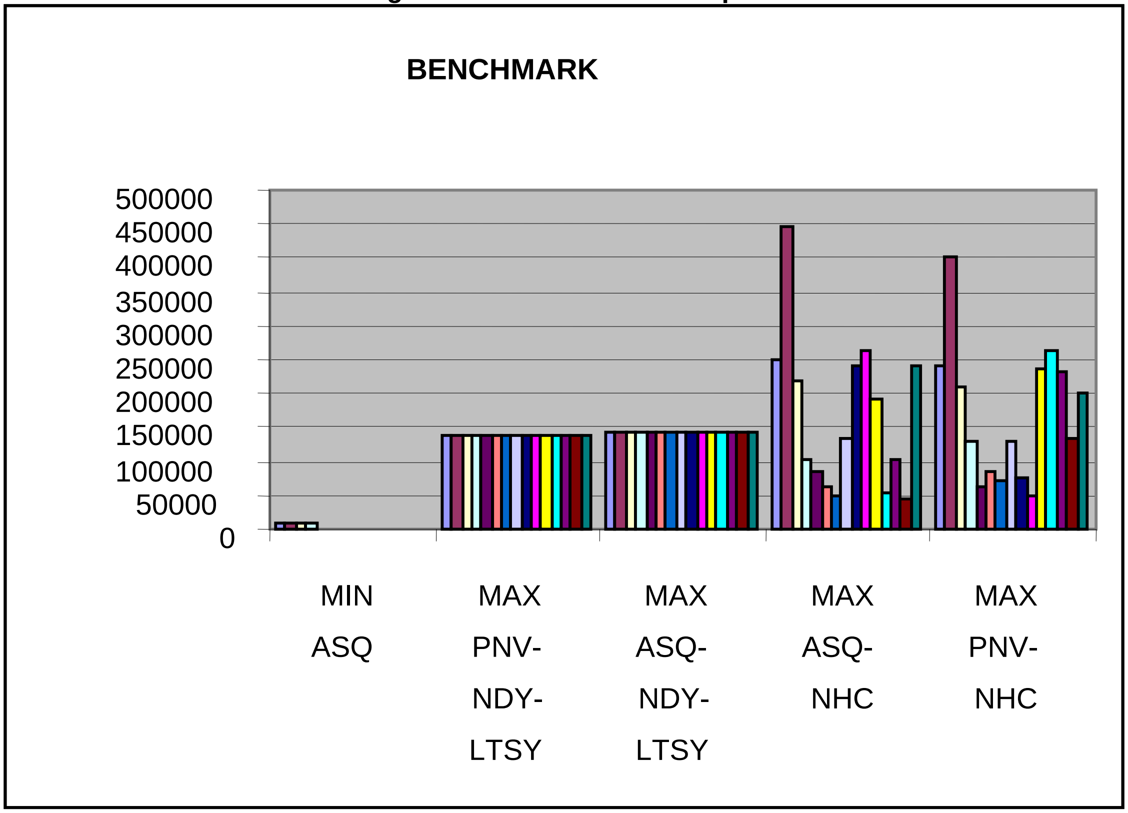
The tentatively suitable land base had benchmark scenarios applied to show the maximum biological capability of the ANF's timber resource. The suitable timber base acres had the same scenarios applied, including a constraint that allowed for a maximum of 1,200 acres of riparian areas suitable for harvest in each decade. Comparisons, displayed in Figures B-2 and B-3, show differences, or trade-offs, of implementing harvest constraints to meet minimum regulatory requirements as set in Forest Service direction. These harvest constraints are coarse assumptions applied to maintain habitat for some threatened, endangered and sensitive (TES) species, for clean water requirements, etc.

Analysis on tentatively suitable lands shows the effect of implementing the NFMA constraint of Non-declining Yields. For ASQ, in the maximize harvest objective function runs, it creates a drop of 92,112 MCF, or a 36 percent reduction, in the first decade's outputs. The effect of adding the LTSY constraint creates a further reduction of 22,298 MCF, or a total reduction of 45 percent, but resulting yields for each decade are the same. Eliminating these large swings in decade outputs is the main reason for the required NFMA constraints.

Maximizing Present Net Value (PNV) produces positive numbers in all cases. The effect of adding the Non-declining Yield and LTSY harvest constraints creates a reduction of 102,336 MCF, or a 43 percent reduction. For decade 1, the minimum level benchmark for timber shows OGM related timber production of 6,992 MCF. For decades 2, 3 and 4 respectively, the production is 8,026 MCF, 9,910 MCF, and 9,811 MCF. Growth for the minimum objective function becomes negative between decades 10 and 11, illustrating mortality as the natural growth forest ages. Figure B-4 illustrates the effect.

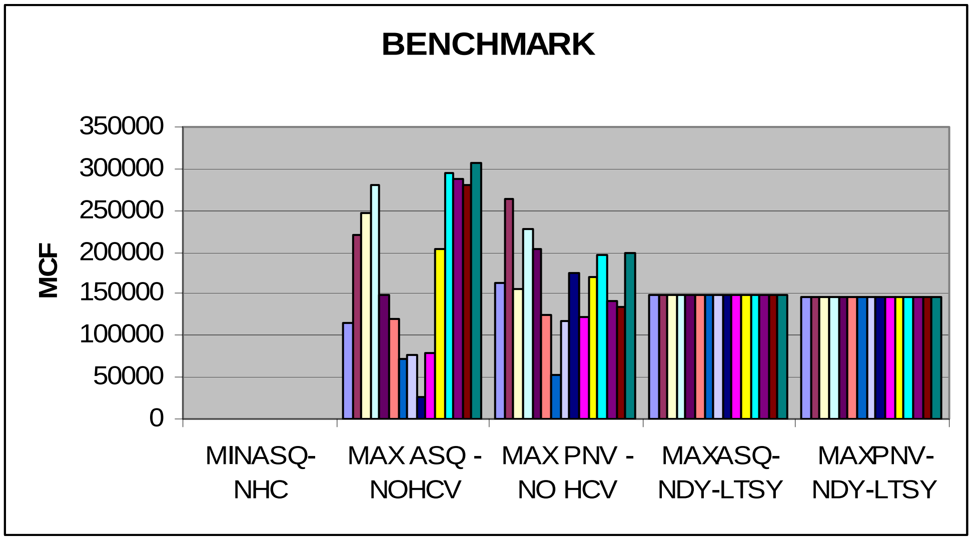
Figure B-3 shows ASQ for the PNV objective function and ASQ for the max timber objective function for decades 1 to 15. The effects of the harvest constraints are also displayed. All PNV calculations share a common annual discount rate of 4 percent per year. The minimum level benchmark represents the the level of management that would be needed to maintain and protect the unit as part of the National Forest System. As a benchmark, there is essentially no active management on the ANF, only custodial management related to minimal maintenance of the forest assets to avoid adverse impacts on other properties outside of the ANF. A SPECTRUM analysis was done on the minimum benchmark to evaluate what consequences could occur if essentially no active management mangement was done. The minimum benchmark does assume that cumulative effects upon the ANF remain the same as those that would influence the alternatives. The primary focus was on wildlife habitat such as the distribution of structural stages. (See Figure B-9). This was considered in Appendix E.

Figure B-2. Benchmark Comparison



PNV = Present Net Value
ASQ = Allowable Sale Quantity
NDY = Non-Declining Yield
LTSY = Long Term Sustained Yield
NHC = No Harvest Constraints

Figure B-3. Benchmark Comparison, ASQ decades 1 to 15



PNV = Present Net Value
ASQ = Allowable Sale Quantity
NDY = Non-Declining Yield
LTSY = Long Term Sustained Yield
NHC = No Harvest Constraints

Figure B-4. Benchmark Objective function minimize ASQ decades 1 to 15

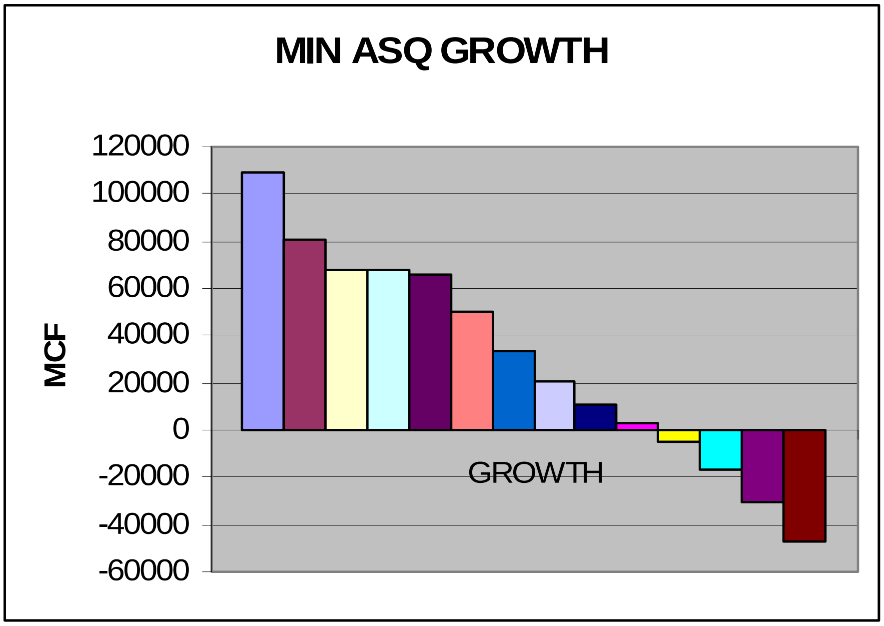


Figure B-5. Benchmark Objective function maximize PNV decades 1 to 15 Structural Stages

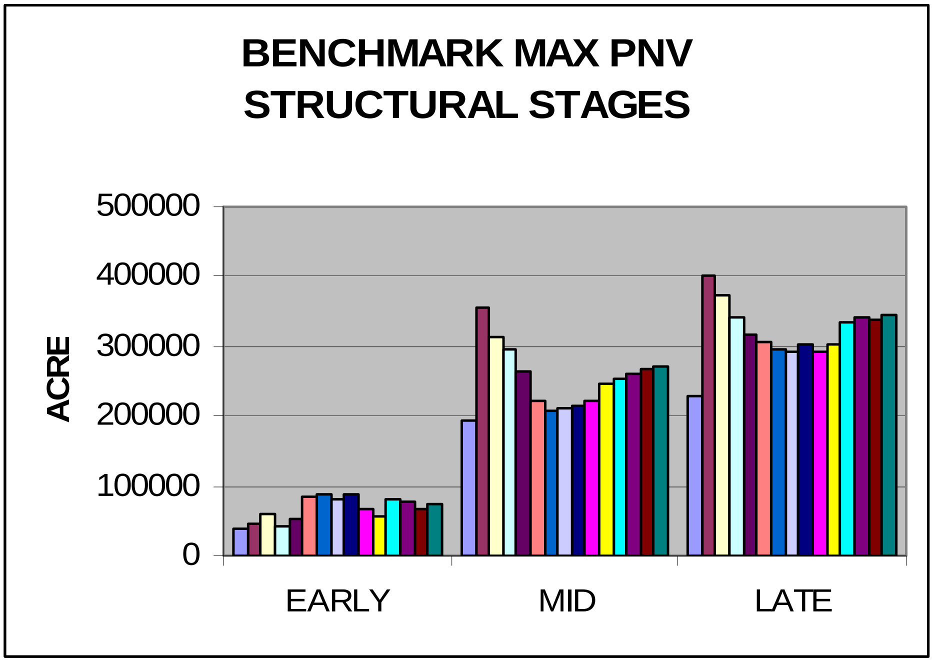


Figure B-6. Benchmark Objective function maximize ASQ decades 1 to 15 Structural Stages

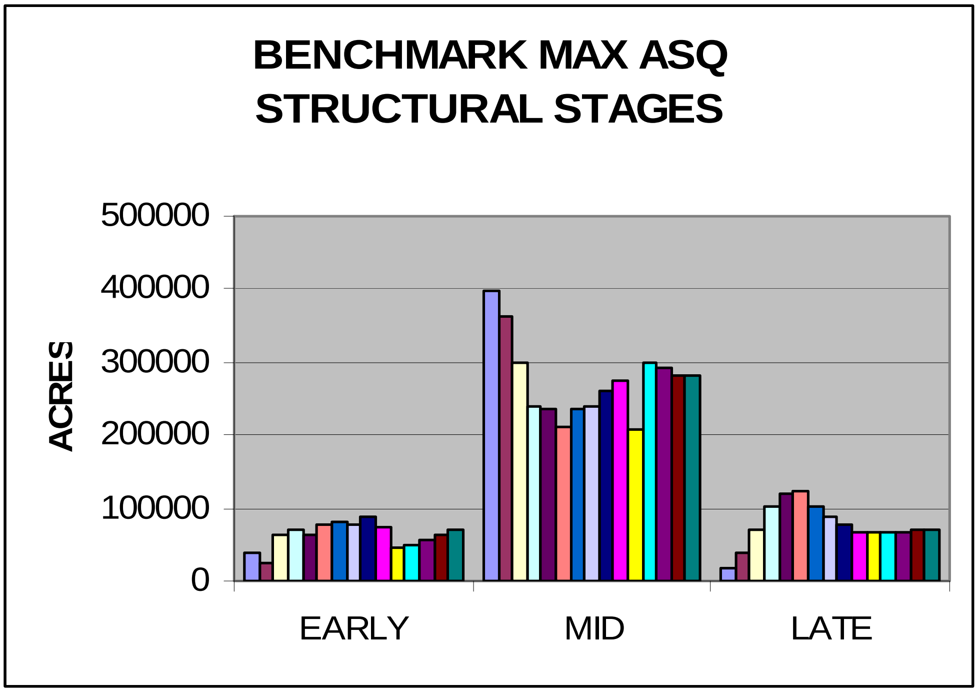


Figure B-7. Benchmark Objective function maximize ASQ decades 1 to 15 Indiana Bat Habitat

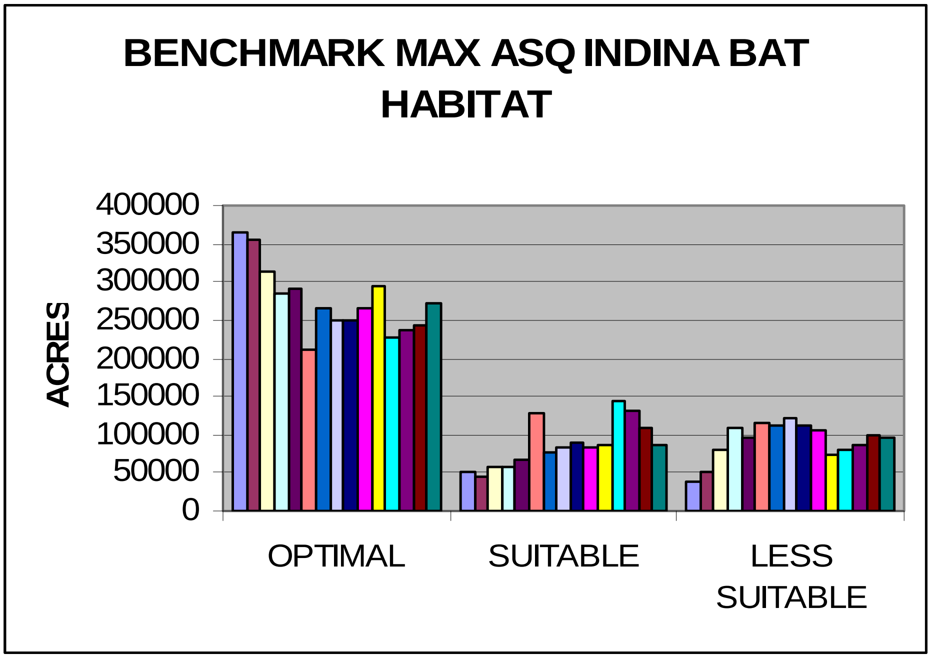


Figure B-8. Benchmark Objective function maximize PNV decades 1 to 15 Indiana Bat Habitat

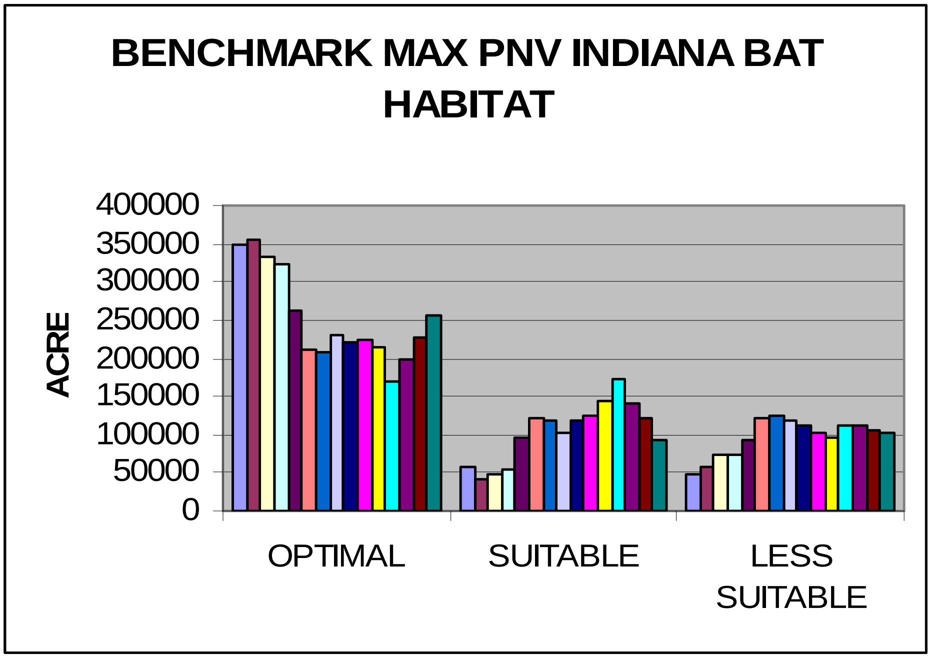
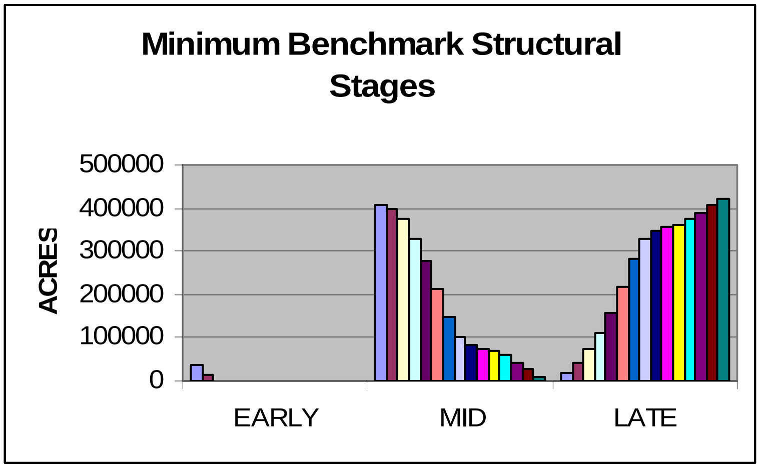


Figure B-9. Benchmark Objective function minimize ASQ Structural Stages



Results of Alternative Modeling

Benchmark scenarios were used to model Alternatives A, B, Cm, and D as a check of both the model and benchmark assumptions. Results and trends were similar to the first benchmark runs. Next, all Forest Plan constraints by alternative were applied to the models, including harvest constraints of non-declining flow and LTSY, and all the Alternative Models were run with a maximize PNV function for decades 1 to 15. ASQ was specified to be less than or equal to LTSY. ASQ results are displayed in Figures B-10 through B-11.

Objective Function Formulations for the ANF SPECTRUM Model

Mathematical notation

Maximize: $$Z' = \sum_{i=1}^{16} \sum_{j=1}^{R} \sum_{k=1}^{N} P_{ijk} X_{jk}$$ This row is labeled OFPNV in the matrix

Subject to: constraints specific to each alternative, as explained in Appendix B of FEIS. where,

R = number of management regimes

N = number of analysis units

Xjk = acres of analysis unit k allocated to management regime j

Pijk = net discounted net revenue per acre from activities and products produced on analysis unit k under regime j in period i (discount rate of 4%)

Departure Analysis and the 1/2 and 1/2 Rule

A departure analysis was completed for the DEIS; however, departure modeling was not conducted for the FEIS. The DEIS departure model was constrained to maximize ASQ in decades 2 and 3. The ASQ was 103,367 MCF in decade one, 126,383 MCF in decades 2 and 3, and 101,287 MCF in decades 4 through 15. Since model calculations for Structural Stages, Age Classes, and Indiana Bat Habitat are calculated differently, they are not presented here for the departure model to avoid confusion by making comparisons to the final models. Structural Stages, Age Classes, and Indiana Bat Habitat in the final models are calculated using the 1/2 and 1/2 rule for the model. The 1/2 and 1/2 rule calculates the attribute as one-half of the value at the beginning of the decade for the existing stand and one-half the value is reported for the regenerated stand. SPECTRUM reports the values at the beginning of the decade; although, harvest occurs at the mid point of the decade. The Results are displayed by decade.

Volume Outputs

Volumes were calculated in SPECTRUM using three outputs. The ALL MCF output calculates the volume from yield tables, the Hbd-Eq (Harvest Board foot Equivalents) are derived from the ALL output as a simple dependent relationship by multiplying the ALL output by a factor of 6.1. The Hbd-ST (Harvest Board foot Saw Timber) is derived from the ALL output as a complex dependency relationship utilizing the dominant layer from the yield table and a forest type specific time coefficient factor. Results of these outputs are displayed in Figures B10- B12, and the volumes in MCF for each alternative are listed in Table B-34.

Figure B-10. SPECTRUM Modeling–Comparison of Alternatives (MCF)

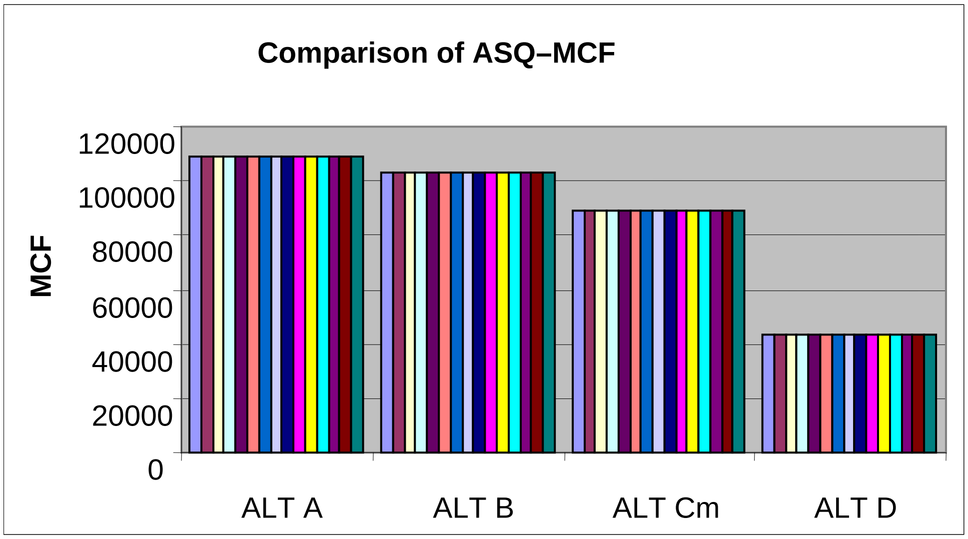


Figure B-11. SPECTRUM Modeling–Comparison of Alternatives (MBF-Eq)

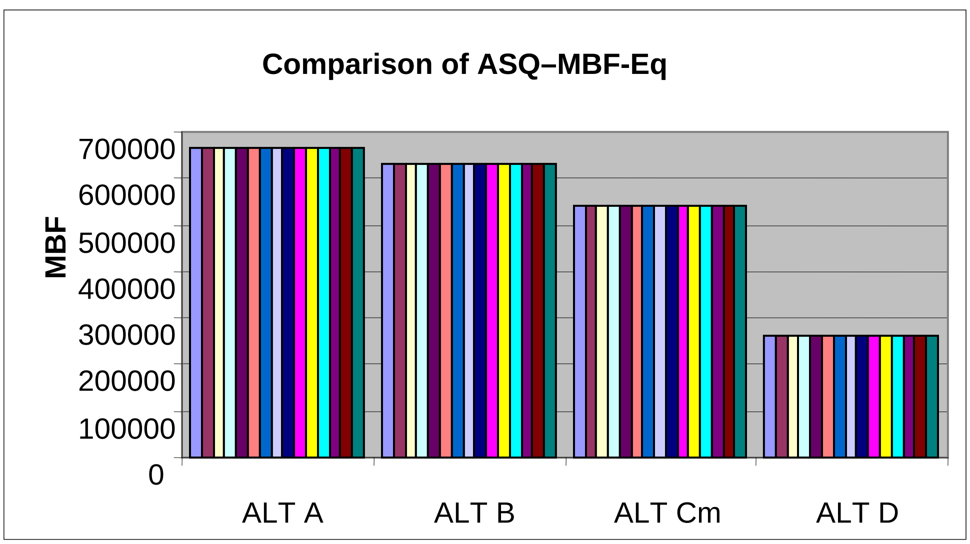


Figure B-12. SPECTRUM Modeling–Comparison of Alternatives (MBF-St)

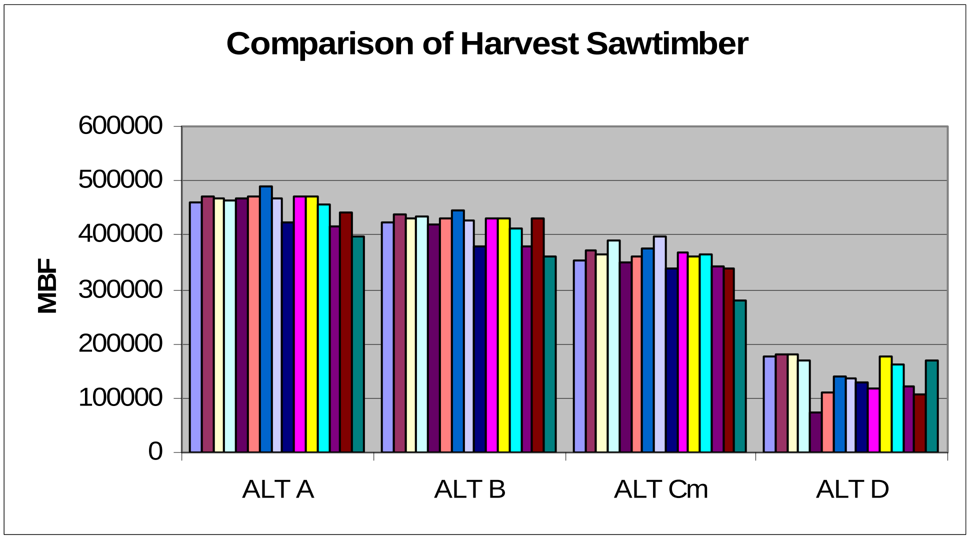


Table B-34. Volume Output (MCF) by Alternative by Decade

Alternative	Units	Decade 1 to 15
ALT A	MCF	108,969
ALT B	MCF	103,408
ALT Cm	MCF	88,745
ALT D	MCF	43,074

LTSY

LTSY is defined as “the highest uniform wood yield from lands being managed for timber production that may be sustained under a specified management intensity consistent with multiple use objectives” (USDA-FS 1982–CFR 219.3). The four model alternatives that were evaluated calculated the ASQ as a function less than or equal to the LTSY.

Table B-35. Long-term Sustained Yield

Alternative	Units	Decade 1 to 15
ALT A	MCF	108,969
ALT B	MCF	103,408
ALT Cm	MCF	88,745
ALT D	MCF	43,074

Analysis of Volume Results

- Alternative A shows the highest volume in decades 1 to 15.
- Alternative B shows the second highest volumes in decades 1 to 15.
- Alternative Cm shows the third highest volume in decades 1 to 15.
- Alternative D shows the lowest volume in decades 1 to 15.

Growing Stock and Growth

Growing stock, or standing inventory, is the volume of live trees present for a given area at an indicated point in time. The INV output from SPECTRUM is calculated in MCF. This variable indicates the standing inventory present for a given subpopulation at a specified planning decade. The ACINV output indicates the acres of a given population for a specified decade.

Growth from one decade to the next can be calculated by observing the change in growing stock from one decade to the next, as well as accounting for harvest during the earlier decade. As an example, decade 1's growth is defined as the growth that accrues between decade 1 and 2. This growth is equal to the growing stock displayed for decade 2, minus that for decade 1, plus the harvest in decade 1.

In Tables B-36 and B-37, Alternative Cm is used to illustrate how standing inventory and growth change over time. These values are effected by the amount, type and timing of silvicultural treatments applied in each alternative. The values calculated for these tables assume a harvest of 88,745 MCF per decade and a conversion factor of 6.1 MBF per MCF. In the following tables, the population description Suitable Forested Land refers to lands suitable for scheduled timber harvest activities.

There is an observed relationship between average growing stock per acre and average growth per acre per year. The denser the growing stock, the slower the growth.

Table B-36. Growing Stock (Alternative Cm)

Population	Units	Decade				
		1	2	6	10	14
All Forested Lands	MCF	1,464,579	1,472,203	1,423,334	1,429,707	1,428,532
	MCF/Acre	3.16	3.18	3.07	3.08	3.08
	MBF-Eq	8,933,932	8,980,438	8,682,337	8,721,213	8,714,045
	MBF-Eq/Acre	19	19	19	19	19
Suitable Forested Land	MCF	1,145,553	1,140,050	1,087,708	1,083,304	1,089,637
	MCF/Acre	3.01	3.00	2.86	2.85	2.87
	MBF-Eq	6,987,871	6,954,307	6,635,020	6,608,154	6,646,784
	MBF-Eq/Acre	18	18	17	17	17

Figure B-13. Growing Stock (Alternative Cm)

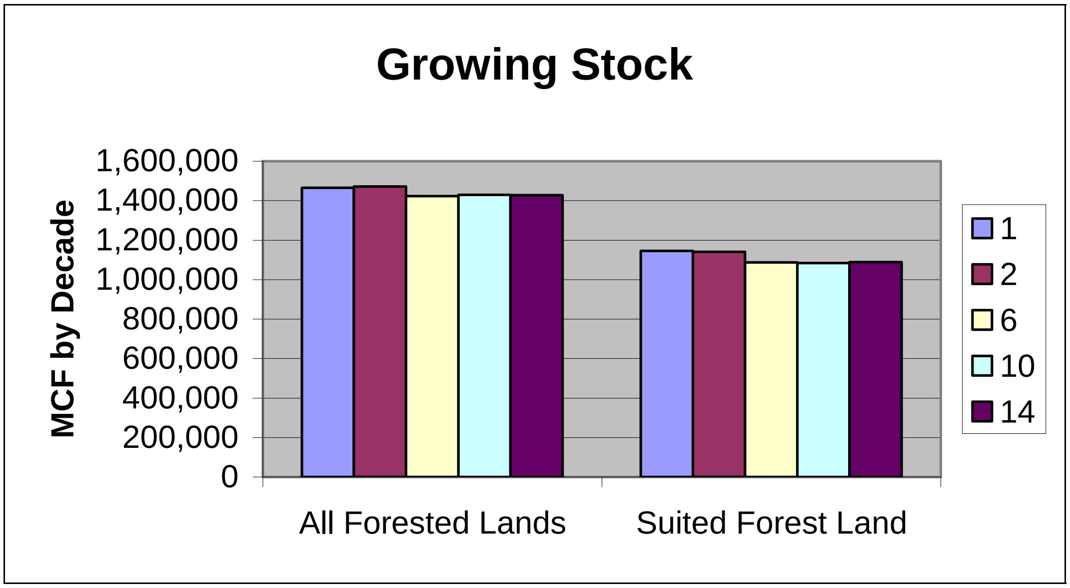
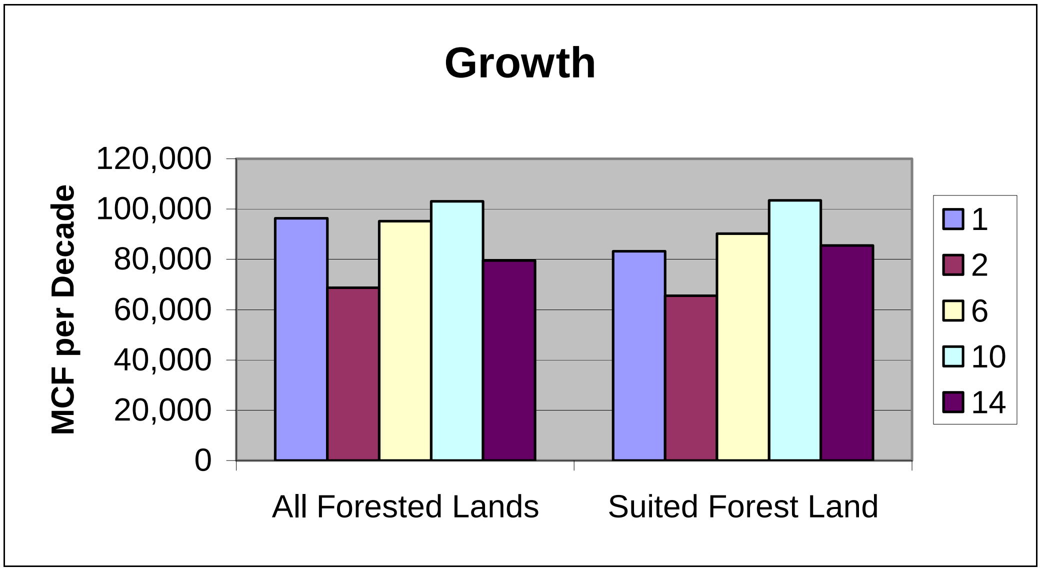


Table B-37. Growth (Alternative Cm)

Population	Units	Decade				
		1	2	6	10	14
All Forested Lands	MCF	96,369	68,765	95,216	103,071	79,580
	CF/Acre/Year	20.8	14.8	20.5	22.2	17.2
	BF/Acre/Year	127	91	125	136	105
Suitable Forested Land	MCF	83,243	65,555	90,208	103,485	85,529
	CF/Acre/Year	21.9	17.2	23.7	27.2	22.5
	BF/Acre/Year	134	105	145	166	137

Figure B-14. Growth (Alternative Cm)



Structural Stages by Alternative

Figure B-15. Alternative A Structural Stages

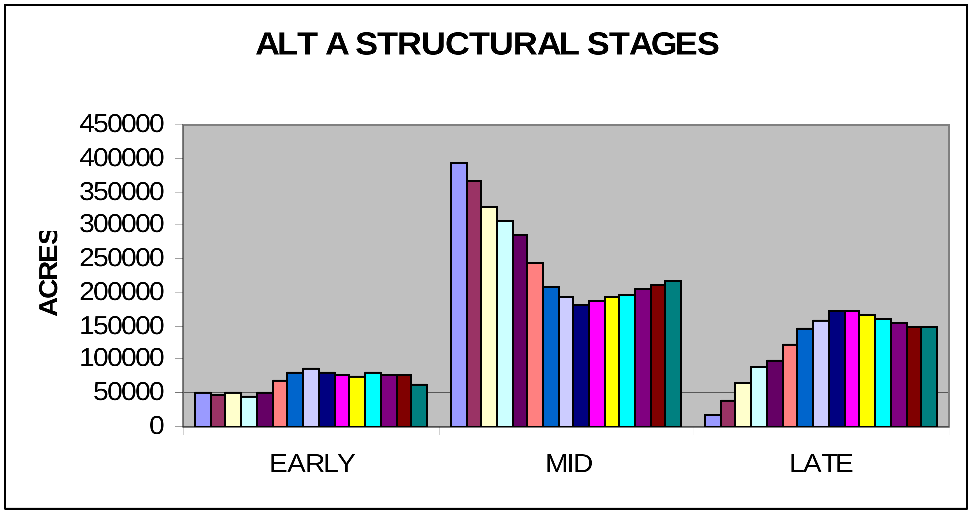


Figure B-16. Alternative B Structural Stages

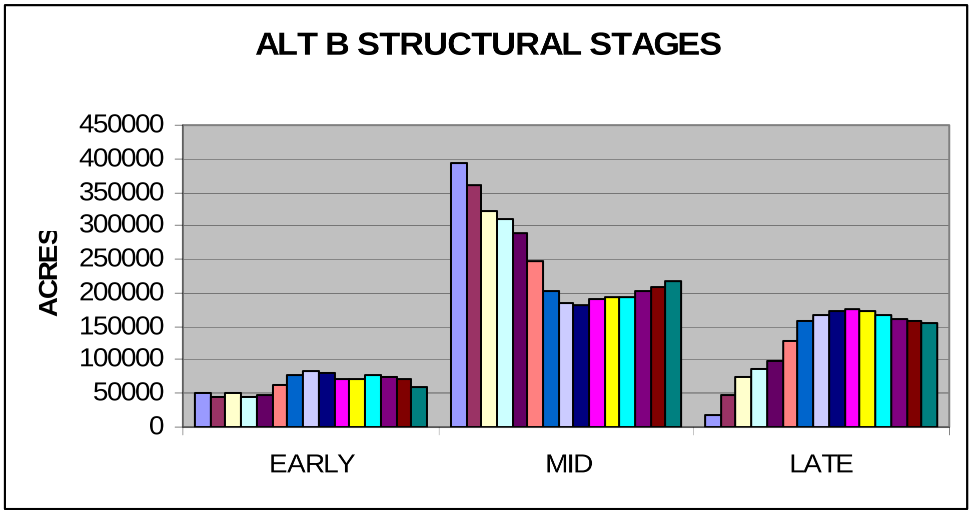


Figure B-17. Alternative Cm Structural Stages

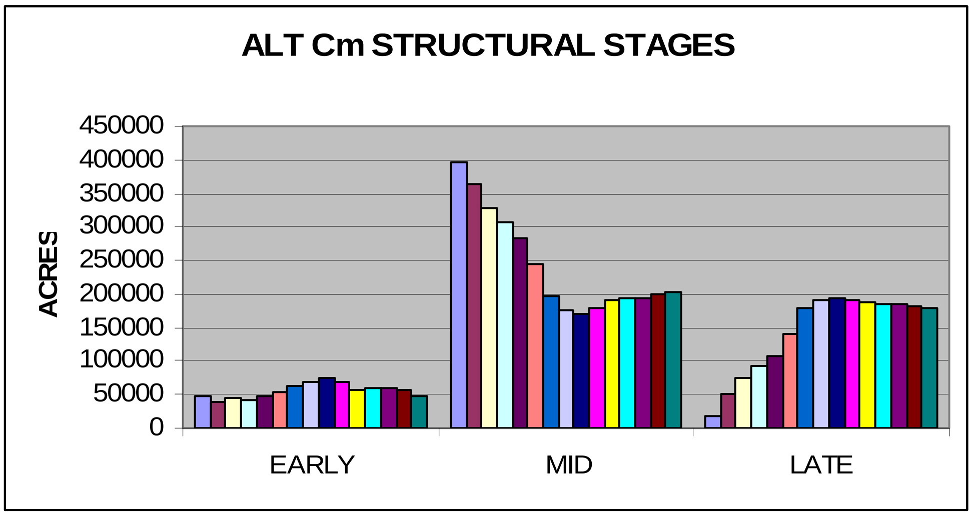
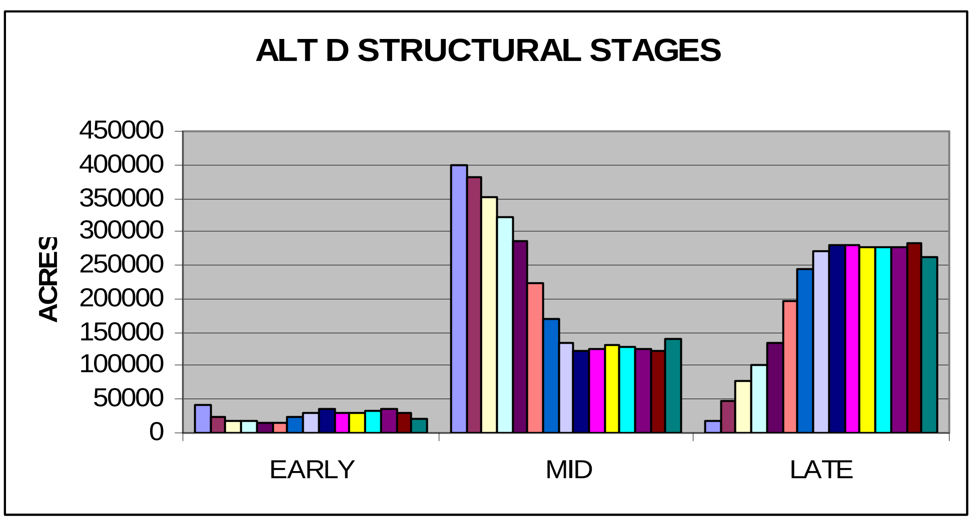


Figure B-18. Alternative D Structural Stages



Analysis of Structural Stages

- Structural stages for Alternatives A, B and Cm generally show similar values.
- The Early Structural Stage for Alternative D is the lowest of the four alternatives, and the Late Structural Stage is the highest.
- The Early Structural Stage generally is the lowest among all alternatives.

Indiana Bat Habitat by Alternative

Figure B-19. Alternative A Indiana Bat Habitat

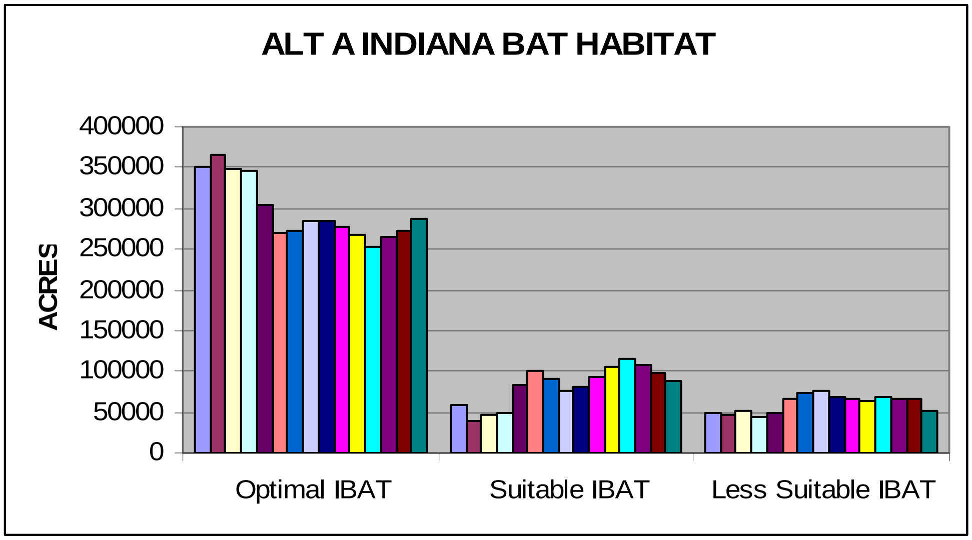


Figure B-20. Alternative B Indiana Bat Habitat

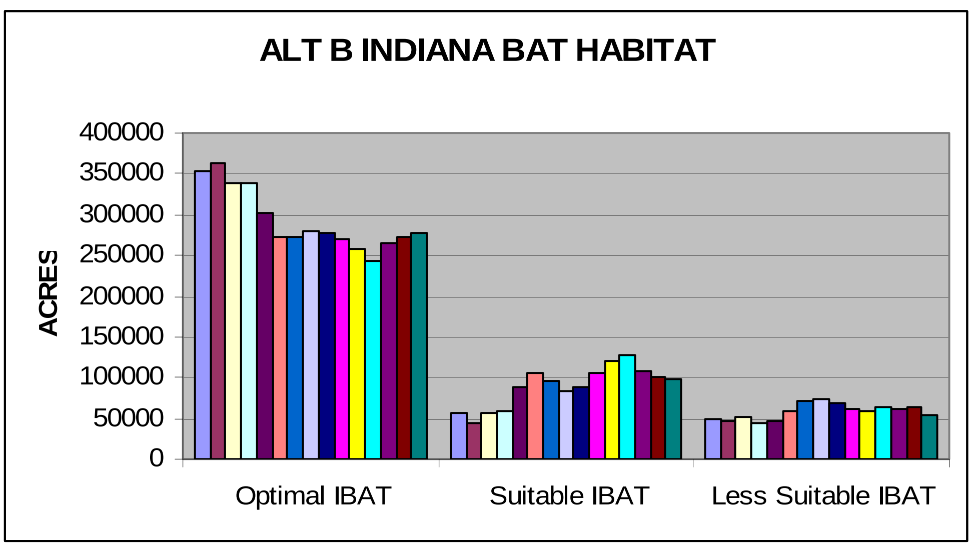


Figure B-21. Alternative Cm Indiana Bat Habitat

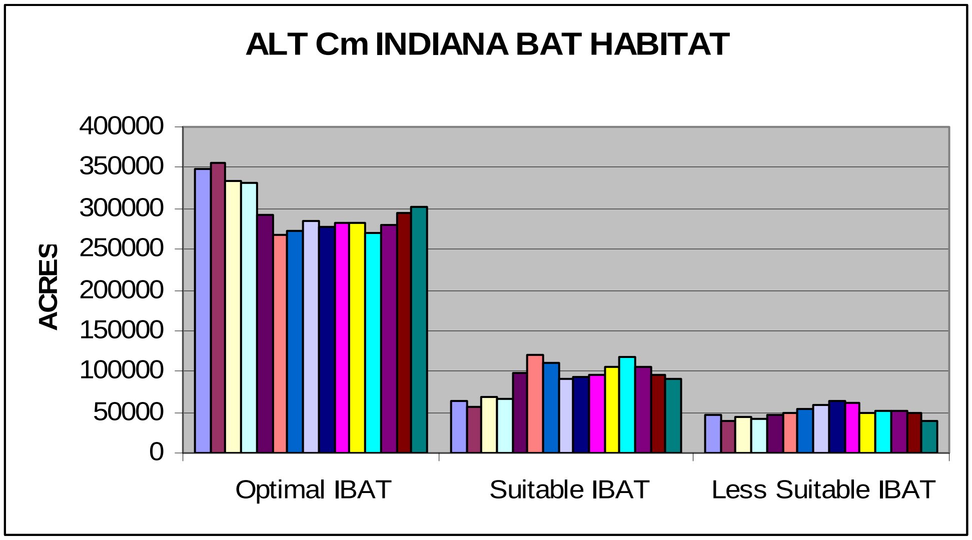
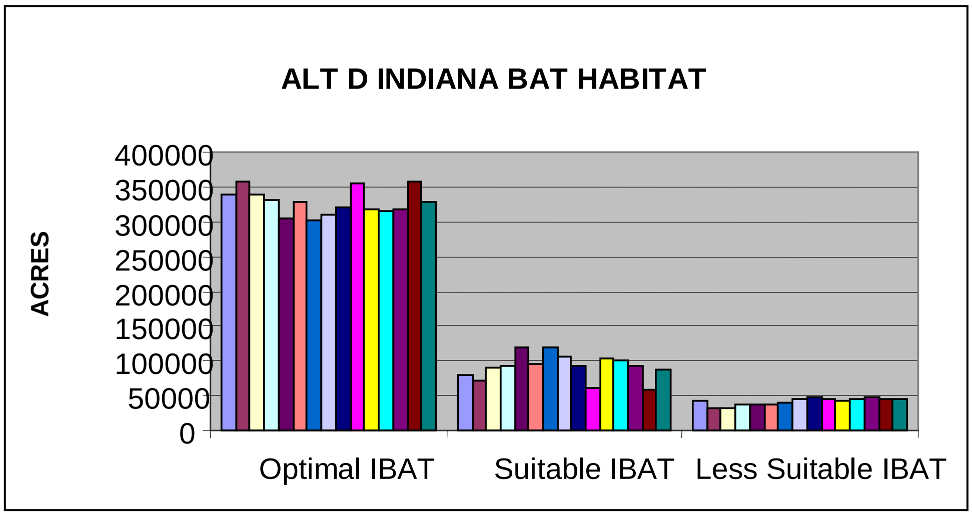


Figure B-22. Alternative D Indiana Bat Habitat



Analysis of Indiana Bat Habitat

- The Less Suitable Habitat is the lowest in all alternatives.
- Optimum Indiana Bat Habitat is the highest within each alternative among all alternatives.

Forest Composition Predictions

This section describes the assumptions used to analyze changes in forest composition over time. Forest composition is described in terms of the major forest types on the ANF: Allegheny hardwoods (AL), upland hardwoods (UP), northern hardwoods (NR), oak types (OK), hemlock (HM), conifer (CF), aspen (AS), and mixed low-stocked areas (MIX). The process of analysis included use of the SPECTRUM model for stands with even-aged regeneration harvests, while this discussion describes assumptions used for areas managed using uneven-aged methods, or where no active management occurred.

Forest Type Composition Resulting from Even-aged Management

Forest type conversions were estimated for even-aged regeneration harvests using the transfer classes (regenerated forest type and proportions) displayed in the following table. Following even-aged regeneration harvest, existing stands of one type transferred into another forest type based on the proportions displayed in the table. These transfer class assumptions are based on the tree species dominating each forest type (including their shade-tolerance, preference by deer, and regeneration potential), anticipated site conditions that would be created through even-aged final harvest or overstory removal, reforestation activities, research conducted on the Allegheny Plateau (Marquis et al. 1992; Horsley et al. 1994), and past experience on the ANF. SPECTRUM modeling calculated forest compositional outcomes based on these assumptions and associated transfer classes for even-aged regeneration harvests.

Table B-38. Forest Composition, Even-aged Management

Existing Forest Type	Regenerated Forest Type	Proportion
MIX	AL	0.25
	NR	0.25
	OK	0.25
	UP	0.25
AL	AL	0.9
	UP	0.1
NR	NR	0.1
	UP	0.7
	AL	0.2
OK	OK	0.9
	UP	0.05
	AL	0.05
UP	UP	0.8
	AL	0.2
HM	HM	0.2
	UP	0.8
AS	AS	1.0
CF	CF	1.0

Forest Type Composition Resulting from Uneven-aged Management

Short-term Changes

In all alternatives, it was assumed no forest type conversions would occur as a result of uneven-aged management in the next 20 years (decades 1 and 2). This is because only one entry will have been made to areas managed using uneven-aged management by decade 2. This would result in only about 20 percent of the treated stands regenerated, not enough to cause a change in tree species composition sufficient to change the forest type.

Long-term Changes

SPECTRUM modeling did not track forest type conversions that would be anticipated over a period of 6 decades as a result of uneven-aged management. Some degree of forest type compositional changes would likely occur following 6 decades of active uneven-aged management, as several commercial entries will have been made in many areas managed under this system, regenerating portions of treated areas. Forest composition assumptions for uneven-aged management are based on the tree species dominating each forest type (including their shade-tolerance, regeneration potential, and preference by deer), anticipated site conditions that would be created through uneven-aged management, including group sizes used, reforestation activities, potential tree seedling species composition, research conducted on the Allegheny Plateau (Marquis et al. 1992; Horsley et al. 1994), and past experience on the ANF. In all alternatives, it is assumed that group selection would be the regeneration method applied in areas managed using uneven-aged methods. Mixed (low stocked), conifer, aspen, and hemlock forest types were not modeled under uneven-aged prescriptions.

Alternative A

Forest type conversions were manually calculated for uneven-aged harvest acres based on the following transfer classes in Alternative A, which would utilize group sizes of less than 0.5 acres.

Table B-39. Forest Composition Decade 6 (2065), Uneven-aged Regeneration, Alternative A

Existing Forest Type	Regenerated Forest Type	Proportion
AL	AL	0.60
	UP	0.40
NR	NR	0.75
	UP	0.25
OK	OK	0.55
	UP	0.45
UP	UP	0.95
	NR	0.05
HM	n/a	
AS	n/a	
Mix	n/a	
CF	n/a	

Alternatives B, Cm and D

Forest type conversions were manually calculated for uneven-aged harvest acres based on the following transfer classes in Alternatives B, Cm and D, which would utilize group sizes of 1 to 3 acres, depending on the forest type.

Table B-40. Forest Composition Decade 6 (2065), Uneven-aged Regeneration, Alternatives B, Cm+ D

Existing Forest Type	Regenerated Forest Type	Proportion
AL	AL	0.75
	UP	0.25
NR	NR	0.55
	UP	0.40
	AL	0.05
CF	n/a	
OK	OK	0.85
	UP	0.15
UP	UP	0.90
	AL	0.10
HM	n/a	
AS	n/a	

Forest Type Composition Resulting from No Active Management

Short-term Changes

Due to the natural disturbance regime affecting the ANF, including disturbance frequency, it was assumed the structure and density of forest overstories on the ANF would remain fairly stable in the next 20 years. However, it is acknowledged that individual tree mortality and death of groups of trees due to age, decline and mortality, insect and disease infestation, or natural disturbances would occur to some extent. For the purposes of this exercise, it was assumed that forest type conversions in unmanaged areas would not occur to any great extent in decades 1 and 2 of Forest Plan implementation.

Long-term Changes

SPECTRUM modeling did not track forest type conversions that would be anticipated over a period of 6 decades as a result of no active management. It was assumed overstory mortality would result in small (<0.5 acre) gaps in the forest canopy over the next 6 decades as individual or small groups of trees could naturally fall out of the overstory due to age, decline and mortality, insect and disease infestation, or natural disturbances.

Many factors can affect tree species composition on the ANF over time. Each species has its own regeneration requirements and characteristics. Seed supply, seed predation, and forest floor conditions (e.g. bare ground and the available sun light) affect seedling success. Interfering vegetation and intense deer browsing impacts also are likely to affect tree species composition, in the absence of management. This process will result from some tree species developing seedlings more readily then others given the environment conditions.

Data on tree seedling species composition on the ANF has been collected in several types of forestwide surveys, each conducted within a specific time-frame during the past 12 years (USDA-FS, ANF, 1995a, Appendix L and Appendix M; Morin et al. 2001; Morin, et al. 2006). In general, the conclusion of these surveys is that current overstory species distribution is not being maintained. The understory tree seedling composition determines the future overstory tree composition that would occur in the event of a disturbance to the overstory trees. Based on existing understory conditions on much of the ANF, it was assumed there would be changes in forest type over time as stands develop following natural disturbance in the absence of management.

Forest type conversions were manually calculated for acres that were not managed based on the following transfer classes. These transfer class assumptions are based on the tree species dominating each forest type (including their shade-tolerance, regeneration potential, preference by deer), anticipated site conditions resulting from mortality of individual or small groups of trees, potential tree seedling species composition, research conducted on the Allegheny Plateau (Marquis et al. 1992; Horsley et al. 1994), and past experience on the ANF.

Table B-41. Forest Composition Decade 6 (2065), No Active Management Occurred, All Alternatives

Existing Forest Type	Future Forest Type	Proportion
AL	AL	0.60
	UP	0.40
NR	NR	0.75
	UP	0.25
OK	OK	0.82
	UP	0.18
CF	CF	0.75
	UP	0.25
UP	UP	0.95
	NR	0.05
HM	HM	0.95
	UP	0.05
AS	AS	0.50
	UP	0.50
Mix	n/a	

Other Resource Analysis Used to Develop Alternatives

Other information key to the results of the analysis is shown here for roads, recreation, scenery, and wildlife**.**

Roads

Future access planning was accomplished using GIS data. Knowledge from the ANF forestwide Roads Analysis (USDA-FS, 2003b) and subsequent project level roads analysis was utilized as well as experience from laying out roads on the ANF for 20 plus years. Based on the management area direction and allocation, a potential road system was developed for each alternative that will provide access for the proposed management activities (Table B-42) Projected System by alternative and management area). The following criteria were used in developing this potential road system:

- Minimize the number of perennial and intermittent stream crossing.
- Minimize the length of road crossings on group 3 soils.
- Utilize existing corridors as much as possible (often private OGM roads).

- Minimize the use of ROWs.
- Minimize crossing management areas that exclude roads to access management areas that require additional access.

With hunter access being the primary tool to manage the annual deer harvest and the knowledge that this will be a long-term access need, the management area direction was revised for local roads. Future road management under the LRMP for Alternatives B thru D is projected to be 1/3 open, 1/3 restricted, and 1/3 closed. The road management for Alternative A continues the 1986 Forest Plan direction of 20 percent open, 20 percent restricted, and 60 percent closed. These objectives were for a 50 year time frame and did not recognize the long-term needs for hunter access to maintain the deer herd.

Table B-42. Projected Road System by Alternative and Management Area

MA	Alternative A				Alternative B			
	Existing Forest Service (miles)	Existing corridor (miles)	New corridor (miles)	Total (miles)	Existing Forest Service (miles)	Existing corridor (miles)	New corridor (miles)	Total (miles)
1.0	14.8	3	5	**24**	14.6	3	5	**23**
2.1	15.8	1	1	**18**				**0**
2.2				**0**	169.9	39	0	**208**
3.0	924.6	141	162	**1228**	961.0	159	183	**1303**
5.1				**0**				**0**
5.2				**0**				**0**
6.1	193.8	55	139	**388**	23.6	8	11	**42**
6.2	39.3	10	19	**69**				**0**
6.3	5.0		0	**5**	4.9		0	**5**
7.1	21.1			**21**	32.6	0		**33**
7.2				**0**		0	0	**0**
7.3				**0**	3.5	0	0	**4**
8.1				**0**	2.6	0	0	**3**
8.1p				**0**		0	0	**0**
8.2	5.6			**6**	1.0			**1**
8.3	0.0			**0**	0.0			**0**
8.4	0.7			**1**	0.7			**1**
8.5				**0**				**0**
8.6	3.7			**4**	11.6			**12**
9.1	2.0	0		**2**				**0**
COE				**0**				**0**
Private	42.2	60	17	**120**	42.2	60	15	**117**
Reservoir	0.3			**0**	0.3			**0**
River								
2020 estimate	1268.6	191	116	**1576**	1269	203	103	**1574**
Total 2060 estimate	**1268.9**	**271**	**344**	**1884**	**1268.5**	**269**	**214**	**1751**

Table B-42. Projected Road System by Alternative and Management Area, continued

MA	Alternative Cm				Alternative D			
	Existing Forest Service (miles)	Existing corridor (miles)	New corridor (miles)	Total (miles)	Existing Forest Service (miles)	Existing corridor (miles)	New corridor (miles)	Total (miles)
1.0	14.8	3	5	**27**	13.6	2	4	**20**
2.1	15.8	1	1	**14**	401.8	65	57	**524**
2.2			0	**268**	258.9	54	0	**313**
3.0	924.6	141	146	**1168**	387.6	58	57	**503**
5.1				**0**				**0**
5.2				**0**	0.6	0	0	**1**
6.1	193.8	55	10	**52**	57.4	17	18	**93**
6.2	39.3	10		**0**				**0**
6.3	5.0		0	**5**	4.9		0	**5**
7.1	21.1			**33**	32.6			**33**
7.2			0	**2**	10.5		0	**11**
7.3				**0**				**0**
8.1			0	**3**	2.6		0	**3**
8.1p			0	**0**		0	0	**0**
8.2	5.6			**1**	1.0			**1**
8.3	0.0			**0**	0.0	0	0	**0**
8.4	0.7			**1**	0.7			**1**
8.5				**0**				**0**
8.6	3.7			**12**	11.6			**12**
9.1	2.0	0		**0**				**0**
COE				**0**				**0**
Private	42.2	60	16	**119**	42.2	60	16	**118**
Reservoir	0.3			**0**	0.3			
River								
2020 estimate	1268.6	191	85	**1538**	1226	171	69	**1466**
Total 2060 estimate	**1268.9**	**271**	**178**	**1703**	**1226.3**	**258**	**152**	**1636**

Recreation

Motorized Trail Construction

It is assumed that future motorized trail construction projects will create snowmobile connectors to communities within Penn DOT ROWs adjacent to existing State Routes. A total of 36 miles is predicted to be completed by the end of decade two, which equals 1.8 miles/year.

Table B-43. Prediction Snowmobile Trail Construction Projects

Project Location	Miles of Construction
Tionesta to connector 21	5.25
Ridgway to Owls Nest	12.0
Bradford to ASL 1 (Willows)	10.50
Sheffield to ASL 1 (Dunham Siding)	8.25
Total	36.00

It is assumed that most potential ATV/OHM trail construction will occur by the end of decade 2.

Table B-44. Prediction ATV/OHM Trail Construction

Alternative	Estimated Miles of Trail Construction	Miles per Year
A	72	3.6
B	124	6.2
Cm	45	2.3
D	12	.6

Combine the projected yearly snowmobile and ATV/OHM trail miles and round to the nearest whole number. (Whole numbers appear in Table 2.2 of the FEIS)

Table B-45. Prediction Total Motorized Trail Construction

Alternative	Miles per Year
A	5
B	8
Cm	4
D	2

Non-motorized Trail Construction

It is assumed that future construction and reconstruction is based on decadal accomplishments in the last planning period. In the last 20 years, 100 miles of trail have been constructed, or 5 miles/year. Therefore, it is predicted that 50 miles of new non-motorized trails will be constructed in both decades 1 and 2.

Dispersed Site Enhancement in CUAs

It is assumed that future dispersed site inventory is just starting on the ANF. However, based on existing information and current capability, approximately one area per year will be enhanced to address environmental degradation and user satisfaction. Inventory and prioritization of future site enhancement will continue. It is expected that some of the more popular CUAs will be prioritized as a result of the implementation of the Travel Management Rule.

Developed Site Construction and Reconstruction

It is assumed that all Development Scale 4 and 5 campgrounds, with the exception of Dewdrop, have been reconstructed over the last decade. It is also assumed that the Recreation Facility Master Planning will directly influence all developed site management in the future. The Recreation Facilities Master Plan is being developed and implementation will modify existing facility capability to meet demand and customer needs. Based on the outcome of the Master Plan exercise, facilities will be retained, developed for alternate use, or decommissioned.

Landscape Capability Analysis

A landscape capability analysis was performed to delineate suitable ATV/OHM intensive use areas (IUA) and Equestrian Use Areas (EUA). This analysis was also be used to estimate the potential miles for ATV/OHM trail development by area (see the LRMP Table 2).

Introduction and Methodology

The following material summarizes the IUA, EUA, and Equestrian Open Riding Area inventory and development analysis. Both IUAs and EUAs identify areas generally acceptable for building trails based on a broad scale evaluation of social, physical, and biological characteristics.

Since the implementation of the 1986 Forest Plan, the ANF has been managed under the Intensive Use Area Concept. Five IUAs were located throughout the ANF, totaling approximately 118,500 acres. This number includes private inholdings within the delineated boundaries of the IUAs. The 1986 Forest Plan restricted ATV and trail bike use to designated trails within these IUAs.

Table B-46. Intensive Use Areas

Intensive Use Area	Acres
Bluejay/Duhring	46,576
Westline	25,650
Twin Lakes/Highlands/Owls Nest	18,956
Marshburg/Stickney	18,163
Grunderville/Chapman	9,180
Total	118,525

Equestrian trails were not addressed in the 1986 Forest Plan. Historic use has been recorded from about the mid 1950s in several areas of the ANF. Riding is allowed cross country and is restricted from system hiking trails. Riding on ATV trails and snowmobile trails is permitted. Documented impacts to soil and water resources were addressed in project level analysis in the Spring Creek EIS (USDA-FS 2004i), resulting in a yet to be constructed 42 mile dedicated trail system.

Analysis techniques involved the use of GIS data to evaluate all lands within the ANF proclamation boundary for their suitability as either an IUA or EUA. The analysis methodology was essentially the same for both uses and involved determining land masses that met minimum physical, biological, and social criteria. The criterion chosen to evaluate suitability is based on resource capability and ecosystem management principles. The analysis results provide an overall forestwide suitability evaluation that requires confirmation at the project level scale to determine ultimate feasibility.

To establish geographic placement of IUAs, exclusionary criteria were applied to forest lands within the proclamation boundary to determine any suitable area for development. Areas directly adjacent to the existing IUAs were evaluated first for logical addition. Similarly, areas without trail development in the IUAs that have some, many, or all the exclusionary criteria were also located for potential elimination from the IUAs. Lastly, other areas not contiguous to the existing IUAs were evaluated for consideration as new IUAs. Ground level information and resource specialist expertise was also used in the final evaluation.

A similar exercise was undertaken with the development of the EUAs and Equestrian Open Riding Areas. However, since none currently exist, an initial investigation was made using local knowledge of the historic use areas. Once the boundaries were determined, the same analysis methodology used above was applied, which resulted in the first iteration of EUAs. A second run was then made to determine the suitability of other areas within the proclamation boundary. The results of both exercises were used to develop a range of alternatives.

It is important to note EUAs were initially evaluated as described above. Due to further development of the issue it was varied by alternative. In subsequent meetings with equestrian groups, a clearer determination of the actual extent of the EUAs was made (compared to the initial determination now displayed in Alternative D of 47,225 acres). The net result of these meetings was the reduction in size of the original EUAs for Alternatives B and Cm. These EUAs are now much smaller and are the same size for both alternatives. The EUAs now total 10,567 acres.

Alternative Development Criterion

A range of alternatives was developed to address the range of public comments received. Three primary action alternatives included high development, moderate development (approximately the same as existing), and low development. The analysis output varied on the emphasis placed on the criteria below. In addition, the same criteria and methodology are applied to Alternative A. The resulting acres by alternative are displayed in Table B-47.

Alternative B–Consider Areas with Minimal Resource Concerns

- Private lands, exclude all
- MA 5.1, 6.4, 8.0, and 6.3, exclude all
- No IRA/RRA development
- Floodplains, exclude concentrations
- NWI, exclude concentrations
- Riparian, avoid but consider if it doesn't dissect
- Streams, Special status streams (no crossings)
- Group 3 soils, avoid concentrated areas
- Slope, exclude >30 percent and <5 percent
- Landscape linkages, no new trails in MA 2.2
- Trails, already existing ATV
- 13 Percent Area, avoid
- municipal watersheds, avoid
- Rattlesnake dens/raptors, avoid concentrations
- DS3 ELT, depressed areas/perched areas (avoid if significant)
- Road densities, use ROS to determine experience/avoid RM and SPM
- Public input, do not develop previously identified areas

Alternative Cm–Consider Some Areas with Resource Concerns

Same criterion as Alternative B with the following exceptions:

- Breakout IRA/RRA separately/some development
- Landscape linkages (MA 2.2), trail/road density not to exceed present densities
- Public input, develop previously identified areas

Alternative D–Consider All Available Areas

Same criterion as Alternative B with the following exceptions:

- Develop all IRA/RRA if feasible
- Riparian, include all areas
- Streams, special status streams (no more than 1 crossing per 2 miles)
- Slope, exclude >45 percent and <5 percent
- Landscape linkages (MA 2.2), trail/road density not to exceed present densities
- Public input, develop previously identified areas

Results

Results of the analysis indicate acres of suitable NFS lands available. The purpose of this forest level planning effort is to determine the appropriate location and balance of lands available for this activity. Future project level planning will determine feasibility and amount of trail within the IUAs and EUAs.

Table B-47. Alternative Comparison (Acres)

Element	Alt. A	Alt. B	Alt. Cm	Alt. D
ATV/OHM Trail Riding Opportunities (IUAs)	98,974	113,019	83,202	40,519
Equestrian Trail Riding Opportunities (EUAs)	0	10,567	10,585	49,934
Equestrian Open Riding Areas	506,475	470,084	456,661	0

Scenery

An important component of the Scenery Management System for project analysis and planning is the Concern Level Inventory. This inventory was completed in 2006 for Forest Plan revision analysis and will be used with the scenic integrity level (SIL) map and other scenic inventory data in project analysis. A separate handbook, the ANF Scenic Implementation Guide, provides direction to mitigate and to achieve desired scenic conditions on the ground.

Table B-48. Concern Levels

Concern Level	Description
1	Travelways and use areas include nationally and regionally important locations, including primary roads, scenic byways, trails, wild and scenic rivers and other special designation areas. These areas have the highest concern for scenery based on heavy recreation traffic and the perception that scenery is one of the primary objectives for traveling these travelways.
2	Travelways and use areas include locally important locations, including secondary roads, hiking trails, streams, and all motorized trails. These areas may have high to low use, and may be traveled for dispersed recreation activities with a moderate interest in scenic viewing.
3	Travelways and use areas include all other forest roads, trails, and streams with a low or seasonal use. The interest in viewing scenery is considered low for these corridors. All areas not in Concern Levels 1 or 2.

The following inventory of roads, trails, use areas, rivers and streams is based on the public preferences for scenery as observed by resource specialists on the ANF. See the SIL map for locations assigned to Concern Levels 1 and 2.

Table B-49. Concern Level Inventory

Topic	Concern Level 1	Concern Level 2
Roads		
State Routes	6, 36, 59, 62, 66, 219, 321, 346 (W of SR321), 666, 770, 948, 1003, 1013, 2002, 2005, 2006, 3002 (parts), 3005, 3006, 3022	127, 346 (E of SR321), 2001, 2003, 2010, 2012, 3002 (parts), 3004, 3005, 3018, 3020, 4002, 4004, 4006, 4010
Township Roads	Chapman, EJO361, EMI301, ERI307, ESP301, ESP307, FJE358, FKI345	CFA, EJO359, EMI302, EMI304, EMI518, ESP314.1, FGR392, FHA384, FHI357, FJE327, FKI357, FKI396, MWE301, MWE311.1, WBR444, WBR466, WEK615, WLM416, WME154,WPL405

Topic	Concern Level 1	Concern Level 2
Forest Roads	FR100 (Tidioute Overlook) FR131 (Loleta Grade) FR133e (Tionesta Scenic Area) FR157 (Buzzard Swamp) FR191 (Twin Lakes) FR193.1 (Hearts Content Rec Area) FR193.1 (Hearts Content Day Use Area) FR200 (Buckaloons) FR201 (Bean Fields) FR203 (Dewdrop) FR207 (Minister) FR270 (Tracy Ridge) FR282 (Beaver Meadows) FR284 (Loleta) FR290 (Twin Lakes) FR319 (Buckaloons Launch) FR366 (Loleta Rec Area) FR492 (Jakes Rocks) FR503 (Kiasutha) FR509 (Elijah Boat Launch and Bank Fishing Pathways) FR596 (Wolf Run Marina) FR602 (Willow Bay) FR604(Kinzua Pt Info Ctr) FR605 (Kinzua Beach) FR610 (Red Bridge) FR611 (Red Bridge Bank Fishing) FR615 (Roper Hollow) FR701 (Webbs Ferry)	116,119, 122, 123, 124, 130, 133, 136, 137, 141, 143, 145, 150, 152, 154, 160, 173, 176, 185, 186, 195, 223, 227, 237, 244, 259, 271, 279, 282, 321, 339, 377, 378, 395, 403, and 507 (Devils Elbow)
Non-system Roads	n/a	NS19341, NS27668, NS27669, NS27670
Longhouse National Scenic Byway	SR59 (from FR262 to SR321) FR262 (Longhouse Scenic Drive) SR321 (from SR59 to FR262)	n/a

Topic	Concern Level 1	Concern Level 2
Pedestrian Trails/Trailheads		
All Congressionally Designated Hiking Trails/ Trailheads	Black Cherry National Interpretative Trail North Country National Scenic Trail (NCNST) Tracy Ridge Hiking Trail (NRA)	n/a
Other Hiking Trails/Trailheads (TH) including Cross-country (X-C) Ski	Handsome Lake Trail (Pathway -NRA) Hooks' Brook Pathways Hopewell (Pathway) Hearts Content Interpretive Trail Hearts Content X-C Ski Trail Hickory Creek Wilderness Trail Hopewell Trail (NRA) Jakes Pathways Johnnycake Trail (NRA) Kiasuatha Pathways Land of Many Uses Interpretative Trail (NRA) Loleta Pathways Minister Creek Trail Morrison Boat To and Pathways. Morrison Trail and TH (FR515) Rimrock X-C Ski Trail Seneca Trail (Buckaloons) Tanbark Trail Tionesta Scenic Area Interpretive Trail and TH Tracy Ridge X-C Ski Trail (NRA) Twin Lakes Pathways Webb's Ferry Pathways	Amsler Springs TH Beaver Meadows Hiking Trail Brush Hollow X-C Ski/Hiking Trail and Trailhead (TH-FR851) Buzzard Swamp Hiking Trail and TH (FR376) Campbell Mill Interpretative Trail (Dewdrop) Deerlick X-C Ski Trail and Road(WSH324, FR139,620) Irwin Run Boat Launch (FR852) and Bank Fishing Pathway Laurel Mill X-C Ski/Hiking Trail and Trailhead (FR848) Little Drummer Interpretive Trail and TH (FR685B) Loleta Hiking Trail Longhouse Trailhead Longhouse Interpretative Trail (Kiasutha) Mill Creek Trail Songbird Soujourn Interpretative Trail Tidioute Riverside Trail Timberdoodle Flats Interpretive Trail and TH (FR879) Twin Lakes Trail Westline X-Country Ski Trail and TH (FR855)
Equestrian Trails/Trailheads		
Equestrian Trails/Trailheads	n/a	Spring Creek Trails

Topic	Concern Level 1	Concern Level 2
Motorized Trails/Trailheads		
All ATV/OHM/ Snowmobile Trails/Trailheads	n/a	Allegheny Snowmobile Loop (ASL) ASL Snowmobile Connector 2-28 (except 13 and 27), Chapman and Graybill Marienville ATV Trail and TH (FR225 and FR395) Marienville Bike Trail Rocky Gap ATV Trail and TH (FR155) Timberline ATV Trail and TH (FR232), Pigs Ear, and Buehler Willow Creek ATV Trail

Topic	Concern Level 1	Concern Level 2
Use Areas		
Developed Recreation Areas	**Areas including Management Areas (MA 7.1):** Beaver Meadows Rec Area Big Bend Buckaloons Rec Area Chapman State Park Dew Drop Rec Area Elijah Run Boat Launch Handsome Lake Boat Access Campground Hearts Content Day Use Hearts Content Rec Area Hooks Brook Boat Access Campground Hopewell Boat Access Campground Jakes Rocks Overlook Kiasuatha Rec Area Kinzua Beach Kinzua Point Information Center Kinzua Wolf Run Marina Loleta Rec Area Minister Creek Campground Morrison Campground Pine Grove Boat Access Campground Red Bridge Rec Area Rimrock Overlook Roper Hollow Boat Launch Tidioute Overlook Tionesta Boat Access Campground Tracy Ridge Rec Area Twin Lakes Rec Area Webbs Ferry Boat Launch Willow Bay Rec Area	**Other Areas:** Bear Creek Campground Big Rock Overflow Birdsall Eddy Camp Nine Camp Area Camp Olmsted Camp Run Rec Res Area Dunkle Corners Farnsworth Administrative Site Hall Residence (Bat Barn) Hoffman Farm Camp Area Irwin Run Canoe Launch Kelly Pines Campground Old Powerhouse PA Field Trial Red Mill Campground Seldom Seen Rec Res Area Seneca Pumped Storage Reservoir Sugar Bay Dispersed Area

Topic	Concern Level 1	Concern Level 2
Administrative Sites	**All Administrative Sites (MA 7.1)** Laboratory (FR496) Bradford RD (FR653) Marienville RD (FR702) Supervisors Office, Warren, PA Ridgway RD (FR281) Sheffield Administrative Site Mead Street House (FR372) Marienville Administrative Buildings (4 total)	n/a
Scenic Areas	**All Scenic Areas (MA 8.3)** Hearts Content Scenic Area Tionesta Scenic Area	n/a

Topic	Concern Level 1	Concern Level 2
Rivers and Streams		
Rivers and Streams	Allegheny Reservoir Allegheny River Clarion River Kinzua Creek Morrison Run (Remote Trout Stream) Tionesta Creek Tionesta Lake	Bear Creek Big Mill Creek Blue Jay Creek Brown Run Camp Run Chappel Run East Br. Millstone Creek East Fork Run East Hickory Creek Farnsworth Branch Fourmile Run Hedgehog Run Hunter Creek Kinzua Creek Kinzua Creek -South Branch Martin Run Meade Run Millstone Creek Minister Creek–3 branches Queen Creek Salmon Creek Six Mile Run Spring Creek Sugar Run Tionesta Creek–East Branch Tionesta Creek–South Br. Tionesta Creek–West Br. Two Mile Run W. Br. Millstone Creek Willow Creek Wolf Run–Jenks Twp Wolf Run–Highland Twp

Topic	Concern Level 1	Concern Level 2
Rivers and Streams (continued)		
State Wilderness Trout Streams	n/a	Arnot Run Crane Run East Hickory Creek Fourmile Run Wildcat Run So. Branch Kinzua Creek
Remote Trout Streams	n/a	East Fork Run Pell Run Tracy Run

Source: Allegheny National Forest resource specialists with district approval.

Management Indicator Species (MIS)

Definition

"Management Indicators Species are plant and animal species, communities, or special habitats selected for emphasis in planning, and which are monitored during forest plan implementation in order to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent." (Forest Service Manual 2620)

Considerations for Choosing Management Indicator Species

Species of concern that lend themselves well to credible monitoring protocols are good candidates for MIS status under the 1982 Planning Rule. This rule directs the Forest Service to designate MIS status where appropriate. A species is not a good candidate for MIS status when the species is not influenced by management activities or when credible and cost effective population trend data is not obtainable for the planning area.

Monitoring Considerations for Management Indicator Species

A good experimental design is required to isolate the effects of Forest Service management activities to MIS populations from all the other factors that influence their populations (e.g. winter severity, hunting, winter range conditions for migrants, etc.). A good experimental design includes replication, randomization, and controls.

1. Because methodologies to determine population numbers and/or estimate trends vary by species, conclusions that relate population trends to habitat conditions are also reached through a variety of methods. These methods include:

    a. Population trends can be determined through the use of 100 percent population counts or can be estimated through the use of population sampling designed to estimate actual population numbers. (Although rarely used, 100 percent population counts can be feasible for some species, such as for populations in very restricted geographic areas.) These are the most intensive and rigorous methodologies, usually reserved for some federally listed species or some high risk globally-imperiled species selected for MIS status.

    b. Population trends can be estimated through the use of population indices. These indices are not estimates of actual population numbers, but are aimed at reflecting population trends or relative abundance for a species. Properly designed population indices are a well accepted method for assessing populations for many taxa. Examples could include state hunting/fishing information, track counts, and bird point counts. This method is commonly used in natural resource management.

c. Population trends can be estimated using population occurrence data. This approach would be appropriate for a MIS where the risk to local or broad extirpations is low to moderate (cost of making a management decision that would adversely affect the species is low to moderate) and there is high correlation and understanding for a MIS and its associated habitat(s) (high likelihood the conclusions regarding population trends would be correct).

d. When population data is not available, population trends may be inferred using species-habitat relationships information. This approach involves inferring population trends from trends in amount and condition of habitat over time, based on known relationships between species and habitat.

2. Site-specific monitoring or surveying of a proposed project or activity area is not required. At the project-level, habitat analysis will be conducted, as appropriate. These analyses will determine the effects, including cumulative effects, for each alternative on each MIS selected for the project. The effects to MIS habitat for the project are put into perspective by discussing forestwide MIS conditions and trends.

Proposed Changes to ANF Management Indicator Species List

The 1986 Forest Plan identified 16 MIS.

Table B-50. Management Indicator Species from the 1986 Forest Plan

MIS	Habitat Indicator
American Woodcock	Permanent Openings/Regenerating Deciduous
Barred Owl	Old Growth Mixed Hemlock-deciduous
Beaver	Regenerating Deciduous (Aspen)
Black-throated Green Warbler	Mature Mixed Hemlock-deciduous
Brook Trout	Cold Water Habitat
Great Blue Heron	Old Growth Mixed Hemlock-deciduous
Hermit Thrush	Mature mixed Hemlock-deciduous with Dense Understory
Magnolia Warbler	Regenerating Hemlock
Pileated Woodpecker	Old Growth Deciduous
Rattlesnake	Regenerating Deciduous
Red-shouldered Hawk	Mature Deciduous
Ruffed Grouse	Regenerating Deciduous
Smallmouth Bass	Cool Water Habitat
Walleye	Cool Water Habitat Demand Species
White-tailed Deer	Regenerating Deciduous
Yellow-bellied Sapsucker	Mature Deciduous

Monitoring of these MIS has demonstrated the need to select new MIS (ANF Need for Change, September 2003). Concerns with the current MIS list include: (1) the large number of MIS makes it difficult to monitor all of them at a level that will detect population change, (2) some species are difficult to monitor (3) some species are habitat generalists (4) inability to isolate the effects of ANF management on populations from all the other factors that influence populations (e.g. winter severity, hunting, winter range conditions for migrants, etc.). Rationale and species selected as MIS for the ANF LRMP can be found in Chapter 3 of the FEIS–Plant and Animal Section.

Table B-51. Disposition of Management Indicator Species from the 1986 Forest Plan

MIS	Habitat Indicator	Effects of Forest Service management activities to MIS populations	Other factors that influence their populations (e.g. winter severity, hunting, winter range conditions for migrants, etc.).	Disposition
American Woodcock	Permanent Openings/ Regenerating Deciduous	Management activities include the creation and maintenance of early structural conditions, only one component of preferred habitat. In addition to creation of early structural habitat for nesting, we also maintain or improve openings that are utilized for singing/courtship display.	Single brooded species with potential for low reproductive success, decline of breeding habitat in the Northeast and excessive hunting on winter range. Their habitat requirements change throughout the season as well as by life stage. This species was originally selected as an indicator of permanent openings and regenerating deciduous habitat. However, it is now recognized that wet soils, often in lowlands and bottoms, are specific components of woodcock habitat. These low, wet areas with small openings and saplings contain earthworms, an important food source. Small openings near early successional stands and near wet soils comprise a small portion of the ANF overall and populations are assumed to be low.	Propose dropping as a MIS because other factors are influencing populations more than Forest Service management activities. Little management occurs in preferred bottomland habitat. Availability of nesting (early structural) as well as singing/roosting habitat will continue to be monitored.

Barred Owl	Old Growth Mixed Hemlock-deciduous	Forest Service activity that may negatively affect populations is habitat alteration from timber harvest. However, active management within the barred owl's preferred habitat is focused on riparian dependent species and would be given preferential consideration if habitat enhancement projects are proposed.	Human disturbance and the impacts from non-native invasive species have a greater influence on populations than Forest Service activities. Recreationists often seek out wooded riparian areas for camping and fishing. However, it is unclear how much disturbance the barred owl will endure before abandoning a nest site (Fergus 2000). Hemlock wooly adelgid has the potential to significantly alter preferred habitat conditions. It is estimated that its advance to the ANF is eminent and current landscape control methods are lacking. In other regions, hemlock wooly adelgid has caused greater than 95% mortality of hemlock. Permanent resident throughout its range.	Propose dropping as a MIS. Forest Plan direction will continue to buffer active nest sites from Forest Service activities. Monitoring will continue. Other factors are greater influences to population numbers. Preliminary analysis of monitoring data indicates that it is difficult to isolate effects from Forest Service management. Suitable habitat will continue to be tracked.
Beaver	Regenerating Deciduous (Aspen)	Forest Service activities that may affect populations are the creation and/or maintenance of early structural aspen stands and road maintenance and removal of dams for road protection.	Populations are greatly affected by trapping, which in turn is affected by pelt prices, number of trappers/season, weather (open versus iced conditions), etc. Population numbers have increased since the turn of the 20th century due to regulated trapping and less pelt demand. Beaver where believed to be once extirpated from PA and reintroduced. Under average conditions, an acre of aspen will support a 5 to 6 member colony for 1 to 2 years.	Propose dropping as a MIS. Beaver populations are more influenced by trapping pressure than Forest Service management. A component of their habitat requirement (early structural aspen creation/maintenance) will be monitored across the ANF and tracked in the FACTS database.

Black-throated Green Warbler	Mature Mixed Hemlock-deciduous	Forest Service activity that may negatively affect populations is habitat alteration from timber harvest.	Human disturbance and the impacts from non-native invasive species have a greater influence on populations than Forest Service activities. Recreationists often seek out wooded riparian areas for camping and fishing. However, it is unclear how much disturbance this species will endure before abandoning a nest site. Hemlock wooly adelgid has the potential to significantly alter preferred habitat conditions. It is estimated that its advance to the ANF is eminent and current landscape control methods are lacking. In other regions, hemlock wooly adelgid has caused greater than 95% mortality of hemlock. Winter range is the Bahamas and Greater Antilles (Fergus 2000).	Propose dropping as a MIS. Forest plan direction will continue to buffer active nest sites from Forest Service activities. Monitoring will continue. Other factors are greater influences to population numbers. Second most common species on the ANF and forestwide monitoring indicates that it is difficult to isolate effects from Forest Service management.
Brook Trout	Cold Water Habitat	Forest Service management activities that may impact populations include water quality degradation from sedimentation or increased water temperatures.	Brook trout populations are greatly influenced by flow conditions during critical periods (summer low-flow, fall spawning, late winter/spring scour flows), angling pressure (highly sought species) and stocking by the PA Fish and Boat Commission.	Propose dropping the brook trout as a MIS because other factors are influencing populations more than Forest Service management activities. Propose using aquatic invertebrates to monitor stream habitat using established protocols. Forest plan includes management direction to conserve and enhance habitat.

Great Blue Heron	Old Growth Mixed Hemlock-deciduous	Harvest of woodland rookeries or disturbance during nesting period. Because this species selects predominantly forested areas with minimum disturbance for nesting, fragmentation through regeneration harvest, as well as roading or other disturbance into isolated or remote areas suitable for nesting pose the greatest habitat related threats to this species.	Great blue heron numbers have increased over the past twenty years in the Northeast (Fergus 2000). Primary threats include degraded feeding areas and loss of woodland rookeries either from logging or human disturbance. Throughout its range, the loss and/or degradation of feeding areas (wetlands, swamps, riparian corridors) either direct loss or degradation of water quality seems to be the greatest impact on populations.	Propose dropping the great blue heron as a MIS. Wetlands on the ANF are presently protected though Forest Plan direction, including giving preferential treatment to riparian dependent wildlife, such as the great blue heron. Potential effects from forest activities are significantly reduced through implementation of existing forestwide standards and guidelines that call for protection of known nests, as well as riparian areas and wetlands. Known nest sites will continue to be monitored.
Hermit Thrush	Mature Mixed Hemlock-deciduous with Dense Understory	Forest Service activity that may negatively affect populations is habitat alteration from timber harvest.	Southern edge of breeding range. Winters farther north than other brown thrushes, less dependent on tropical forest for wintering (Kaufman 1996; McWilliams and Brauning 2000).	Propose dropping as a MIS. Habitat generalist: conifer or mixed woods, forest floor; in winter, woods thickets, parks. Difficult to isolate Forest Service management effects to this species.
Magnolia Warbler	Regenerating Hemlock	Habitat alteration due to timber harvest that may affect understory structure, particularly the amount and distribution of regenerating hemlock.	Loss of conifer due to anticipated encroachment of hemlock wooly adelgid.	Propose dropping as a MIS. Monitoring on the ANF indicates that this is a much more common species than formerly thought and adapts to second-growth woods and cut-over areas better than some other warblers. Difficult to isolate Forest Service management effects to this species.

Pileated Wood-pecker	Old Growth Deciduous	It is unclear what level of Forest Service activities, such as timber harvest, would negatively affect populations since snags are left in harvest units.	Occurs at very low densities which makes population monitoring difficult, and populations may respond to landscape/watershed impacts rather than stand-level harvest.	Propose dropping pileated woodpecker as a MIS because they occur at very low densities which makes population monitoring difficult, and populations may respond to landscape/watershed impacts rather than stand-level harvest. Current management direction already leaves all snags in all timber harvest units, so if large standing woody debris is the key habitat, it is uncertain how management would provide more habitat and what the threshold or trigger point at which leaving more will improve habitat for the pleated woodpecker. Monitoring of the amount of snags and snag longevity will continue for the Indiana bat.
Rattle-snake	Regenerating Deciduous	Forest Service activities, such as roads, vegetation management, may effect populations.	Hunting and human disturbance are significant factors in population numbers.	Propose maintaining as an indicator of remote and/or connected mid-late structural habitat. Den sites tracked in FAUNA. Forest plan management direction calls for buffering den sites and opening up the canopy near den sites.
Red-shouldered Hawk	Mature Deciduous	Loss or alteration of nesting habitat due to timber harvest and activities that increase public access into occupied nesting habitat can adversely affect this species.	Prevalence and spread of native and exotic insects and pest and the resulting impacts to nesting habitat (PIF 2004).	Propose dropping as a MIS. While this species can be affected by management, ANF monitoring indicates that this species is more tolerant of management activities than the northern goshawk and as a result, we propose dropping the red-shouldered hawk as an MIS and add the northern goshawk as an MIS.

Ruffed Grouse	Regenerating Deciduous	Forest Service activities that may affect populations are the creation and/or maintenance of early structural habitat and improvement of brood habitat.	Decline of early successional forest across much of its range.	Propose dropping the ruffed grouse as a MIS. Although population density varies, this species utilizes a wide variety of habitat conditions and it is difficult to isolate effects of Forest Service management activities. Preferred habitat conditions will continue to be tracked.
Small-mouth Bass	Cool Water Habitat	Forest Service management activities that may impact populations include water quality degradation from sedimentation.	This species is an important game fish and occurs in larger waters that are more influenced by non Forest Service activities. It is not supplemented with any stockings to boost its population like the walleye, but is subject to fishing pressure. Smallmouth bass can still be monitored each year, but using it as an MIS is not warranted since it is difficult to detect changes in ecological conditions based primarily on the influences from non Forest Service activities.	Propose dropping the smallmouth bass as an MIS. Populations are more influenced by non Forest Service activities.
Walleye	Cool Water Habitat Demand Species	Forest Service management activities that may impact populations include water quality degradation from sedimentation or increased water temperatures.	This species was monitored annually because of its importance as a game fish. This species is not an ecological indicator, but was used as a demand species because of its popularity with anglers. The population is artificially enhanced each year through an annual stocking program. Walleyes occur in larger waters that are more influenced by other activities than Forest Service management.	Propose dropping the walleye as a MIS. Walleyes occur in larger waters that are more influenced by other activities than Forest Service management. Walleye can still be monitored each year, but using it as an MIS is not warranted since it is difficult to detect changes in ecological conditions that may be influenced by non Forest Service management activities.

White-tailed Deer	Regenerating Deciduous	Timber harvest or reforestation activity that alters forest structure and available forage can affect this species.	Populations of deer are greatly influenced by hunting, predation and mortality from automobile collision. Deer are not evenly distributed over the landscape. Distribution is greatly affected by surrounding land use and available forage. For example, in areas that have an appropriate agricultural component, populations may be higher, while at the same time have less effect on regenerating forests.	Propose dropping white-tailed deer as a MIS. Deer are habitat generalists and populations are greatly influenced by other non Forest Service activities. Hunting is considered the single greatest factor that affects deer numbers and distribution. The intent of this habitat indicator, amount of regenerating deciduous forest, will continue to be tracked.
Yellow-bellied Sapsucker	Mature Deciduous	Any management activity that may alter the availability of standing dead wood can affect this species.	Habitat conditions: moist forest, woodlots, orchards and clearcuts where some trees remain (Fergus 2000).Yellow-bellied sapsuckers on the southern fringe of its breeding range. It winters in the southeastern U.S., the West Indies and Central America.	Propose dropping the yellow-bellied sapsucker as a MIS. It is the fifth most common species on the ANF and forestwide monitoring indicates that it is difficult to isolate effects from Forest Service management activities. Present dead wood guidelines maintain adequate habitat.

Economic Efficiency Analysis

Economic efficiency and financial efficiency analysis evaluate how well the alternatives compare in producing benefits relative to costs. Each alternative was analyzed and compared for financial efficiency and economic efficiency. Financial efficiency examines only those items that are financial in nature in a comparison of the estimated expenditures of the ANF compared to the estimated revenues. Economic efficiency analysis considers not only the costs and revenues, but also the benefit values of certain goods and services that are not currently exchanged in the financial transactions of the ANF. This section contains a brief description of the cost data used, the revenue data used, and the estimation of non-market values (primarily recreation).

Costs

The initial evaluation of costs began with an examination of the ANF budget for the period from 2001 to 2005. The following table displays the various budget line items associated with that budget.

Table B-52. ANF Budget from 2001 to 2005

Fund Code Description	Fund Code	Final Budgets (dollars, thousands)					Real 5-year Average, 2005 dollars
		2001	2002	2003	2004	2005	
Recreation and Facility Construction and Maint.	CMFC	1,161	1,814	406	1,426	3,245	1,646
Road Construction and Maint.	CMRD	1,447	1,244	1,440	1,528	1,929	1,557
Trail Construction and Maint.	CMTL	288	297	256	302	641	365
Fire Facilities	CMC2	0	0	32	0	0	7
Infrastructure Improvement	CMII	19	109	60	3	0	40
SUBTOTAL	n/a	2,915	3,464	2,194	3,259	5,815	3,614
Inventory and Monitoring	NFIM	802	1,010	818	772	1,102	925
Law Enforcement	NFLE	26	28	52	0	0	22
Lands	NFLM	241	247	254	252	298	265
Minerals and Geology	NFMG	759	802	677	760	751	771
Forest Planning	NFPN	302	150	407	612	692	441
Recreation, Wilderness and Heritage	NFRW	1,350	1,450	1,563	1,364	1,288	1,443
Timber Management	NFTM	2,347	3,076	3,028	3,428	2,779	3,011
Reforestation, TSI, Soil, Water, Air, Noxious Weeds	NFVW	511	601	496	531	637	570
Wildlife, Fish, TES	NFWF	358	391	386	358	363	382
Condition Class	NFCC	0	0	0	4	0	810
SUBTOTAL	n/a	6,696	7,755	7,681	8,081	7,910	7,832
Knudsen Vandenberg Act	CWKV	1,705	2,044	1,744	980	1,254	1,595
Fee Demo	FDCL/FDDS	110	110	310	300	264	223

Real Estate Acquisition	LALW	44	43	43	40	30	41
Reforestation and TSI Trust Fund	RTRT	295	268	295	357	357	323
Salvage	SSSS	1,100	400	938	1,289	1,530	1,076
Timber Pipeline	TPSP	0	940	0	574	1,566	625
10% Fund, roads and trails for states	TRTR	316	435	939	241	231	445
SUBTOTAL	n/a	3,570	4,240	4,269	3,781	5,232	4,330
Fire Preparedness	WFPR	262	300	305	305	341	311
Hazardous Fuels	WFHF	56	37	45	78	62	57
SUBTOTAL	n/a	318	337	350	383	403	368
C and M, NFS, Perm and Trust, Fire	VARIOUS	13,499	15,796	14,494	15,504	19,360	16,143
SUBTOTAL	n/a	13,499	15,796	14,494	15,504	19,360	16,143
Co-op Work, FS	CWFS	325	325	245	245	250	287
Federal Highway Trust Fund	HTAE	10	7	7	10	0	7
SCSEP	NFSA/D/C	318	374	386	369	355	370
Quarters Maint.	QMQM	10	10	15	0	0	7,284
SUBTOTAL	n/a	663	716	653	624	605	671
TOTAL ALL FUNDS	n/a	14,162	16,512	15,147	16,128	19,965	16,814

The five year period was adjusted for inflation and used as an average baseline for estimating budget costs. The cost categories were estimated for the alternatives in four basic ways:

Fixed Costs at Specified Levels

A total cost was estimated for Recreation and Facility Construction, Administrative Facility Maintenance, Road Construction and Maintenance (including CWFS and 10% funds) based on historic trends and current needs. Minerals and Geology was increased above current levels in order to keep pace with the increased level of OGM development being experienced by the ANF. With plan revision work completed, it is estimated that costs for planning will decline. Hazardous fuels costs reflect an assumption of some increase to meet objectives for this work in the LRMP.

Fixed Costs at Historic Average

Inventory and Monitoring, Fire Preparedness, Federal Highway Trust Fund, and Quarters maintenance were simply estimated at the 5-year average.

Variable Costs from SPECTRUM Model

Timber Management, Reforestation, TSI, Soil, Water, Air and Noxious Weeds, Knudsen-Vandenberg Act, Reforestation and TSI Trust Fund, Salvage, and Timber Pipeline were all represented in the SPECTRUM model in two major groups associated with timber management and silviculture. Both combined use of trust funds with appropriated dollars for an overall estimate. The timber group consisted of Timber Management, Salvage and Timber Pipeline funds and was represented in the SPECTRUM model with three activities: Sale Planning, Sale Administration and Sale Preparation. The silviculture group included Reforestation, TSI, Soil, Water, Air and Noxious Weeds, Knudsen-Vandenberg Act, and Reforestation and TSI Trust Fund represented in the

SPECTRUM model with the following activities: release, herbicide treatment, scarification, planting, fencing, site preparation, controlled burning, fertilization, pre-commercial thinning, and stocking surveys.

The cost of these activities was estimated as a result of the SPECTRUM model solutions for each alternative.

Variable Costs Estimated for the Alternatives

Trail Construction and Maintenance, Lands, Recreation, Wilderness and Heritage, Wildlife, Fish and TES, and Real Estate Acquisition. The variability in these costs is estimated for variations in the alternatives. Trail Construction and Maintenance is estimated based on the amounts of motorized and non-motorized trails constructed and maintained for each alternative. Lands and Real Estate Acquisition are increased to include within the budget funding for both the purchase of subsurface rights and administration costs associated with those purchases. These vary based on the amount of land intended for purchase in each alternative. Recreation Wilderness and Heritage varies as a result of the amount of recreation and wilderness area visits anticipated in each alternative. Wildlife, Fish and TES costs are estimated based on variation in wildlife investments in the different alternatives.

BLIs Not Used in Constructing the Estimated Budget

Fire Facilities, Infrastructure Improvements, Law Enforcement, and Condition Class were only infrequently allocated and thus are not used in estimating the future budget. The 10 percent fund, Coop work, and Fee Demo are all considered to be part of the totals for Recreation and Facility Construction, Road Construction and Maintenance, and Trail Construction and Maintenance.

Results by Cost Category

With these costs in place, the following results were estimated for each of the major cost categories for each alternative for decades 1 and 2 in thousands of 2005 dollars. Unless separately displayed in the table, the costs for both the first and second decades were estimated to be the same.

Table B-53. Estimated Budgets for Decades 1 and 2

Budget Item	Average	A	B	Cm	D
	2005 dollars, thousands				
Recreation and Facility Construction	1,645	1,600	1,600	1,600	1,600
Administrative Facility Maintenance	0	175	175	175	175
Road Construction and Maintenance	2,289	2,500	2,500	2,500	2,500
Trail Construction and Maintenance Decade 1	365	411	446	396	366
Trail Construction and Maintenance Decade 2	-	446	506	426	386
Inventory and Monitoring	925	925	925	925	925
Lands Management	265	500	655	820	1050
Minerals and Geology	771	1,000	1,000	1,000	1,000
Forest Planning	441	250	250	250	250
Recreation, Wilderness and Heritage	1,443	1,493	1,498	1,504	1,511
Timber Group Decade 1	4,712	14,845	14,092	10,757	4,034
Timber Group Decade 2	-	15,386	14,589	10,697	4,623
Silviculture Group Decade 1	2,488	2,551	3,065	3,822	1,231
Silviculture Group Decade 2	-	2,418	2,920	3,271	1,671
Wildlife, Fish, and TES Species	382	400	380	380	340
Real Estate Acquisition	41	800	1,300	1,825	2,550
Fire Preparedness	311	310	310	310	310
Hazardous Fuels	57	80	80	80	80
Federal Highway Trust Fund	7	7	7	7	7
Quarters Maintenance	7	7	7	7	7
Total Budget Decade 1 *	**16,814****	**27,854**	**28,331**	**26,358**	**17,936**
Total Budget Decade 2*	**-**	**28,298**	**28,702**	**25,778**	**18,985**

* Totals may not add due to rounding errors

** Historic Budget includes 439 thousand dollars in minor funds that are not estimated for alternatives

Revenues

Revenues are built into the SPECTRUM model and represent estimated future ANF timber sale receipts. Value assignments used in the model depend on the indicated Forest Type Group and Dominant Layer combination. Each Forest Type Group and Dominant Layer combination has an assigned dollars per thousand cubic feet (dollars/MCF).

Product value and volume distribution expected determine the value assignment for a given Forest Type Group and Dominant Layer combination. Major commercial species present and the relative quality of their products (i.e., sawtimber and pulpwood) characterize this distribution. The distribution of volume derives from an analysis of harvest predictions using recent forest inventory surveys without any growth modeling (i.e., the current condition).

First, the percent of total volume is determined by Forest Type Group, Value Group and Dominant Layer. Second, a dollars/MCF value is determined by Forest Type Group, Value Group and Dominant Layer. These two sets of values are then used to create weighted average dollars/MCF for each Forest Type Group and Dominant Layer combination.

Table B-54. Revenues by Dominant Stand Layer

Forest Type	Dominant Layer 3 (10-15 DBH)	Dominant Layer 4 (15-20 DBH)	Dominant Layer 3 (20+ DBH)
	dollars		
Allegheny Hardwoods	7,332	9,119	9,846
Aspen	28	28	28
Conifer	1,744	1,597	1,598
Hemlock	1,265	567	568
Northern Hardwoods	2,688	2,823	2,824
Oak	1,436	2,324	2,325
Upland Hardwoods	3,973	5,875	5,876
All Low Stocking	279	279	279

When the initial analysis from the model was completed, it was observed that both the financial values and sawtimber percentage seemed to be substantially higher than recent average cut and sold reports would indicate. Cut values have averaged $6,329/mcf and average sold values averaged $5,668/mcf over the 2001 to 2005 period. The model results suggested sawtimber percents of approximately 65 percent; whereas the cut sawtimber percentage from 2001 to 2005 was 55.6 percent. These discrepancies may have occurred for several reasons. One is that the model schedules the most valuable stands for harvest in the first decade that may have higher percentages of sawtimber and higher values than the ANF has recently experienced. Much of the ANF's recent harvest has come from salvage volume and this may have reduced recent average prices.

In the FEIS analysis, an adjustment to the model timber value results was made. This adjustment recomputed the value based upon changing the sawtimber percentage from 65 to 55.6 percent and assuming that the remaining volume was in pulp or fuel wood valued at average prices for these products for 2001 to 2005 period. This had the effect of reducing the model values by about 25 percent. In order to have better financial analysis in the SPECTRUM model this reduction factor was directly applied to all of the timber values in the model for the FEIS analysis. This yielded estimates of annual average timber revenues for each alternative displayed in the following table.

Table B-55. Annual Timber Receipts by Decade and Alternative

Decade	Alt. A	Alt. B	Alt. Cm	Alt. D
	dollars, thousands			
1	68,972	64,460	53,317	27,082
2	70,746	67,408	51,209	24,260
3	58,532	57,700	49,638	26,128
4	49,248	48,708	47,454	25,524
5	48,329	46,208	42,174	19,626
6	49,496	49,151	42,691	20,765

In addition to the timber revenues, the ANF receives revenues for minerals and special uses. Over the period from 2001 to 2005, this averaged $95,259. This was also included as average annual revenue in each decade for efficiency analyses.

Non-market Values

Economists have long considered a variety of other goods and services to be of economic value even when they are not directly exchanged in financial markets. Most of the other resources provided by the ANF, such as recreation, water, wildlife, and other values associated with natural places, are not exchanged in markets. To provide some estimation of these non-market values, a set of non-market values has been established for a 12 hour recreational visitor day or RVD for certain recreational activities. The following table shows the amount of RVDs estimated for each of these activities on the ANF, the original 1989 value for these RVDs, and the adjusted value for 2005.

Table B-56. Recreational Visitor Days and Value by Recreation Type for 1989 and 2005

Recreation Activity	ANF RVDs	Value per RVD, 1989	Value per RVD, 2005
		dollars	
Camping Picnicking Swimming	876,897	14.02	19.43
Mechanized travel and viewing scenery	53,791	10.53	14.59
Hiking, Horseback Riding, and water travel	50,647	16.27	22.55
Winter Sports	17,846	42.62	59.07
Wilderness	34,874	20.94	29.02
Other Recreation (except wildlife and fish)	18,860	61.43	85.14
Hunting	249,840	45.05	62.44
Fishing	234,225	76.20	105.61
Non-consumptive Wildlife Uses	227,532	43.60	60.43

To identify variations in the projected amount of this recreation, a number of basic assumptions were used relative to what factors in the alternatives would influence specific activities. Each of the RPA value categories is made up of a number of more specific activities. Each of these component activities was examined to evaluate how they could be affected by the alternatives under consideration. Only four activities (backpacking, camping in unroaded areas, ATV/OHM travel, horseback riding, and bicycling) were considered to directly vary as a result of the alternatives. Each of these activities could have opportunities expanded or limited as a result of the alternative.

A number of activities varied indirectly as a result of wilderness study recommendation. Wilderness area recreation activities are treated separately from all other recreation activities; no matter what the recreation activity is, if it occurs in a wilderness area, it is counted as a wilderness visit or RVD. In order to account for the change in recreation and wilderness recreation that could occur in the alternative, a number of basic accounting adjustments were done. These adjustments first determined if the activity could occur on lands that could become wilderness areas and if the activity was also consistent with wilderness designation. Each of these recreational activities was then estimated on a per acre basis for the forest. As areas recommended for wilderness increased, the wilderness recreational use increased based on the per acre estimate and decreased by the same amount elsewhere.

The following lists the aggregate RPA activities, their component activities and an indication of how these activities varied by alternative. Recreational activities shown with a W varied as part of the wilderness accounting. Activities shown with a * varied on some other basis.

Camping, Picnicking and Swimming

1. Camping in developed sites (did not vary)
2. W Primitive camping (varied only as wilderness accounting)
3. W* Backpacking, camping in unroaded areas: varied based on unroaded areas
4. Picnicking and family day gatherings (did not vary)
5. W Other non-motorized activities (varied only as wilderness accounting)

Mechanized Travel and Viewing Scenery

1. W Viewing natural features on NFS lands (varied only as wilderness accounting)
2. Off highway vehicle travel: varied based on the potential miles of trail
3. Driving for pleasure on roads (did not vary)
4. Motorized water travel (did not vary)
5. Other motorized activities (did not vary)

Hiking, horseback riding, and non-motorized water travel

1. W Hiking or walking (varied only as wilderness accounting)
2. W* Horseback riding: varied based on opportunities for horse use
3. Non-motorized water travel (did not vary)

Winter Sports

1. Snowmobiling (did not vary)
2. Downhill skiing (not present on ANF)
3. W Cross country skiing and snow shoeing (varied only as wilderness accounting)

Wilderness (varied only as wilderness accounting)

Other non-wildlife recreation

1. W Visiting historic and prehistoric sites (varied only as wilderness accounting)
2. W General relaxing, hanging out (varied only as wilderness accounting)
3. Bicycling: varied based on suitable areas
4. W Gathering forest products (varied only as wilderness accounting)

Hunting (varied only as wilderness accounting)

Fishing (varied only as wilderness accounting)

Non-consumptive wildlife activities

1. W Viewing wildlife, birds and fish (varied only as wilderness accounting)

Once new base levels were estimated for each of these recreational activities, the projected increase in these levels was identified for each of the alternatives. Projections from the Northern region of the U.S. as identified in Projections of Outdoor Recreation Participation to 2050 by Bowker, English and Cordell 1999 were used to project rates of increase for each of the aggregate RPA activities.

Other non-market values applicable for the ANF have not been calculated. These are difficult to estimate and are not likely to show substantial variation among the alternatives.

Results of the Analysis

Table B-57 shows the results of the analysis, assuming a discount rate of 4 percent is used for the calculation. This rate has been established nationally for use in national forest planning. The PNV is identified for each alternative for a 100 year period. The first row shows the PNV with only ANF costs and revenues taken into account. The second shows the PNV with ANF costs and revenues and the values of recreation using with the local projection. The third shows the present net value with the ANF costs and revenues and the values of recreation using the national projection.

Table B-57. Present Net Value of the Alternatives

Efficiency Measure	Alt. A	Alt. B	Alt. Cm	Alt. D
	(2005 dollars, thousands)			
PNV (Market Only/Financial)	879,945	812,775	645,270	223,672
PNV (Market and Non-market)	3,119,657	3,056,646	2,874,207	2,429,392

A review of the table indicates that Alternative A has the highest PNV with any of the three measures, followed by Alternative B and Alternative Cm. Alternative D is lower primarily due to less efficiency in producing market goods.

Economic Suitability Analysis

One additional economic analysis examined the suitability of major forest types for timber harvest and production. This analysis examined the discounted costs and revenues of the different silvicultural regimes modeled in the SPECTRUM runs. This analysis was done with models developed for the FEIS as a number of changes were made to the model and the economic data between DEIS and FEIS that would affect the results. Harvest of both existing and regenerated stands was examined in the analysis. All costs and revenues were estimated to occur at midpoint (of fifth year) of each decade and were discounted at a rate of 4 percent for each year from the future.

The following activities are associated with the analysis:

- Timber activities: sale planning, sale preparation and sale administration.
- Silvicultural Activities (primarily associated with the establishment of the regenerated stand): release, herbicide treatment, scarification, planting, fencing, site preparation, controlled burning, fertilization, pre-commercial thinning, and stocking surveys.

Timber activities are expected to occur on all acres harvested, but silvicultural activities do not always occur on every acre. Estimates of the proportion of these activities likely to occur are included in the model. The amount and intensity of these activities varies by forest type.

It is not possible to examine every situation presented in the model for this type of economic analysis. Values and costs may vary with age, certain site conditions, and prescriptions. Represented in the analysis are the predominant types of harvest prescriptions selected by the SPECTRUM model. Most of these were in the analysis of Alternative Cm, although a few are from other alternative runs.

Allegheny Hardwoods

The Allegheny hardwoods forest type contains a large amount of black cherry that contributes to its high value. Relative to the other forest types, it is easier and faster to regenerate in even-aged silvicultural systems as the black cherry grows fast and needs less attention. The even-aged silvicultural system was modeled with a preparatory harvest, or seed cut, followed by a final removal cut. With Allegheny hardwoods, the period between these two harvests is less than 10 years and is modeled with an assumption of two entries in the same decade in SPECTRUM. As a result, costs and revenues in the decade of harvest are much higher and there is no separation in the modeling of the two harvest entries.

The following activities are associated with the Allegheny hardwoods:

- Timber activities: sale planning, sale preparation and sale administration.
- Silvicultural Activities: release, herbicide treatment, fencing, site preparation, fertilization, pre-commercial thinning, and stocking surveys.

Harvest of Existing Stands

Three situations for harvest of existing Allegheny hardwood stands were examined. High stocked stands with a shelterwood harvest, moderate stocked stands with a shelterwood harvest, and uneven-aged management as modeled with the RUMFC prescription. Low stocked stands of Allegheny hardwoods were not specifically examined. It is recognized that these stands would require silvicultural investments to reach higher stocking levels. Stands of this nature that are poorly stocked with site limitations were otherwise removed from the suitable harvest base (See earlier discussion on suitable lands for timber production).

Table B-58. Present Net Value for Existing Allegheny Hardwoods (per 100 acres treated)

Measure	Shelterwood High Stocking	Shelterwood Moderate Stocking	Uneven-aged Management
Discounted Costs	$637,900	$639,900	$276,600
Discounted Revenues	$2,348,200	$1,904,600	$669,500
Present Net Value	$1,710,200	$1,264,700	$392,900

As the preceding table shows, Allegheny hardwoods deliver a high return with even-aged harvests that more than offsets the timber and reforestation costs. The uneven-aged situation has lower discounted costs and revenues due to an extended regime evaluated for 14 decades in the future. The two shelterwood regimes only evaluate one decade for the existing regime. A better comparison is made when the existing harvests are combined with regenerated silvicultural regimes.

Harvest of Regenerated Stands

Two situations for regenerated Allegheny hardwoods stands are displayed in the following table. The first shows a situation for a shelterwood harvest in decade 9 after an initial harvest in the first decade. The second represents a regime with a thin in decade 8 and a shelterwood harvest in decade 10.

Table B-59. Present Net Value for Regenerated Allegheny Hardwoods (per 100 acres treated)

Measure	Shelterwood without thinning	Shelterwood With Thinning
Discounted Costs	$28,300	$27,700
Discounted Revenues	$47,500	$85,500
Present Net Value	$19,300	$57,800

The discounted costs, discounted revenues, and present net value of the regenerated stands are far less than that of the existing stands due to the long discount period that reduces the present value.

The existing and regenerated regimes are combined for 1) the highest even-aged return (high stocking in the existing stand followed by a harvest with thinning), 2) the lower even-aged return (moderate stocking in the existing stand followed by a harvest without thinning), and 3) the uneven-aged regime, as displayed in the following table.

Table B-60. Present Net Value for Allegheny Hardwoods Combined (per 100 acres treated)

Measure	Even-aged High	Even-aged Low	Uneven-aged
Discounted Costs	$665,600	$668,200	$276,600
Discounted Revenues	$2,433,700	$1,952,100	$669,500
Present Net Value	$1,768,000	$1,284,000	$392,900

Even-aged harvest of Allegheny hardwoods is clearly economically efficient. Most of the alternatives emphasize even-aged management for the Allegheny hardwoods to create younger age classes. Unless constrained, the SPECTRUM model selects these even-aged prescriptions when using a maximum PNV objective function. In some situations, notably in MAs 2.1 and 2.2, these hardwoods are modeled with the uneven-aged prescription.

Upland Hardwoods

The upland hardwood forest type also contains black cherry that contributes to its high value. However, the proportion of black cherry is lower in upland hardwoods than in Allegheny hardwoods. Red maple and a variety of other species are present in upland hardwoods. Upland hardwoods are also expected to take longer to regenerate than Allegheny hardwoods. The even-aged silvicultural system most often used and modeled contains a preparatory harvest, or seed cut, followed by a final removal cut. With upland hardwoods, the period between these two harvests is estimated to be approximately 10 years and is modeled with an assumption of two entries in two consecutive decades in SPECTRUM. As a result, the discounted costs and revenues are lower due to the extra decade assumed to achieve regeneration.

The following activities are associated with the upland hardwoods:

- Timber activities: sale planning, sale preparation and sale administration.
- Silvicultural Activities: release, herbicide treatment, planting, fencing, site preparation, fertilization, pre-commercial thinning, and stocking surveys.

Harvest of Existing Stands

Three situations for harvest of existing Allegheny hardwood stands were examined: high stocked stands with a shelterwood harvest, moderate stocked stands with a shelterwood harvest, and uneven-aged management as modeled with the RUMFC prescription on a high stocked stand. Low stocked stands of upland hardwoods were not specifically examined. It is recognized that these stands would require silvicultural investments to reach higher stocking levels. Stands of this nature that are poorly stocked and have site limitations were otherwise removed from the suitable harvest base (see earlier discussion on suitable lands for timber production).

Table B-61. Present Net Value for Existing Upland Hardwoods (per 100 acres treated)

Measure	Shelterwood High Stocking	Shelterwood Moderate Stocking	Uneven-aged Management
Discounted Costs	$319,500	$319,800	$318,400
Discounted Revenues	$1,044,600	$741,400	$261,700
Present Net Value	$725,100	$421,600	($56,600)

( ) parenthetical values are negative

As the preceding table shows, the upland hardwoods deliver a high return with even-aged harvests that more than offsets the timber and reforestation costs. In the uneven-aged situation, the discounted costs exceed the revenues due to the numerous harvest entries and lower return with each entry. The discounted costs and revenues for the uneven-aged regime are much lower due to an extended series of harvests over 14 decades. The two shelterwood regimes only evaluate two decades for the existing regime. A better comparison is made when the existing harvests are combined with regenerated silvicultural regimes.

Harvest of Regenerated Stands

Only one situation for regenerated upland hardwood stands is displayed in the following table. It shows a situation for a shelterwood harvest beginning in decade 11, or 90 years after the final removal of the existing stand in the second decade. While a silvicultural regime with thinning for regenerated stands was available and frequently selected in the alternative SPECTRUM model, these selections did not include scheduling the final shelterwood harvests.

Table B-62. Present Net Value for Regenerated Upland Hardwoods (per 100 acres treated)

Measure	Shelterwood Without Thinning
Discounted Costs	$5,100
Discounted Revenues	$17,500
Present Net Value	$12,400

The discounted costs, discounted revenues, and present net value of the regenerated stands are far less than that of the existing stands due to the long discount period that reduces the present value.

If the regeneration regime is combined with the existing regime, the total PNV for the upland hardwoods is still a very positive value. Even-aged harvest of upland hardwoods is clearly economically efficient, except in uneven-aged management situations. Most of the alternatives emphasize even-aged management for the upland hardwoods to create younger age classes. Unless constrained, the SPECTRUM model tends to select these even-aged prescriptions only after it has already selected the more efficient Allegheny hardwoods. In some situations, notably in MAs 2.1 and 2.2, these hardwoods are modeled with the uneven-aged prescription.

Northern Hardwoods

The northern hardwoods forest type consists primarily of beech, hemlock and sugar maple. These species have far lower timber values than either the Allegheny or upland hardwoods. There is also considerable concern about the ability to maintain and regenerate northern hardwoods due to the problems associated with beech bark disease, hemlock woolly adelgid, and sugar maple decline. Northern hardwoods were evaluated with both even-aged and uneven-aged regimes. Northern hardwoods are expected to take longer to regenerate than Allegheny hardwoods. The even-aged silvicultural system most often used and modeled contains a preparatory harvest, or seed cut, followed by a final removal cut. With northern hardwoods, the period between these two harvests is estimated to be approximately 10 years and is modeled with an assumption of two entries in two consecutive decades in

SPECTRUM. As a result, discounted costs and revenues are lower due to the extra decade assumed to achieve regeneration.

The following activities are associated with the northern hardwoods:

- Timber activities: sale planning, sale preparation and sale administration.
- Silvicultural Activities: release, herbicide treatment, planting, fencing, site preparation, pre-commercial thinning, and stocking surveys.

Harvest of Existing Stands

Four situations for harvest of existing northern hardwood stands of ages 100 to 110 were examined: high stocked stands with a shelterwood harvest, moderate stocked stands with a shelterwood harvest, and uneven-aged management as modeled with the RUMFC prescription on a high and moderately stocked stand. Low stocked stands of northern hardwoods were not specifically examined. It is recognized that these stands would require silvicultural investments to reach higher stocking levels. Stands of this nature that are poorly stocked and have site limitations were otherwise removed from the suitable harvest base (see earlier discussion on suitable lands for timber production).

Table B-63. Present Net Value for Existing Northern Hardwoods (per 100 acres treated)

Measure	Even-aged Shelterwood High	Even-aged Shelterwood Moderate	Uneven-aged Management High	Uneven-aged Management Moderate
Discounted Costs	$339,800	$339,500	$391,600	$323,000
Discounted Revenues	$390,200	$324,300	$297,200	$89,700
Present Net Value	$50,400	($15,200)	($94,400)	($233,200)

( ) parenthetical values are negative

As the preceding table shows, the northern hardwoods are marginal in their ability to deliver a financial return. While even-aged shelterwood management can be efficient in high stocked stands, moderate stands are not estimated to produce a positive discounted net return, although undiscounted revenues exceed undiscounted costs. In the uneven-aged situation, the discounted costs exceed the revenues due to the numerous harvest entries and lower return with each entry. The discounted costs and revenues for the uneven-aged regime are much lower due to an extended series of harvests over 14 decades in the future. This is particularly true for the moderately stocked stands. The two shelterwood regimes only evaluate two decades for the existing regime.

Harvest of Regenerated Stands

Only one situation for regenerated northern hardwood stands is displayed in the following table. It shows a situation for a shelterwood harvest beginning in decade 13, or 110 years after the final removal of the existing stand in the second decade. While a silvicultural regime with thinning for regenerated stands was available, it was rarely selected in the alternative SPECTRUM model. When selected, it did not include scheduling the final shelterwood harvests.

Table B-64. Present Net Value for Regenerated Northern Hardwoods (per 100 acres treated)

Measure	Shelterwood Without Thinning
Discounted Costs	$3,100
Discounted Revenues	$5,000
Present Net Value	$1,800

The discounted costs, discounted revenues, and present net value of the regenerated stands are far less than that of the existing stands due to the long discount period that reduces the present value. It is expected that the level of silvicultural investment associated with managing these stands will bring them to full stocking. Thus the regenerated stand is expected to have a positive return.

If the regeneration regime is combined with the existing regime, the total PNV for northern hardwoods may be positive value. The future situation and management of northern hardwoods remains unclear and future research and experimentation is needed. Unless constrained, the SPECTRUM model tends to defer selecting harvest for these stands. Uneven-aged management may be more desirable to perpetuate these forest types, but reducing the costs of uneven-aged management is needed to make these prescriptions comparable in efficiency to even-aged regimes. Generally, northern hardwoods are scheduled for some harvest in order to develop greater knowledge and experience in their management. These forest types are modeled in MAs 2.1 and 2.2 for these hardwoods with the uneven-aged prescription.

Oaks

The oak forest type consists primarily of northern red, white, chestnut, black, and scarlet oaks mixed with other hardwood species. These species have far lower timber values than either the Allegheny or upland hardwoods. There is also considerable concern about the ability to maintain and regenerate oaks. Oaks in the Allegheny region are dependent on fire and large openings for regeneration. Concern exists that progressive canopy closure of the forest will eliminate oaks within the ANF. Oaks were evaluated with both even-aged and uneven-aged regimes, although the ANF does not regard uneven-aged management as a reasonable method to regenerate oak. The regeneration sequence for oak demands more active and careful silviculture over a longer period of time. Techniques, such as scarification of soils, fencing, and controlled burning, are all part of this silvicultural regime. The even-aged silvicultural system most often used and modeled contains a preparatory harvest, or seed cut, followed by a final removal cut. With oaks, the period between these two harvests is estimated to be approximately 20 years and is modeled with an assumption of two harvest entries in three decades in SPECTRUM. As a result, discounted costs and revenues are lower due to the extra decade assumed to achieve regeneration.

The following activities are associated with the oak forest types:

- Timber activities: sale planning, sale preparation and sale administration.
- Silvicultural Activities: release, herbicide treatment, scarification, planting, fencing, site preparation, controlled burning, fertilization, pre-commercial thinning, and stocking surveys.

Harvest of Existing Stands

Only two situations for harvest of high stocked, existing oak forest types of ages 120 to 130 were examined. There are very few moderately stocked oak stands and these are rarely scheduled for any harvest. A shelterwood harvest sequence and uneven-aged management as modeled with the RUMFC prescription are presented.

Table B-65. Present Net Value for Existing Oaks (per 100 acres treated)

Measure	Even-aged Shelterwood High	Uneven-aged Management High
Discounted Costs	$369,500	$366,600
Discounted Revenues	$294,300	$194,500
Present Net Value	($75,200)	($172,100)

( ) parenthetical values are negative

As the preceding table shows, oak does not presently deliver a positive financial return due to both the limited return over an extended period of time and the high costs needed to ensure regeneration.

Harvest of Regenerated Stands

Only one situation for regenerated oak forest types is displayed in the following table. Given the long periods to develop oak forest types and its lower efficiency, very few complete regeneration situations were found within the 150 year time horizon of the SPECTRUM model. It shows a situation for a shelterwood harvest beginning in decade 13, or 100 years after the final removal of the existing stand in the third decade. While a silvicultural regime with thinning for regenerated stands was available, it was selected in a situation that allowed the final harvest to be completed within the 150 year time horizon of the SPECTRUM model.

Table B-66. Present Net Value for Regenerated Oaks (per 100 acres treated)

Measure	Shelterwood without thinning
Discounted Costs	$3,000
Discounted Revenues	$3,500
Present Net Value	$500

Interestingly, the oaks show a positive return in the regenerated stands. The main reason for this is that most of the costs associated with creating and managing the regenerated stand have been assigned to the existing stand.

If the regeneration regime is combined with the existing regime, the total PNV for the oak forest types would remain negative. Widespread concern about the depletion of oaks and their value as a mast source for wildlife has made efforts to maintain and regenerate the current oak forest types a key component of the vegetation management of the Forest Plan. Without constraints in the model, SPECTRUM would rarely schedule harvest in this forest type. Oak forest types are scheduled for some harvest through even-aged management in all of the management areas that schedule timber harvest. Only MA 2.1 prescribes uneven-aged management for these types.

Minor Forest Types (Aspen, Hemlock and Conifers)

The minor forest types consist of aspen, hemlock, and conifer stands. These forest types represent approximately 20,000 acres, or less than 5 percent of the total forestland of the ANF. Aspen stands are modeled as having a clearcut, the hemlock stands are modeled having two thins followed by a preparatory harvest, or seed cut, followed by a final removal cut in the same decade, and the conifer stands are modeled as having four thins followed by a preparatory harvest, or seed cut, followed by a final removal cut in the following decade. The aspen forest types have timber values that are based on pulp and fuelwood values only. Hemlock values are estimated to decline sharply with increasing age and size. As a result, the PNV values of timber production of these two types are quite negative. For the conifer forest types, there is greater value, but costs associated with regeneration still slightly exceed revenues, resulting in a negative PNV for harvest of existing stands. Regenerated stands could not be evaluated since they do not occur within the planning horizon of the SPECTRUM model. All three minor forest types are scheduled for harvest on only a limited basis usually in the later decades. Concern about the depletion of hemlock by hemlock wooly adelgid and the value of conifers for wildlife was a key consideration for standards and guidelines in the LRMP for the retention of conifers. For aspen, there is considerable concern that this species could be lost from the ANF without active even-aged regeneration activities. Aspen is well known to be shade intolerant.

Consideration of Transportation and Logging Costs

Transportation costs were not directly included in the ANF SPECTRUM model. Any further road construction or reconstruction costs associated with the road network needed for timber harvest activities are expected to be funded through purchaser specified road construction. This purchaser specified road construction activity is part of the sale contracts offered by the ANF. Thus timber purchasers are aware of the road costs they will bear to purchase the timber. Similarly, logging costs on the ANF are generally for ground skidding equipment on low to moderate slopes, and purchasers understand the logging costs of a particular sale. Submitted bid prices are thus adjusted downward as a result of these costs. Experienced values of ANF sales were used to reduce the estimated timber values (see earlier Economic Efficiency Analysis), thus accounting for the cost of road construction or reconstruction connected with timber sales.

It is estimated that 113,129 acres of the ANF would require road construction to bring these areas within a half-mile skidding distance without skidding across streams. To access this total land area, approximately 263 miles of non-system roads (primarily OGM roads) would need to be converted and upgraded to system roads and 168 miles of new construction would be needed. The cost of converting and upgrading the 263 miles of road is estimated at $30,000 per mile and the cost of constructing the new miles is $50,000 per mile. For each 100 acres requiring road access, this would add approximately $14,400 of cost per 100 acres harvested at the time of the initial entry [100*((263*$30,000) + (168*$50,000))/113,129]. If these costs are assumed to occur at the fifth year for existing harvests (consistent with the previous analysis), they are discounted at 4 percent to $11,835.80 per 100 acres. If this cost is then reduced from the PNV results previously displayed for the existing stands of the four major forest types, the following changes occur:

Table B-67. PNV per Forest Type with Transportation Costs

Forest Type and Stocking	Original PNV	PNV with Road Cost
Allegheny Hardwood, High	$1,710,200	$1,698,364
Allegheny Hardwood, Moderate	$1,264,700	$1,252,864
Allegheny Hardwood (Uneven-aged)	$392,900	$381,064
Upland Hardwood, High	$725,100	$713,264
Upland Hardwood, Moderate	$421,600	$409,764
Upland Hardwood (Uneven-aged)	($56,600)	($68,436)
Northern Hardwoods, High	$50,400	$38,564
Northern Hardwood, Moderate	($15,200)	($27,036)
Northern Hardwoods (Uneven-aged), High	($94,400)	($106,236)
Northern Hardwoods (Uneven-aged), Moderate	($233,200)	($245,036)
Oaks, High	($75,200)	($87,036)
Oaks (Uneven-aged)	($172,100)	($183,936)

( ) parenthetical values are negative

Adding these transportation costs into the analysis does not fundamentally change the original outcomes. Those situations with positive PNVs retain positive PNVs, while those with negative PNVs are reduced further.

As existing roads serve a variety of purposes, including recreation and wildlife management, as well as timber harvest, the cost of road maintenance is not charged to timber in this economic analysis. Cooperative Road (CWFS) funds used for immediate and deferred road maintenance are collected from timber purchasers in addition to the purchase price of the timber. This cost is also a consideration similar to purchaser specified road construction and reconstruction that reduces the bid value of timber.

Economic Impact Analysis

The results of the economic impact analysis are presented in Chapter 3 of the FEIS in Economic Conditions section. This section briefly describes the data and methods used in the economic impact analysis. The section describes the IMPLAN/FEAST (Impact Analysis for Planning and Forest Economic Analysis Spreadsheet Tool) model and the determination of the values used in the economic impact analysis for recreation, wildlife, timber, federal expenditures, payments to local governments and oil and gas. Much of this information has already been covered in the preceding Economic Efficiency Analysis section, so rather than repeat that information in this section, there will be appropriate cross references

One of the significant changes was a redefinition of the basic economic sectors that are being used by the federal government to track various activities. Prior to 2002, economic statistics were collected for Standard Industrial Classifications, or SIC codes. This system identified various types of businesses with a specific code that could be collapsed into more aggregated codes. Beginning in 2002, a different structure for organizing this information was implemented that is called the North American Industry Classification System, or NAICS. While the two systems are similar, NAICS offers a different structure than SIC for reporting. In the presentation of the economic conditions in Chapter 3 of the FEIS, economic data that describes the conditions of different sectors prior to 2002 is based on the SIC classification, while data after 2002 and the results of the alternatives are based on the NAICS structure.

IMPLAN/FEAST Model

The primary tool used for estimating the contribution of the ANF to the four county economic region of Elk, Forest, McKean and Warren Counties of Pennsylvania is IMPLAN. IMPLAN is a software package for personal computers that uses the latest national input-output tables from the Bureau of Economic Analysis (BEA). 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 is from the most recent secondary data for the four county ANF economic region. County data is aggregated in the model to develop one IMPLAN model for the four county ANF economic region.

Input-output analysis gives estimates of employment and labor income for an increase or decrease in final demand on certain sectors or industries within an economy. Three types of economic impacts are estimated:

1. direct impacts, such as increased demand in sawmills to process timber sold by the ANF
2. indirect impacts, such as purchases of machinery by the sawmill
3. induced impacts, such as spending from wages earned through the direct and indirect impacts

Impacts include all those industries that sell the final product as well as all of the industries involved in the processing of intermediate products (e.g. logging company to sawmill). Thus, the impact assumes an increase or decrease in demand is made on the economy and estimates what this change in final demand will mean in employment and labor income. Impacts are only generated to the extent that industries are present in the ANF region. If they are not present, the impact is assumed to be on the broader economy outside the ANF region.

A result from this model is the identification of response coefficients for each resource or activity in the ANF economic region. These impact response coefficients provide a per unit estimate of the economic impact of a change in the level of a resource or activity. The response coefficients generated within IMPLAN have been extracted and used in FEAST. 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 of alternatives in employment and labor income. The ANF analysis represents an annual average impact essentially for the midpoint of the first decade that assumes full implementation of the alternative.

Information used in IMPLAN is specific to Pennsylvania from the year 2002 based upon NAICS data. Employment and income data was derived from the U.S. Department of Commerce, BEA regional economic projections from 2002. Basic assumptions of IMPLAN do not include fundamental restructuring of the economy, nor does it predict the specific future of industry related to the opening or closing of businesses.

Estimating Recreation Impacts

The sub-section on Non-market values in the preceding Economic Efficiency Analysis section described how base levels of recreation were identified for each of the alternatives. The same basic approach was used to estimate base levels of recreation for the impact analysis; a discussion on determining base recreation levels will not be repeated here. For the economic impact analysis there were four major differences in the estimation of recreation impacts as compared to estimation of recreation values in the efficiency analysis. These are described here.

The first difference is that the efficiency analysis used recreation estimates in RVDs, or recreational visitor days, and the impact analysis is based upon the economic impact associated with a visit. Using the information prepared in Spending Profiles of National Forest Visitors (Stynes and White, May 2005), spending profiles were developed per visit for each of the recreational activities in the National Visitor Use Monitoring. These spending profiles are used in IMPLAN/FEAST to estimate the impacts of these recreational activities on specific economic sectors.

The second difference is that only recreation visitors from outside the four county ANF economic region are assumed to create an impact upon the region. Since residents within the ANF economic region would be spending for basic goods and services whether or not they were actively recreating on the ANF, their recreational expenditures do not create a new impact upon the ANF economic region. It is the spending of outside visitors that generates the local economic impact. For purposes of the impact analysis, 39 percent (Stynes and White, 2002) of the recreational visits to the ANF are estimated to be visitors outside the ANF economic region.

The third difference is that the individual recreational activities are again aggregated into different groups to focus on their impact to the local economy. The non-local visits of each of the specific activities were estimated consistent with approach described in the previous sub-section on Non-market values in the Economic Efficiency Analysis section. These groups and their component individual activities are: developed camping, primitive camping, ATV/OHM use, horseback riding, fishing, hunting, bicycling, snowmobiling, hiking or walking, water travel, general day use, wilderness visitation, and other.

Primitive camping includes primitive camping and backpack camping in unroaded areas. Water travel includes motorized water travel and non-motorized travel. General day use includes picnicking and family gathering, viewing wildlife, viewing natural features, and driving for pleasure. Other activities include viewing prehistoric and historic sites, general relaxing, hanging out, other motorized activities, cross-country skiing and snow shoeing, other non-motorized activities and gathering of forest products.

The fourth difference is that the economic impact analysis is for the first decade, not for the 100 year time horizon for the economic efficiency analysis. The base levels of each of these recreation impacts are estimated for 2002 and projected for the next eight years to estimate the impacts of the alternatives. The projection is based on the projections for the northern region estimated in Projections of Outdoor Recreation Participation to 2050 by Bowker, English and Cordell 1999. Some sensitivity analyses were done with other recreation projections. One of these simply assumed that each activity would increase by 20 percent to the midpoint of the first decade. The estimated breakdown of recreational visits used in the analysis is displayed in the following table.

Table B-68. Recreational Activity by Type and Alternative

Activity Group	Current	Alt. A	Alt. B	Alt. Cm	Alt. D
Developed Camping	24,977	26,072	26,072	26,072	26,072
Primitive Camping	37,315	37,221	39,062	38,543	39,010
OHM use	7,550	7,684	7,886	7,617	5,527
Horseback Riding	3,677	3,872	3,813	3,813	3,485
Fishing	63,219	64,776	64,776	63,197	60,952
Hunting	67,035	68,032	68,032	66,374	64,016
Bicycling	607	631	629	613	590
Water Travel	5,002	5,429	5,429	5,429	5,429
Snowmobiling	145,569	150,908	150,908	147,229	141,999
Hiking and Walking	12,166	12,671	12,671	12,671	12,671
General Day Use	156,659	168,618	168,618	166,106	162,535
Other	83,938	86,411	86,411	84,411	81,567
Wilderness Visitation	10,467	10,362	10,362	24,695	45,076

Estimating Timber Impacts

The impact of timber harvest on the local economy begins with the estimation of the stumpage value and the quantity of timber estimated to be produced. The preceding section under Economic Efficiency Analysis provided a description of how stumpage values for ANF timber were estimated for the alternatives. See this section to understand the calculation of stumpage values. This same basic information was used for the impact analysis.

Timber values are broken down by sawtimber, pulpwood and fuelwood for the economic impact analysis. Based upon historic average prices from 2001 to 2005, pulpwood value has been $29.43 (in 2005 dollars) per MCF and fuelwood has been $64.95 per MCF. The remaining timber values as previously described in the Economic Efficiency Analysis section were assigned to the sawtimber.

Despite the fact that the ANF has a small softwood component in hemlock and conifer stands, approximately 98.5 percent of the volume sold by the forest has been hardwood. Therefore, all timber impacts are represented as hardwood impacts. The resulting inputs to the IMPLAN/FEAST analysis, including the current level of the past 5 years and the annual average for the midpoint for the alternatives, are displayed in the following table.

Table B-69. Forest Product Impacts by Type and Alternative

Item	Current	Alt. A	Alt B.	Alt Cm	Alt. D
Sawtimber MMCF	1822	6059	5750	4934	2395
Pulpwood MMCF	1067	4043	3836	3300	1598
Fuelwood MMCF	268	796	755	648	314
Sawtimber M dollars	17,740	68,801	64,298	53,178	27,014
Pulpwood M dollars	34	119	113	97	47
Fuelwood M dollars	15	52	49	42	20

Estimating Federal Expenditures

The sub-section on Costs in the preceding Economic Efficiency Analysis section described the methods used to estimate the level of the ANF budget for both the current level and for the alternatives. Refer to that section for this information. For the economic impact analysis there is only one substantial difference.

This difference is that for the economic impact estimation, costs associated with land acquisition for the alternatives that appear in the preceding discussion on the budget were excluded from the analysis, as these are not likely to find redistribution within the local economy. For the economic impact analysis, the ANF budget level is represented as an average of the 2001 to 2005 ANF budgets and the alternatives are represented as an average for the first decade. The inputs used to represent federal expenditures in thousands of 2005 dollars for the FEAST/IMPLAN analysis are displayed in the following table.

Table B-70. Expenditures by Alternative

Measure	Current	Alt. A	Alt. B	Alt. Cm	Alt. D
ANF Expenditures, M dollars	16,814	27,054	27,001	24,533	15,386

Estimating Payments to Local Governments

Payments to local governments were not included in the economic efficiency analysis as it is considered to be a sharing of revenues between the federal and local governments. The payments to these governments are included as part of the overall revenue totals. Since all of the alternatives project higher revenues than the average of the past 5 years (2001 to 2005), it is assumed that all of the counties will opt for payment with the 25 percent fund when full plan implementation is in place. Therefore, the calculation of the level of payments to local governments was a straightforward 25 percent share of the total federal revenues anticipated for the ANF during the plan period. The current level is the actual average of payments to the local governments from 2001 to 2005. Of these payments approximately 52 percent has been distributed to school districts and 48 percent has been distributed to townships for road projects. This same breakdown is assumed to continue in the future. The inputs used to represent payments to local governments in 2005 dollars for the FEAST/IMPLAN analysis are displayed in the following table.

Table B-71. Payments to Local Governments by Alternative

Measure	Current	Alt. A	Alt. B	Alt. Cm	Alt. D
Payments to Govt., M dollars	5,619	17,267	16,139	13,353	6,946

Oil and Natural Gas

The cumulative effects section in Chapter 3 of the FEIS provides estimates of the economic contribution from the development of the ANF subsurface for oil and gas production. Since these subsurface development rights are not held by the ANF, private companies are developing these rights. The discussion in Chapter 3 of the FEIS estimates the current contribution made by oil and gas and future contribution based on the average scenario identified in Appendix F that describes the oil and gas resource of the ANF. This section contains a basic description of the analysis and some more detailed results of this analysis.

Appendix F identified the historic development on the ANF over the past 20 years. This indicated that in the past 5 years (2001 to 2005) an average of 357 wells were drilled for oil and natural gas. It also identified a most likely projection for the future of 512 new wells drilled each year during the plan period. This considers that the recent changes in energy prices and availability will stimulate increased development and production from the ANF subsurface.

One of the first assumptions to make for an economic impact analysis of oil and natural gas development is an estimation of future prices. Historically, prices for both commodities have been extremely volatile and variable. This has been true for the recent 5 year period. In both cases, it was assumed that a recent 5 year average would understate the prices of these commodities, but that the most recent high prices experienced at the end of 2005 were not likely to persist throughout the plan period. Prices for both commodities have shown some decline since the end of 2005. Thus a price for each was selected in the high end of the recent range of prices. For oil this was $50 per barrel of crude oil and for natural gas, $8.00 per MCF.

Secondly, estimates of production for ANF wells were needed. An average well on the ANF provides most of its production in the first 5 years of operation. An annual production average based upon average production rates for the state of Pennsylvania suggest that wells produces 2,000 barrels of oil or 4.2 million cubic feet of gas per year for the first 5 years. For 25 years following this, production drops to 550 barrels of oil per year or 2.2 million cubic feet of gas per year. Following this, oil production essentially ceases and gas production declines to about 1 million cubic feet or less per year. The cost of developing a well for the ANF was identified as $60,000 per well.

Using this basic production information and comparing this to the current well situation and the projected future situation suggests that the projected increase in well development will also increase production from the ANF subsurface. The following table summarizes the estimated levels of well drilling and production for the midpoint of the plan period (2013).

Table B-72. Current and Projected Oil and Gas Development

Item	Current Level	Future Level
Wells Drilled	357	512
Gas Production (MMCF)	19,756	28,153
Oil Production (Barrels)	6,524,075	8,724,700

These estimates were then applied to the FEAST/IMPLAN model to estimate the current and projected contribution of the ANF's subsurface oil and gas to the ANF region's employment and labor income (as shown in thousands of dollars). The results by sector are displayed in the following table.

Table B-73. Oil and Gas Developments Contribution to the Local Economy

Industry	Current Jobs	Projected Jobs	Current Labor Income	Projected Labor Income
Agriculture, Forestry and Fishing	3	5	$12.4	$17.2
Mining	977	1,346	$31,637.9	$43,693.3
Utilities	3	4	$252.4	$347.9
Construction	2	3	$100.6	$139.0
Manufacturing	13	18	$674.8	$938.4
Wholesale Trade	7	9	$302.8	$420.5
Transportation and Warehousing	12	17	$492.6	$683.8
Retail Trade	60	83	$1,286.4	$1,778.6
Information	6	8	$227.1	$315.8
Finance and Insurance	13	18	$477.9	$661.8
Real Estate and Rental and Leasing	7	9	$223.4	$310.3
Professional, Scientific, and Technical Services	18	24	$647.3	$894.7
Management of Companies	4	5	$378.0	$528.9
Administration, Waste Management and Removal Services	7	10	$157.2	$217.7
Educational Services	6	9	$139.2	$192.2
Health Care and Social Assistance	53	73	$1,766.7	$2,440.3
Arts, Entertainment, and Recreation	16	23	$184.3	$260.1
Accommodation and Food Services	32	44	$341.4	$471.6
Other Services	29	41	$552.2	$763.2
Government	53	73	$2,412.2	$3,323.8
Total Forest Management	1,321	1,823	$42,266.7	$58,399.2
Percent Change from Current	---	38.0%	---	38.2%

Recently, prices have exceeded the estimates of $50 per barrel of oil and $8 for natural gas. Given that the price of oil and natural gas were far below the $50 and $8 assumptions in 2002, the IMPLAN model is calibrated on a much lower overall level. There is difficulty in extrapolating estimates of the oil and gas industry to the local economy using IMPLAN formulated in 2002. Oil and gas activity is a cumulative impact within the ANF and not a direct effect of the plan itself. The preceding analysis only provides some estimate of the economic impact of the private subsurface development of the ANF for oil and natural gas, and it should not be regarded as a definitive estimate.