

## Appendix A - Description of the Analysis Process

### Description of the Analysis Process

#### ***Introduction:***

Appendix A presents a technical discussion of the analysis process and computer models used for the revised Huron-Manistee National Forests' Land and Resource Management Plan (Forest Plan). The appendix focuses on the quantitative methods used to perform the analysis and documents how the analysis was done.

The Forests' major planning goal is to provide enough information to help decision makers and publics determine which combinations of goods, services and land allocations will maximize net public benefits. The regulations (36 CFR 219) developed under the National Forest Management Act of 1976 provide the analytical framework within which these decisions are made.

The National Forest Management Act of 1976 and its regulations also state that the requirements of the National Environmental Policy Act and its regulations (40 CFR 1500-1508) must be applied in the analytical process. The National Environmental Policy Act regulations require that the environmental effects of a proposed action and alternatives to that proposed action must be disclosed.

Information presented in this appendix supplements the broader and less technical descriptions included in the body of the effects analysis in Chapter III of the Final Environmental Impact Statement. This discussion includes modeling components and inputs, rules, methods and management constraints. Additional information and documents used in the analysis process are contained in the Huron-Manistee National Forests' planning records. The planning record in its entirety is incorporated here by reference.

The results from the modeling process are estimates of what can be expected if alternatives are implemented. In addition, they facilitate comparison of alternatives.

### Forest Activity Scheduling Model (Spectrum)

#### ***Introduction:***

This section documents the work associated with the formulation and analysis of the forest activity-scheduling model for the Huron-Manistee National Forests. The forest planning analysis problem can be stated as follows: given a fixed area of land, what activities should be assigned to each land unit over the next 150 years to achieve the desired future conditions and still meet all physical, operational and regulatory constraints?

The Forests used the Spectrum Modeling Program as a timber harvest-scheduling tool to report timber outputs, costs and benefits. Spectrum is a software package developed by the Forest

Service's Ecosystem Management staff, in cooperation with the Rocky Mountain Forest and Range Experiment Station. Spectrum simultaneously analyzes the trade-off between the many goals, constraints, management activities, timing options and landtypes, which are necessary to manage a large forest. Spectrum uses linear programming optimization software called C-WHIZ, which in turn uses a modified Simplex algorithm for high-speed model solutions.

Spectrum is a linear programming model. It assumes that the relationship between outputs and the land base are linear, that is, twice the number of similar acres yields twice the outputs. Other resource programs, such as recreation, are not addressed by Spectrum because they are not related directly to vegetation management. Spectrum builds a matrix of coefficients and transfers the file to a linear programming package for problem solution. The primary reason Spectrum was selected for use in the planning process was the ability of the model to allocate scarce resources to competing demands based on selected criteria. The model then writes a report and produces a data file that contains the results. The data file can then be analyzed through comparisons with information in other databases.

The Huron-Manistee National Forests model scheduled vegetation management for 15 decades and provided an estimate of long-term sustained yield capability for each of the alternatives. The model was designed to track proposed management by Forest, Huron National Forest versus the Manistee National Forest, and timberland suitability, suitable or unsuitable lands. The model was designed to analyze the entire Huron-Manistee National Forests and suitable timberlands. Depending on the forest type and management goals, management options included no treatment, selection, shelterwood and clearcutting. Intermediate treatments or thinnings were prescribed in some cases. Succession was modeled for aspen-birch forest types. The modeling results indicated that conversion from selected forest types to barrens, openings and other forest types was possible.

### ***Development of Land Allocation Model (Spectrum):***

Land management planning is the major mechanism for making large-scale and long-term forestland allocations and resource management decisions. Planning consists largely of exploring a national forest's productive potential and experimenting with various allocation choices. A forest model is the primary planning tool because it permits studying the consequences of choices without actually committing valuable resources to "on-the ground" experimentation or having to wait many years to observe an outcome. People, not the model, make decisions about structuring land allocations, choosing and pursuing trade-offs, and accepting one result instead of another. The model is a device for organizing elements of the decision problem and discovering possible outcomes and choices.

The model is used in the analysis to simulate different management actions on forest resources and environmental conditions. This model is also designed to find the optimum solution to a problem posed by the potentials and limitations of land and resources; the effect of costs, budgets and resource prices; and the desired objectives of resource yields and environmental conditions.

***Spectrum Model Design:***

The basic elements of the Spectrum structure are Outputs and Costs, Analysis Units, Management Prescriptions, Time Periods, Objective Functions and Constraints. Outputs are those goods and services that are produced whether purposely or incidentally because of management of the Huron-Manistee National Forests. Selection of outputs to be used in Spectrum has major bearing on the structure of the model and on the results of the analysis. Outputs from the vegetation management model included allowable sale quantity for each alternative, timber management schedules to achieve each allowable sale quantity, and plant and animal habitat acreage.

Alternative models were developed on several assumptions, including:

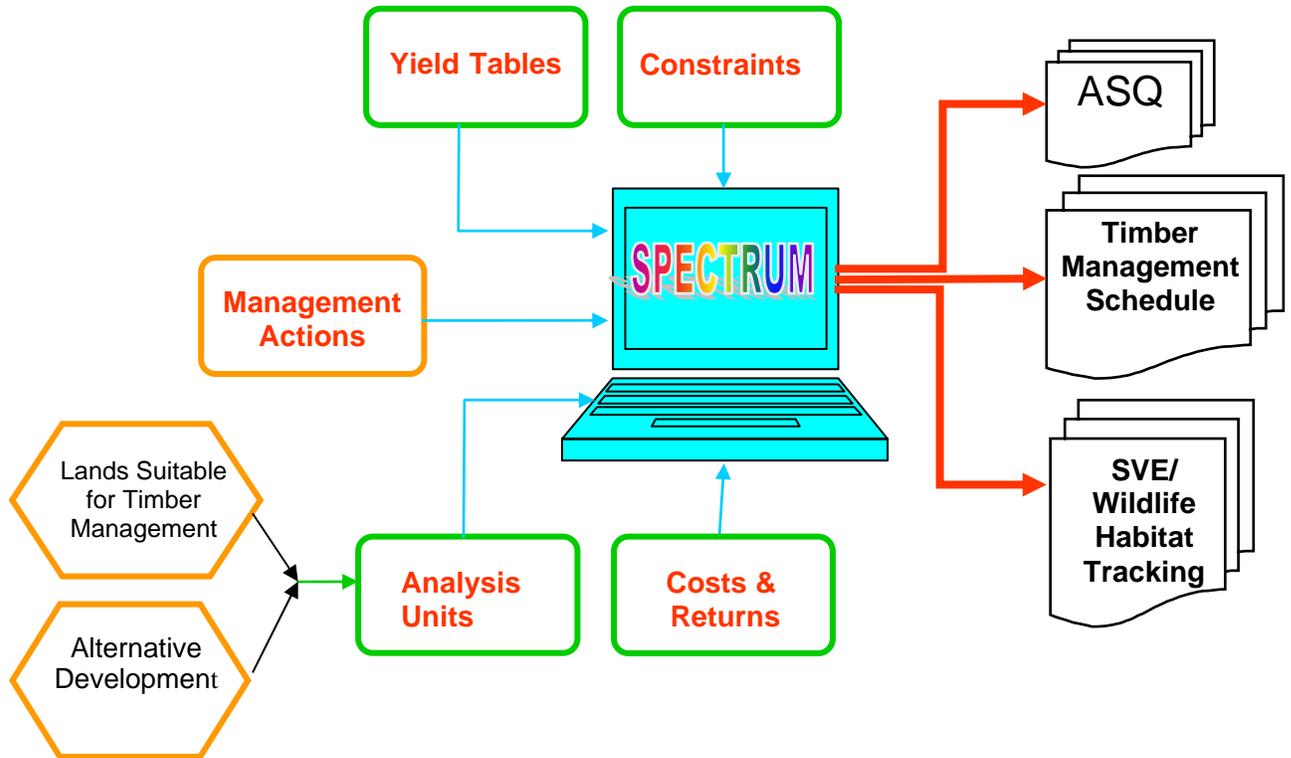
- The Forest Plan will be a strategic Plan that will guide broad land-based decisions to implement certain goals and objectives.
- “On-the-ground” decisions will apply Standards and Guidelines of the Plan and implementation guides to meet goals and objectives of the strategic Forest Plan.
- Models used in this analysis are sufficient for strategic planning.
- Each alternative will use the same Standards and Guidelines.
- Management Prescription Areas will remain essentially the same, except there would be no semiprimitive motorized areas under Alternative C.
- Alternative A was modeled using the Standards and Guidelines for the 1986 Forest Plan, as amended.
- Alternatives B and C used the same revised Standards and Guidelines with only the timing of implementation of (management actions varied).

In designing a Spectrum model, the modeler inputs resource data; specifies resource interactions; sets goals and objectives; outlines management actions; defines activities and outputs; sets the planning horizon; delineates the landscape into management areas; and inputs economic data.

Model design identified questions the model needed to answer and assessed what information was available for model input. The planning team identified the following factors that needed to be considered in Spectrum:

- Variety of species/product yields,
- Vegetation class acreage projections by one or more sub-categories,
- Age-class distributions by forest type/species, and
- Varied social and economic conditions across the Forest.

**Figure A-1. Timber Harvest Schedule Model - Process Overview.**



**Development of Analysis Units:**

The Huron-Manistee National Forests’ land base, which is inventoried and tracked in the Forest Combined Data Systems database, was classified by using five levels of information summarized in Table A-1. The five levels of information on the Huron-Manistee National Forests produced unique analysis units which varied by alternative. Alternative B contained 3,086 analysis units. Management actions are associated with analysis units in Spectrum.

**Table A-1. Identification Levels Used to Classify the Huron-Manistee National Forests’ Land Base for Analysis.**

Level	Description	Number of Categories
1	Management Area by Forest	44
2	Vegetation Class	9
3	Age Class Distribution	21
4	Old Growth	2
5	Timber Suitability	2

The following land attributes were used to stratify the Forests' land base for modeling: (1) Management areas, (2) Forest vegetation class, (3) 10-year age-classes, (4) Old-growth/Non-old-growth designation and (5) Suitable and non-suitable forestland for timber management.

### **(1) Management Areas:**

A management practice is a site-specific action, measure or treatment, such as tree planting and barrens creation, designed to implement management prescriptions, whereas a management prescription is a combination of management practices applied to a specific management area.

Management areas are areas of land that have a specific management prescription (see Forest Plan, Chapter III). Management area boundaries are based on landtype associations and were developed during the planning process in the mid-1980s. This provides a consistent ecological foundation for planning and management. The Huron-Manistee National Forests were stratified into management areas, each with its own description; prescription; and set of Standards and Guidelines. Land allocations by acres were assigned to each management area and transferred to the model. Emphasizing each management area goals and constraints, the model determined what type of vegetation management should be done and when.

The assignment of management prescriptions to each alternative is based upon a combination of ecological, economic and social factors. These factors vary across the alternatives in order to explore a range of options. Spectrum's allocation capabilities are applied to the management actions and timing of choices. The model estimated, by decade and by management area, the following outputs and conditions:

- Maximum timber harvest totals or allowable sale quantity;
- Species/product timber harvest volumes;
- Forest cover type acres, including barrens and openings;
- Forest cover type age-class distributions;
- Timber harvest methods by acres; and
- Standing timber volume (inventory or standing capital).

Forest and management areas help guide land allocation and management. The number of management areas varied by alternative.

**Table A-2. Level 1 Identifiers – Huron-Manistee National Forests' Management Areas by Forest for Alternative B.**

Management Area <sup>1/</sup>		
H2.1	H8.1	M4.4G
H2.1G	H8.2	M4.4W
H4.2	H8.4	M5.1
H4.2D	H9.1	M6.1
H4.2G	M2.1	M6.2
H4.2KW	M2.1G	M6.2D
H4.2W	M2.1W	M6.3
H4.3	M4.2	M8.1
H4.3D	M4.2G	M8.2
H4.3G	M4.2W	M8.3
H4.3W	M4.3	M8.4
H4.4	M4.3D	M9.1
H4.4G	M4.3G	M9.2
H6.1	M4.3W	M9.2W
H7.1	M4.4	

<sup>1/</sup> Management Area:

Number is the management prescription area.

H - Huron National Forest.

M – Manistee National Forest.

D – Deer emphasis sub-unit of a management area.

G – Grouse emphasis sub-unit of a management area.

W – General wildlife emphasis sub-unit of a management area.

## (2) Vegetation Classes:

Review of the forest cover types described in the 1986 Forest Plan and consultation with the forest silviculturalist and other resource management specialists assisted the planning team in selecting the vegetation classes for stratifying the Forests' land base (Table A-3).

Current vegetation age classes may lose or gain acreage over time. For example, unmanaged aspen / birch is modeled to succeed to high site oak or northern hardwoods. In addition, openings may be created as part of a fuelbreak strategy.

**Table A-3. Level 2 Identifiers – Vegetation Classes.**

<b>AB</b> – Aspen/birch (includes forest types such as quaking and bigtooth aspen, paper birch, balsam poplar and aspen-white spruce-balsam fir).
<b>HSO</b> – High site oak; Site index greater than 55 (includes white pine-northern red oak-white ash, oak-aspen, black oak, white oak, northern red oak, yellow poplar-white oak-northern red oak, mixed oak and black locust).
<b>LC</b> – Lowland conifer (includes black spruce, northern white cedar, tamarack, mixed swamp conifers and cedar-aspen-paper birch).
<b>LH</b> – Lowland hardwood (includes black ash-elm-red maple, red maple (wet) and mixed lowland hardwoods).
<b>LLC</b> – Long-lived conifer (includes red pine, white pine, white pine-hemlock, hemlock, Norway spruce, white spruce, white spruce-balsam fir-Norway spruce, black spruce (upland) and northern white cedar (upland)).
<b>LSO</b> – Low site oak (includes jack pine-oak, red pine-oak, plus forest types with site index less than 55, including white pine-northern red oak-white ash, black oak, white oak, northern red oak, mixed oak and black locust).
<b>NH</b> – Northern hardwood (including northern hardwoods-hemlock, mixed northern hardwoods, sugar maple-beech-yellow birch, sugar maple-basswood, black cherry-white ash-yellow poplar, red maple (dry site) sugar maple, beech and mixed upland hardwoods).
<b>SLC</b> – Short-lived conifer (includes jack pine, scotch pine, conifers and balsam fir-aspen-paper birch).
<b>OPEN</b> – Openings (includes lowland brush, brush/shrub and upland openings).

**(3) Age Class Distribution:**

Age classes are needed for analyzing ecological, silvicultural and biological information. Ten-year age classes were widely used in the preparation of the Forest Plan and the accompanying environmental impact statement published in 1986. It was determined that 10-year age classes were appropriate for Spectrum modeling of a programmatic plan. Current age classes were determined by inventory conditions (Table A-4). For example, short-lived forest types have fewer age classes than long-lived forest types. Significant acres of northern hardwoods are being managed for an uneven-aged structure, and these acres are tracked separately in Spectrum.

**Table A-4. Level 3 Identifiers – Age Class Groups.**

Age Class			
0-9	40-49	80-89	120-129
10-19	50-59	90-99	130-139
20-29	60-69	100-109	140-149
30-39	70-79	110-119	150+

**(4) Old Growth:**

Currently, 174,119 acres have been designated as old growth (1986 Forest Plan, as amended. See Environmental Impact Statement, Chapter III, for further discussion of the old-growth decision). To account for the earlier decisions regarding old growth, each analysis unit is identified in Spectrum as “old growth” or “not old growth” (Table A-5).

**Table A-5. Level 4 Identifiers – Old Growth.**

Old-Growth Designation
Old Growth
Not Old Growth

**(5) Timber Suitability:**

The final level identifier entered into Spectrum was timberland suitability for timber production. Each analysis unit was given a suitability designation of either suitable or not suitable for timber production (Table A-6). Several factors are considered in designating a stand’s suitability. (See Environmental Impact Statement, Appendix H for further discussion of suitability analysis).

**Table A-6. Level 5 Identifiers – Suitability of Land for Timber Production.**

Suitability Designation
Suitable
Unsuitable

**Yield Tables:**

Estimated harvest volumes, called “yield tables” are an important input to Spectrum. Spectrum uses the yield tables to estimate a harvest schedule by method, harvest volumes and the present net value of each alternative.

Yield tables developed during the first round of planning in the mid-1980s were used for this latest plan revision, as the yield tables were determined to be valid and did not require redevelopment. Verification of existing yield tables was accomplished by comparing existing standing volumes to outputs from recent timber sales.

This process identified aspen/white birch yield tables as an exception. During the yield table verification process, it was discovered that the 1986 aspen/white birch yield coefficients were underestimated. Forest silviculturalists developed new aspen/white birch yield tables utilizing Forest Inventory and Analysis data.<sup>1</sup> The Forest Vegetation Simulator (an individual tree-

<sup>1</sup> Under the authority of several acts including the McSweeney-McNary Forest Research Act of 1928, the Forest Service conducts periodic forest inventories of all states including Michigan. The Forest Inventory and Analysis program has the responsibility to collect, maintain and analyze this data. Sample plot data collected by the Forest Inventory and Analysis includes individual tree information such as tree height, diameter and species. Each plot is assigned a forest type, age, and other site information that happens to correlate well with the Forest’s Combined Data Systems stand polygon data.

growing model) was used to create the aspen yield table. The Lake States variant of this model was used. Outputs were imported into Spectrum from an Excel spreadsheet.

Input yields for Spectrum included the following species--products:

- Aspen / white birch--pulpwood/sawtimber
- High site oak--pulpwood/sawtimber
- Lowland conifer--pulpwood/sawtimber
- Lowland hardwood--pulpwood/sawtimber
- Long-lived conifer--pulpwood/sawtimber
- Lowland hardwoods--pulpwood/sawtimber
- Low site oak--pulpwood/sawtimber
- Northern hardwoods--pulpwood/sawtimber
- Short-lived conifer--pulpwood/sawtimber

Yield tables are used as inputs in the Spectrum model. Spectrum projects future outputs, long-term sustained yield, and other concerns related to forest vegetation for alternatives.

Management actions in Spectrum were identified. Management actions along with timing are the options among which the model “chooses” for each analysis unit. Management actions are driven by management area cover type composition objectives and are constrained by biological considerations. For example, in some management areas, it was necessary to have management action options that convert other forest types to barrens for species viability objectives for species such as Karner Blue Butterfly, and to openings to accomplish timber fuel hazard reduction.

### **Development of Model Constraints:**

Several types of constraints were developed for the Spectrum model in response to Standards and Guidelines and the management requirements in the National Forest Management Act of 1976, regulations (36 CFR 219.27). Constraints were also developed in response to management goals and to improve the model’s simulation of actual management of the Forests. These additional constraints include:

- Constraints assigning congressionally and administratively designated areas to specific prescriptions,
- Constraints ensuring that the management requirements are met in each alternative,
- Timber scheduling constraints and
- Operational constraints that constrain timber harvest to a realistic solution

### **Long-Term Sustained Yield and Non-declining Yields Constraint:**

Long-term sustained yield 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-Forest Service 1982 - CFR 219.3). Long-term sustained yield can also be explained as the potential average growth and is displayed in

Spectrum as an annual yield for the final period modeled. The long-term sustained yield constraint is used to ensure that the harvest of timber in the final decade of this projection is not greater than the long-term timber production capacity of the Forests. Long-term sustained yield capacity is computed using the acreage scheduled for each regeneration prescription applied in the model.

**Perpetual Timber Harvest Constraint:**

This constraint ensures that the remaining timber inventory will allow achievement of non-declining harvest levels beyond the modeling horizon. To achieve this condition the constraint requires that the Forest contain as much timber inventory volume at the end of the final period as the Forest would have, on the average, under the management intensities selected in the analysis. Without this constraint, the Spectrum model would have no reason to leave enough inventory at the end of 150 years to sustain timber harvest levels into perpetuity.

**Non-declining Yield Constraint:**

This constraint ensures that the harvest of timber in a decade is greater than or equal to the harvest of timber in the previous period. This constraint indirectly limits the model to a lower present net value and reduced flow of timber in the early decades, but also provides community economic and social stability through the controlled flow of timber.

**Management Requirements Constraints:**

These constraints limit the model so that the management actions and intensities selected are consistent with the emphasis of an individual alternative. Some of these constraints are specifically defined in the constraint section of the model and others are implemented through the definitions of the management actions, the management action theming and the definitions of the scheduling options. For example, if there are no schedules defined for a specific prescription, then analysis units that contain that prescription are constrained to only allow minimum level management. In addition, maximum and minimum levels of early successional conditions are constrained for the different prescriptions and alternatives, as are levels of thinning, amounts of woodland management, low-site oak conversion and uneven-aged management.

**Species Viability/Management Indicator Species Constraints:**

The wildlife, ecological and botanical team set certain goals for wildlife habitat. These were incorporated into the Spectrum model, specifically, Species Viability Evaluation habitat goals (barrens, openings, and aspen management) for ruffed grouse, Karner blue butterfly and Kirtland's warbler (Tables A-7, A-8 and A-9) (See Environmental Impact Statement, Appendix B for a description of the Species Viability Evaluation process).

**Table A-7. Spectrum Constraints Related to Species Viability Concerns, Acres of Forest Types Converted or Succeeding to Other Types.**

Forest	VegClass - Conversion from	VegClass - Conversion to	Acres - accomplished over 5 decades	Note
Huron	AB	NH	1,180	Succession acres
Huron	AB	HSO	1,180	Succession acres
Huron	HSO	HSO	810	Unmanaged acres
Huron	LH	LH	180	Unmanaged acres
Huron	LLC	Barrens	9,100	Conversion acres
Huron	LSO	Barrens	4,100	Unmanaged acres
Huron	NH	NH	2,580	Unmanaged acres
Huron	SLC	Barrens	6,000	Conversion acres
Manistee	AB	HSO	150	Conversion acres
Manistee	AB	NH	150	Conversion acres
Manistee	HSO	Barrens	8,500	Conversion acres
Manistee	HSO	HSO	780	Unmanaged acres
Manistee	LH	LH	220	Unmanaged acres
Manistee	LLC	Barrens	16,400	Conversion acres
Manistee	LSO	Barrens	7,700	Conversion acres
Manistee	NH	NH	9,100	Unmanaged acres
Manistee	SLC	Barrens	6,700	Conversion acres
Total constraint acres			74,830	

VegClass=Vegetation Class: AB = Aspen/Birch; HSO = High-site oak; LH = Lowland Hardwood; LLC = Long-lived Conifer; LSO = Low-site Oak; NH = Northern Hardwood; SLC = Short-lived Conifer

**Table A-8. Spectrum Constraints Related to Species Viability Concerns, Acres of Old-Growth Conversion to Barrens.**

Forest	Old growth VegClass - Converted from	Habitat condition - converted to	Acres - accomplished over 5 decades
Huron	LLC	Barrens	816
Huron	LLC	Barrens	861
Huron	LSO	Barrens	795
Huron	LSO	Barrens	472
Huron	OPEN	Barrens	386
Huron	OPEN	Barrens	1,093
Huron	SLC	Barrens	518
Huron	SLC	Barrens	559
Manistee	LLC	Barrens	137
Manistee	LLC	Barrens	572
Manistee	LLC	Barrens	773
Manistee	LSO	Barrens	458
Manistee	LSO	Barrens	631
Manistee	LSO	Barrens	591
Manistee	OPEN	Barrens	181
Manistee	OPEN	Barrens	339
Manistee	OPEN	Barrens	391
Manistee	SLC	Barrens	56
Manistee	SLC	Barrens	106
Manistee	SLC	Barrens	267
Total constraint acres			10,000

VegClass=Vegetation Class: LLC = Long-lived Conifer; LSO = Low-site Oak; SLC = Short-lived Conifer

**Table A-9. Spectrum Constraints Related to Management Indicator Species Concerns.**

Forest	Sub-Management Area	VegClass	Acres / decade
Huron	Ruffed grouse	Aspen	1,875
Huron	Kirtland's warbler	SLC	10,700
Manistee	Ruffed grouse	Aspen	2,500

VegClass=Vegetation Class: SLC = Short-lived Conifer

**Hazardous Fuels Reduction:**

In order to maintain the biological integrity of fire-dependent ecosystems, provide for public safety, and protect public property from wildfire, specific hazardous fuels reduction goals were proposed. These goals were constraint inputs in Spectrum (Table A-10).

**Table A-10. Spectrum Constraints Related to Fuels Hazard Reduction Concerns.**

Forest	VegClass - conversion from	VegClass - conversion to	Acres - accomplished in the 1st decade
Huron	LLC	Open	4,430
Huron	LSO	Open	480
Huron	SLC	Open	2,890
Manistee	LLC	Open	870
Manistee	LSO	Open	320
Manistee	SLC	Open	510
Manistee	SLC	LSO	500
Total constraint acres			10,000

VegClass=Vegetation Class: LLC = Long-lived Conifer; LSO = Low-site Oak; SLC = Short-lived Conifer

### Benefits in Spectrum:

Table A-11 lists the timber stumpage value outputs used in SPECTRUM. The timber benefits are developed from recent stumpage prices paid for timber harvested on the Huron-Manistee National Forests. Receipts are dependent upon the Forest and general vegetative group.

**Table A-11. Priced Output Values Used in the Spectrum Model.**

Priced Outputs		
Product	Huron National Forest	Manistee National Forest
Value per Million Cubic Feet		
AB sawlogs	\$371.42	\$317.48
AB pulpwood	\$234.66	\$232.11
HSO sawlogs	\$503.40	\$971.02
HSO pulpwood	\$157.53	\$368.09
LC sawlogs	\$495.67	\$388.96
LC pulpwood	\$344.25	\$154.09
LLC sawlogs	\$740.11	\$1,123.29
LLC pulpwood	\$487.99	\$535.90
LSO sawlogs	\$503.40	\$971.02
LSO pulpwood	\$157.53	\$368.09
NH sawlogs	\$503.40	\$971.02
NH pulpwood	\$157.53	\$368.09
SLC sawlogs	\$495.67	\$388.96
SLC pulpwood	\$344.25	\$154.09

Product: AB = Aspen/Birch; HSO = High-site Oak; LC = Lowland Conifer; LLC = Long-lived Conifer; LSO = Low-site Oak; NH = Northern Hardwood; SLC = Short-lived Conifer

**Costs used in Vegetation Management and Spectrum Model Use:**

The costs shown in the following Table A-12 are in 2003-dollar values. These are the associated costs of activities, such as stand regeneration, stand improvement and timber harvesting, used in the Spectrum model to create various vegetative conditions. Such activities may occur only when certain conditions are met. These conditions are displayed in the table. Regeneration and other silvicultural costs were estimated from historic records.

**Table A-12. Costs of Activities, Regeneration and Vegetative Class Conversions.**

Vegetation Class	Activity	Cost
All	Timber sale preparation and administration: Clearcutting, thinning, shelterwood	\$676.00/mcf
All	Certification survey	\$8.00/acre
AB	Site preparation, natural	\$25.00/acre
HSO	Site preparation, natural	\$60.00/acre
LC, LH, LSO, NH, SLC (Kirtland's warbler area)	Site preparation, natural	\$35.00/acre
LLC	Site preparation, natural	\$31.50/acre
All	Landline survey - new	\$39.00/acre
All	Landline survey - reestablish	\$10.00/acre
All	Reforestation, timber stand improvement preparation & administration	\$12.50/acre
HSO	Reforestation – oak; shelterwood, 1 <sup>st</sup> cut	\$6.10/acre
HSO	Reforestation – other species, shelterwood, removal cut	\$25.00/acre
LC, LH	Reforestation	\$62.50/acre
LLC	Reforestation, mechanical – disk trencher, Bracke scarifier	\$15.75/acre
LLC	Reforestation, red, white and jack pine planting	\$94.50/acre
LLC	Reforestation, red, white and jack pine planting	\$10.00/acre
LLC	Reforestation, mechanical – furrowing	\$10.00/acre
LSO	Reforestation, mechanical – disc trencher	\$14.00/acre
LSO	Reforestation, mechanical – Bracke scarifier	\$14.00/acre
LSO	Reforestation, normal planting – other species	\$25.00/acre
NH (other forest types)	Natural site preparation (shelterwood)	\$60.00/acre
NH (other species)	Reforestation	\$35.00/acre
NH (other forest types)	Natural site preparation (clearcut)	\$35.00/acre

**Table A-12. Costs of Activities, Regeneration and Vegetative Class Conversions  
(Continued).**

Vegetation Class <sup>1/</sup>	Activity	Cost
SLC (seeding)	Reforestation	\$7.50/acre
SLC	Reforestation (Mechanical furrowing)	\$100.00/acre
SLC	Reforestation (Red, white and jack pine planting)	\$210.00/acre
SLC (Kirtland's Warbler)	Reforestation (Mechanical, roller chopping or furrowing)	\$25.00/acre
SLC (Kirtland's Warbler)	Reforestation (Mechanical, roller chopping, with chains)	\$27.50/acre
SLC (Kirtland's Warbler)	Reforestation (Mechanical, Chain scarifier)	\$15.00/acre
SLC (Kirtland's Warbler)	Planting	\$285.00/acre
SLC (Kirtland's Warbler)	Planting (Fill-in)	\$10.00/acre
SLC (Conversion to LSO)	Regeneration	\$118.50/acre
LSO (Conversion to SLC)	Regeneration	\$460.50/acre
HSO	Browse protection	\$31.50/acre
LC, LH	Browse protection	\$157.50/acre
All forested vegetation classes	Barrens creation	\$250.00/acre
Barrens	Barrens maintenance	\$226.80/acre
All forested vegetation classes	Opening creation	\$400.00/acre
Openings	Opening maintenance	\$200.00/acre
Land line	Boundary survey, establishment	\$39.00/acre
Land line	Boundary survey, re-establishment	\$10.00/acre

<sup>1/</sup> Vegetation Class: AB = Aspen/Birch; HSO = High-site oak; LC = Lowland Conifer; LH = Lowland Hardwood; LLC = Long-lived Conifer; LSO = Low-site Oak; NH = Northern Hardwood; SLC = Short-lived Conifer.

More details on the use of these costs are available in the project record.

## Benchmarks:

Benchmark analyses provide baseline data to support formulation of alternatives, and aid in defining the range within which alternatives can be constructed. Benchmarks estimate the Forest's physical, biological and technical capabilities to produce goods and services. The Planning Regulations specify that, as a minimum, the Analysis of the Management Situation shall include benchmark analyses that define: (1) the range within which alternatives can be constructed; (2) the minimum level of management needed to maintain and protect the Huron-Manistee National Forests as part of the National Forest System together with associated costs and benefits; (3) the maximum physical and biological production potentials of individual significant goods and services together with associated benefits and costs; and (4) monetary benchmark that estimates the maximum present net value of those resources.

Maximum Timber Benchmark: This benchmark provided baseline timber production capability references. The maximum timber benchmark utilized the maximum potential area of the Forests that can be classified as suitable for timber production. Forest land not considered as suitable for timber production in these benchmark analyses include non-forested land, land that is defined as physically unsuitable for timber management according to the Planning Regulations, and land removed through statute or administrative action, such as designated Wilderness.

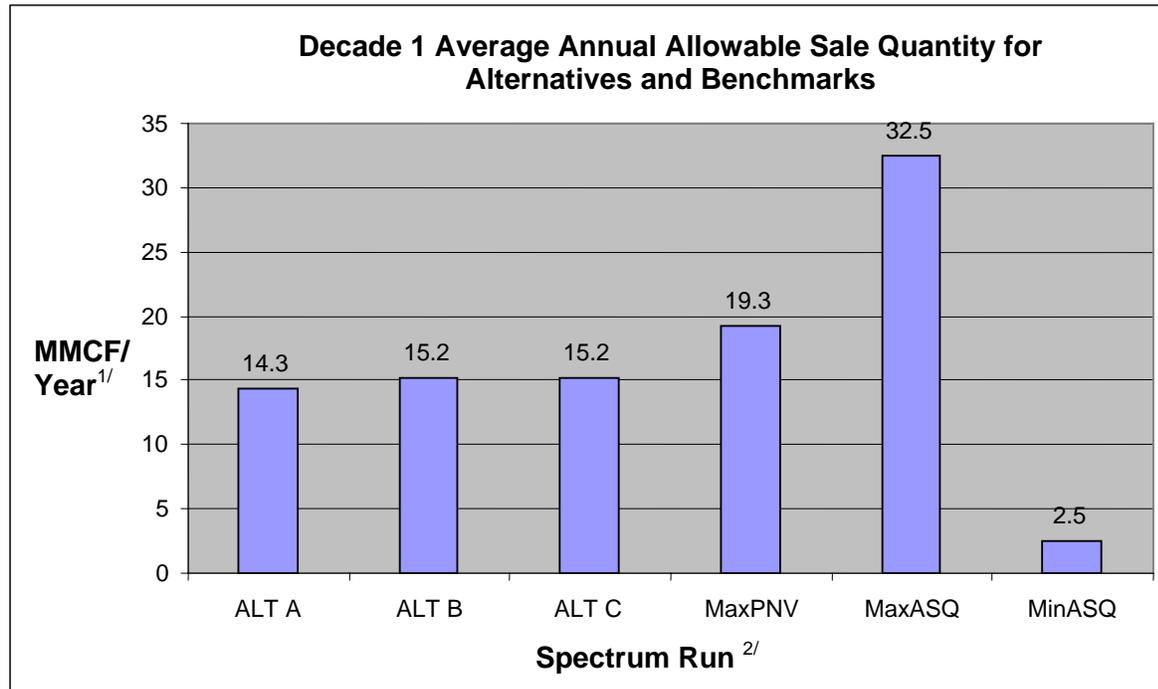
Maximum Present Net Value Benchmark: This benchmark reflected the maximum value of discounted revenues minus discounted costs. Monetary benchmarks estimate the Present Net Value for resources with established market values and those with assigned values. Present Net Value calculations are made using a discounting formula with a 4 percent discount rate. The Present Net Value for major market-priced outputs is maximized by estimating the mix of uses combined with a schedule of outputs and costs.

Minimum Level Benchmark: The Planning Regulations require the identification of a Minimum Level Benchmark (minimum maintenance and protection of the Forest). This benchmark represents only those costs and outputs associated with protecting and managing activities and investments where there is little or no management discretion. Incidental outputs are permissible, but there will be no management action-related timber. Forest vegetation will evolve through natural succession.

The Minimum Level Benchmark represents the least amount of management needed to maintain and protect the Forest as part of the national forest system. The following are minimum management objectives: (1) Protect the life, health and safety of forest users; (2) Conserve soil and water resources; (3) Prevent significant or permanent impairment of the productivity of the land; (4) Administer legally required special uses and mineral leases, permits, contracts, and operating plans; and (5) Prevent environmental damage to the land and resources of adjoining and (or) downstream lands under other ownership. In addition, facility maintenance will be done only to support activities and use that cannot be reasonably discouraged; all other facilities are allowed to deteriorate. Dispersed recreation use will be permitted when and where control activities are not needed. Critical habitat for threatened and endangered species will be protected. In addition, heritage resource management will be limited to the identification and protection of resources associated with proposed ground disturbing activities.

Benchmarks were considered sufficient to meet our analysis needs. With the benchmarks defined, the planning team finalized alternatives for the Draft Environmental Impact Statement. Benchmarks were used to model each alternative as a check of both the model and benchmark assumptions.

**Figure A–2. First Decade Alternative and Benchmark Comparisons of Average Annual Harvest.**



<sup>1/</sup> MMCF=Million Cubic Feet.

<sup>2/</sup> Spectrum Run:

ALT A = Alternative A.

ALT B = Alternative B.

ALT C = Alternative C.

MaxPNV = Maximize Present Net Value.

MaxASQ = Maximize Allowable Sale Quantity.

MinASQ = Minimum Allowable Sale Quantity.

**Table A-13. Spectrum Benchmark Runs by Present Net Value and Allowable Sale Quantity.**

Benchmark Run <sup>1/</sup>	Present Net Value (1,000 \$ 2004)	Allowable Sale Quantity (mcf/decade) <sup>2/</sup>
Maximize PNV	\$82,751	192,600
Maximize ASQ	-\$100,380	324,750
Minimum Level	\$-90,579	24,921

<sup>1/</sup> PNV=Present net value, ASQ=Allowable sale quantity.

<sup>2/</sup> mcf=Thousand cubic feet.

### Estimated Effects of Alternatives:

Each of the three alternatives was analyzed using the Spectrum model. Each alternative had a specific set of objectives. All alternatives had a non-declining yield constraint applied over a 15-decade timeframe. All alternatives had a budget constraint based on approximately 150 percent of the existing budget. Species viability and fuels hazard reduction objectives was applied to

Alternatives B and C. Management indicator requirements were applied to all alternatives.

**Alternative A** was designed to mimic the current plan applied without change. For example, there were no barrens or fuels hazard reduction areas in the current plan and therefore there were none in Alternative A. Harvest activity mirrored proposed harvests in the 1986 Forest Plan.

**Alternative B** was formulated to represent a schedule of vegetation management that improves and protects sensitive plant communities, including restoration of barrens and prairies for Karner blue butterfly and increased jack pine harvest treatment for Kirtland’s warbler, as well as implementation of hazardous fuel reduction through implementation of forest fuelbreaks.

**Alternative C** accelerates the minimum species viability and biodiversity goals of Alternative B in 30 years rather than 50 compared to Alternative B, and decreases the number of acres and rate of activity in hazardous fuel reduction.

The following Table A-14 displays some of the important results from the analysis for the first decade of implementation.

**Table A-14. Spectrum Model Results.**

	Alternative		
	A	B	C
Allowable Sale Quantity (MCF) / 1 <sup>st</sup> Period	143,000	151,677	151,677
Nonchargeable (MCF) 1 <sup>st</sup> Period	7,002	41,700	87,041
Long-Term Sustained Yield (MCF/yr)	33,570	30,642	27,842
Present Net Value (M\$)	-\$69,824	-\$80,980	-\$43,938
Clearcut (acres, 1 <sup>st</sup> Period)	46,216	60,959	69,675
Shelterwood (acres, 1 <sup>st</sup> Period)	9,563	8,261	2,984
Thin (acres, 1 <sup>st</sup> Period)	32,599	59,458	87,707
Uneven-age (acres, 1 <sup>st</sup> Period)	5,692	0	0
Opening Maintenance (acres, 1 <sup>st</sup> Period)	15,000	15,000	15,000
Barrens Creation (acres, 1 <sup>st</sup> Period)	796	9,318	26,217

<sup>1/</sup> MCF=Thousand Cubic Feet.  
M\$ = Thousand Dollars.

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## Social and Economic Resiliency Analysis

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The purpose of this portion of Appendix A is to provide interested readers with additional details regarding the social and economic analyses utilizing the economic computer models IMPLAN (Impact Analysis for Planning) and FEAST (Forest Economic Analysis Spreadsheet Tool). This section does not provide sufficient information to replicate the analysis. For that level of detail, the specialist reports contained in the administrative record should be consulted.

### ***Defining Economic Impact Analysis Area:***

#### **Introduction:**

Defining impact areas for use with IMPLAN (economic input-output model) is a blend of art and science. Due to the complex economic interactions between individuals, firms and governments, no impact area perfectly represents these interactions. Rather, an impact area embodies a set of decisions that offer the best answers to questions that publics, decision-makers and economists ask.

The economic impact area for the Huron-Manistee National Forests is described in the Social and Economic Assessment for the Michigan National Forests, 2003, authored by Drs. Larry Leefers, Associate Professor, Karen Potter-Witter, Professor, Maureen McDonough, Professor, Department of Forestry, Michigan State University.

The impact area for the Huron-Manistee National Forests includes the following counties:

Alcona	Lake
Alpena	Manistee
Crawford	Mason
Iosco	Missaukee
Montmorency	Muskegon
Ogemaw	Newaygo
Oscoda	Oceana
Otsego	Osceola
Roscommon	Wexford

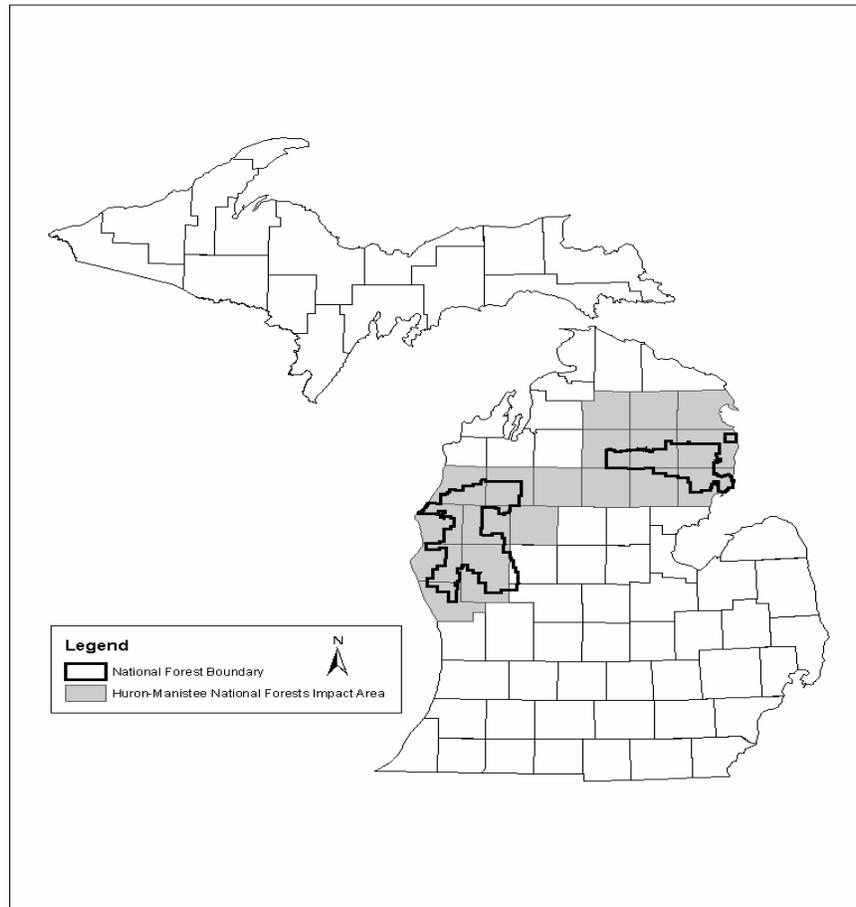
#### **Huron-Manistee National Forests' Economic Impact Area:**

Economic relationships generated within IMPLAN were extracted and used in the FEAST model. The FEAST model was used at the Forest-level to analyze the impacts of Forest Plan alternatives.

Impact areas are defined using historic and anticipated effects of National Forest management. However, there is no guarantee that they will provide the best fit for assessing future effects. Effects of future National Forest management should be monitored to see whether the criteria for

impact area definition discussed above and their application are providing the most credible and useful estimates of local economic impacts.

**Figure A-3. Economic Impact Area for the Huron-Manistee National Forests.**



### **Economic Impact Model:**

Economic effects to local counties were estimated using an economic input-output model developed with IMPLAN Professional 2.0.1017 (IMPLAN). IMPLAN is a software package for personal computers that uses the latest national input-output tables from the Bureau of Economic Analysis, secondary economic data at the county level from a variety of public sources and proprietary procedures to develop an input-output model for a study area. The model was originally developed by the Forest Service and is now the property of the Minnesota IMPLAN Group. Someone who is unfamiliar with IMPLAN cannot readily perform input-output analysis with IMPLAN. A detailed explanation of every step in building the model and constructing individual resource and activity impact files was not made a part of this appendix. To know the procedural process for running IMPLAN, refer to “IMPLAN Professional User’s, Analysis Guide and Data Guide”, Minnesota IMPLAN Group, Inc., 1997, which is part of the Planning of each forest. The Minnesota IMPLAN Group also offers training classes for model usage.

The Huron-Manistee National Forests' model was developed using 2001 IMPLAN data. One model was developed to include both the Huron and Manistee National Forests.

The model area was determined with consideration of such things as generally recognized functional economies, supply-based regions, resident concepts of “local” and contiguous counties.

## **Forest Contribution and Economic Impact Analysis:**

Impact analysis describes what happens when a change in final sales (such as exports and consumer purchases) occurs for goods and services in the model area. Changes in final sales are the result of multiplying units of production (for example, hundred cubic feet of timber harvest or recreation visitor days of recreation use) times sales per unit. Economic impacts were estimated using the best available production and sales data. The source of each is listed below. Impacts to local economies are measured in two ways: employment and labor income. Employment is expressed in jobs; a job can be seasonal or year-round, full-time or part-time. The number of jobs is computed by averaging monthly employment data from state sources over one year. The income measure used was labor income expressed in 2003 dollars. Labor income includes both employee compensation (pay plus benefits) and proprietors' income (for example profits by self-employed).

The planning area model was used to determine the employment and income consequences throughout the economy of one-million-dollar changes for each kind of impact. The results are called response coefficients. Because input-output models are linear, multipliers or response coefficients need only be calculated once per model and then applied to the direct change in output. Spreadsheets were used to calculate total effects by multiplying the response coefficients by estimated levels of dollar activity. A customized Excel workbook called Forest Economic Analysis Software Tool (FEAST) was developed and used for this purpose. Details of FEAST may be examined in the project record. Specifications for developing response coefficients and levels of dollar activity are stated below.

### **Timber:**

#### Sales Data:

Information on timber stumpage values was provided from historical sales records available on each National Forest. Direct information on the shipped value of finished timber products for all processing sectors was not available from any source. Because this information was unavailable, the IMPLAN model was used to derive these production values.

#### Use of the Social and Economic Assessment:

The Social and Economic Assessment for the Michigan National Forests, 2003, indicates a modest mix of timber processing firms in northern Michigan. Of the possible 18 different types of timber processing sectors, only three can be found in this area, such as wood products, furniture and paper. The assessment indicates that wood products employment on the Huron

National Forest side of the impact area in 2003, was approximately 1,354 persons in 54 wood products manufacturing establishments and 78 in five furniture establishments. Employment was estimated at 205 in the paper industry in four establishments. Furniture and fixture earnings were not disclosed for any of the counties in the Huron National Forest impact area.

Wood products employment on the Manistee National Forest side of the impact area was approximately 765 persons in 41 wood products establishments and 940 in 26 furniture establishments. Employment was estimated at 1,184 in the paper industry in five establishments.

#### Use of the Model:

Employment in the lumber and wood products industry is also estimated by the IMPLAN model. One million dollars of exports were modeled through each timber-processing sector to determine a “response coefficient.” Timber volume from the National Forests was multiplied by historical stumpage prices and multiplied by the response coefficient for “logging camps” to obtain the total economic impact. The distribution of National Forest timber processors and model relationships between “logging camps” and other sectors were then used to derive the export value for each timber sector. This value was then multiplied by the appropriate response coefficient to determine total economic impact for each sector. All results were then summed for presentation in the Environmental Impact Statement. This process was repeated for each alternative.

#### **Recreation and Wildlife/Fish:**

##### Expenditure Data:

Visitors to the National Forests in Michigan often engage in a variety of activities during a trip. Often these activities cross over boundary lines between public and private lands. Consequently, a general tourism/recreationist expenditure pattern can reliably represent visitors to the National Forests. Several surveys of tourists in northern Michigan were used to build an expenditure profile for most recreationists on the Huron-Manistee National Forests. Where studies that are more specific were not available, the general expenditure profile from these surveys was used.

The U.S. Fish & Wildlife Service periodically conducts a national survey to obtain, among other information, data on recreation expenditures for hunting, fishing and other wildlife-related recreation. This information is available by state. These expenditure profiles were also organized for use in IMPLAN by the agency’s Inventory and Monitoring Institute. Expenditures were collected on a “per trip” basis, but converted to a person-day basis for use in IMPLAN. Expenditure profiles for non-resident expenditures in Michigan were used for estimating impacts from wildlife-related recreation.

##### Use of the Model:

One million dollars of expenditures for the categories of recreation discussed above were run through the model. The results were then incorporated into the FEAST workbook where they were multiplied by total expenditures for each category. Only non-local recreation expenditures

(tourism export) use is considered for impact analysis.

### **Minerals:**

#### Expenditure Data:

Mineral activities on National Forest System lands generate revenues for the local economy through renting/leasing of heavy equipment; purchase of supplies and materials, and payments of salaries to workers. Expenditures vary by depth of well, type of well, and stage of development. Typical spending profiles for wells in Michigan were used to document spending profiles for typical wells expected to be drilled on the Forests. Data was acquired for both dry holes and productive wells.

#### Use of the Model:

One million dollars of expenditures for the categories of minerals discussed above were run through the model. The results were then incorporated into the FEAST workbook where they were multiplied by total expenditures for each category.

### **Federal Expenditures and Employment:**

#### Expenditure Data:

The Forest adjusted budget estimates by alternative. This budget constraint was used to estimate total Forest expenditures, some of which had local economic effects. Total Forest obligations by budget object code for FY 2003 were used to estimate how the budget would be spent. Forest Service employment was estimated by the Forest staff based on examination of historical Forest Service obligations. Details regarding the expenditures may be found in the project record.

#### Use of the Model:

To obtain an estimate of total impacts from Forest Service spending, salary and non-salary portions of the impact were handled separately. Non-salary expenditures were determined by using the budget object code information noted above. This profile was run through the model for non-salary expenditures per one million dollars, and the results multiplied by total Forest non-salary expenditures. Sales to the Federal Government are treated in the same manner as exports.

Salary impacts result from Forest employees spending a portion of their salaries locally. IMPLAN includes a profile of personal consumption expenditures for several income categories.

### **Revenue Sharing – 25 Percent Fund Payments:**

#### Expenditure Data:

Federal law requires that a portion of current or historical revenues be returned to the states and

counties within which the revenues were received. These payments may be used for a variety of purposes, including schools and roads. It was assumed that 25 percent of all National Forest revenues would be returned to the local impact area, and that a split of 75 percent for schools and 25 percent for roads would represent how local governments spend these revenues. A profile of expenditures for each of these purposes was derived from the model itself. Details regarding the expenditures may be found in the project record.

#### Use of the Model:

The national expenditure profile for state/local government education (schools) and local model estimates for road construction (roads) are provided within IMPLAN. One million dollars of each profile was used to estimate a response coefficient for these Forest Service payments to impact area counties. The results were then incorporated into a spreadsheet where they were multiplied by total expenditures. Sales to local government are treated in the same manner as exports.

#### Output Levels:

Output levels are specified in the FEAST Excel spreadsheet, located in the project record.

#### **Financial and Economic Efficiency Analysis:**

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

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