White Mountain National Forest

# Appendix B
# Analysis Process

# Contents

# Introduction

This appendix will provide additional detail on the process used in the analysis that went into the land suitability analysis, modeling to determine timber harvest schedules and the economic analysis. The land suitability analysis determines the lands that will be suitable for commercial timber harvesting. The timber harvest schedules were used in developing the plan's alternatives and in determining the allowable sale quantity by alternative. This information supplements the vegetation affected environment and effects analysis found in chapter 3 of this document. The other area described in this section is the methodology used in the economic analysis, which complements the social and economic affected environment and effects analysis, also found in chapter 3.

This analysis was performed to fulfill the requirements codified in the Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 as amended by the National Forest Management Act (NFMA) of 1976. These Acts require that renewable resource programs be based on a comprehensive assessment of present and anticipated uses. The demand for and supply of renewable resources must be determined through an analysis of environmental and economic impacts. The regulations promulgating these acts are in Code of Federal Regulations, Title 36, Part 219 (36 CFR 219).

# Scope of the Analysis

This environmental impact statement is being prepared in the context of revising the current White Mountain National Forest Land and Resource Management Plan, which was approved in 1986. A significant part of the analysis effort in the 1986 Plan included modeling and evaluating various ways to allocate the land base to management areas. The entire Forest was available for analysts and specialists at the time to evaluate different areas for their suitability and appropriateness to satisfy several possible multiple use objectives. These uses included timber management, several categories of recreation use, research, as well as recommending areas for potential Wilderness designation. Scope of the analysis in this Plan revision effort is focused on outputs and conditions within various management areas while recognizing the land allocation changes presented in the alternatives.

The areas identified in the 1986 Plan for possible timber management established a baseline for changes proposed in this revision effort. The most significant changes to the lands that permit timber management resulted from additional areas considered for Wilderness designation. Other timber management area boundary changes from the current Plan found in the alternatives are largely due to changes resulting from improvements in mapping accuracy and more complete and detailed information on site-specific conditions between management areas.

# Timber Resource Land Suitability Analysis

During the forest planning process, lands were evaluated to determine their suitability for timber production in accordance with 36 CFR 219.14. The acreage accounting for this evaluation can be found in Appendix E.

In the first stage of this evaluation, lands were excluded if they were not forested, irreversible damage would occur if harvesting took place, lands could not be adequately restocked, or lands were withdrawn from timber production by and Act of Congress, the Secretary of Agriculture, or the Chief of the Forest Service. These steps are reflected in lines 1 through 6 of the table in Appendix E, and the remaining acreage is termed tentatively suitable and shown on line 7.

The second stage of land suitability analysis evaluated the tentatively suitable land to determine the costs and benefits for a range of management intensities for timber production. For the purpose of this analysis, the land was stratified into categories of land that have similar management costs and returns.

The first criterion used in the stratification involved determining the land's ecological land classification (ELC) and is described in Appendix B under *Growth and Yield Modeling*. The ELC stratifies the land based on the various growth and yields that each ELC produces, by species product group.

The second criterion used in stratifying the land was stand age class. The age of the stands were grouped by twenty year intervals based on their year of origin. The oldest grouping captures everything 120 years and older. Growth and yield data was determined for each initial age class by ELC.

The third criterion used site specific information on land suitability evaluated at the stand level of detail. The land suitability class (LSC) identifies areas that are not cost efficient to perform commercial timber harvesting. This would include physical characteristics of the land that would not make it cost efficient to operate, such as slopes that exceed the operable range of timber harvesting equipment used on the Forest. If the site specific LSC identifies the land as unsuitable for commercial timber production, the area was classified as unsuitable.

The Forest also considered transportation requirements necessary to access timber from the existing road network. This review concluded the existing road network is, in general, adequate to provide access and any new road construction would not exceed one mile per year for the entire Forest. To appreciate this, one must understand the recent history of road construction on the Forest.

By the early 1980s, the Forest was constructing roads at the rate of approximately 10 miles per year and nearly as many existing roads were undergoing restoration or significant reconstruction. By the time the 1986 Plan came out, the road system that was necessary to access the timber base was, for the most part, in place. Therefore, for the foreseeable future the vast majority of road work to access timber will be in reconstructing existing

travelways and there will be very minimal new road construction. Exactly which road needs to be reopened or reconstructed are site specific, project level decisions. These decisions are beyond the scope of a Forest Plan revision and consequently were not used as a stratification layer in the land suitability analysis.

The ELC and stand age class criteria stratified the land into areas with similar management costs and returns. The costs are shown in Table B-11 and the returns are based on the stumpage values as shown in Table B-10. Each of the land categories were evaluated to identify the management intensity that results in the largest excess of discounted benefits less discounted cost. For the purposes of this analysis, the Forest calculated their net present value (NPV) discounted at 4% per year in order to evaluate cost efficiency. A positive NPV indicates a cost efficient result and a negative NPV indicates a cost inefficient result. The majority of all of the possible treatment strategy – ELC combinations return positive NPV coefficients. Those that don't are usually not brought into solution when running the model since it typically solves for maximizing NPV as part of its objective function.

Notwithstanding, the Forest recognizes that in certain circumstances there are non-priced benefits to prescribing a cost inefficient management strategy for a particular ELC – age class combination. For example, uneven age treatments may be less cost efficient to perform compared to regeneration harvests but can be used to help preserve the scenic integrity of visually sensitive areas. The fact that these lands can be made more cost efficient by managing them with an even age system supports preserving them as part of the suitable base. By recognizing and evaluating the non-priced benefits achieved when using a cost inefficient management technique, the Forest Service makes more informed decisions of the potential trade-offs of these possible management strategies.

In the third stage of land suitability analysis, portions of the remaining tentatively suitable lands were considered for other potential uses along with their traditional uses. This varied according to the design of each alternative and resulted in the various amounts of lands identified as suitable for timber resource management (Table E-1, line 10).

Since the Draft Environmental Impact Statement was released in September, 2004, the Forest acquired approximately 2,300 acres of additional land. These additional lands have been included in the Land Suitability Analysis and are reflected in Table E-1. The majority of these lands are designated General Forest Management (MA 2.1), and are included in the suitable base. The Forest Service evaluated whether it would be worthwhile to redesign and rerun the timber harvest schedule model (SPECTRUM) to evaluate their potential contribution to the timber resources on the Forest. However, due to the lack of site-specific ecological land type classification and stand examination data, as well as the expected minor effect on the results, they were not included in the timber harvest schedule analysis for the FEIS.

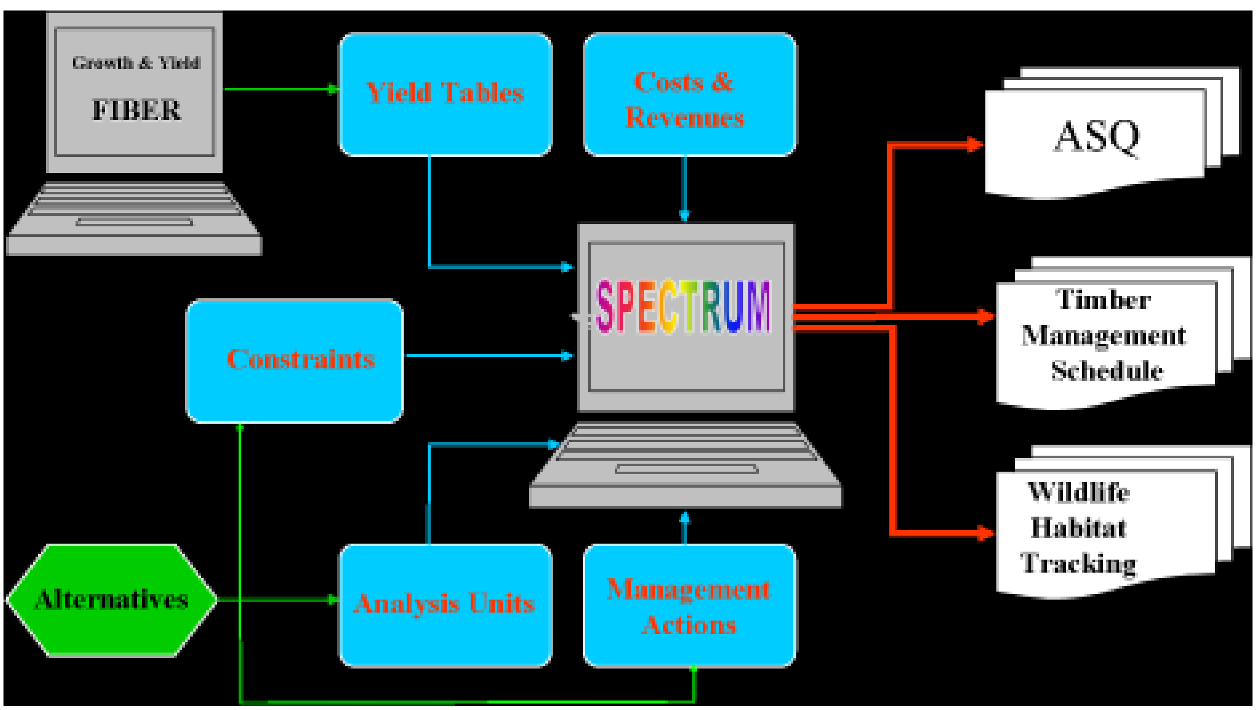
# Growth & Yield and Timber Harvest Schedule Modeling

## Process Overview

Figure B-01 provides a process flow diagram of the timber harvest schedule modeling process. As shown, the growth and yield (FIBER) modeling preceded the timber harvest schedule modeling (SPECTRUM). The end result of the growth and yield modeling was a set of tables of coefficients by tree species and by period (decade) that provided volumetric yields to satisfy all of the possible timber management strategies. Included in the tables are coefficients to track standing inventory volumes as well. Yield tables were determined on a per acre basis and were specific to several ecological land classifications.

The initial or conceptual design of the alternatives included consideration of the original benchmarks established in the 1986 Plan. Those benchmarks provided relevant information to establish possible ranges for the conceptual design of the alternatives. The benchmarks also provided a framework for constraints, the design of analysis units and the development of possible timber management actions. Costs associated with various harvest activities and revenue from timber sales by product were developed as additional inputs to the timber harvest schedule model (SPECTRUM). Outputs from the timber harvest schedule model included an allowable sale quantity (ASQ) for each alternative, the timber management schedules to achieve each ASQ, and some indicators to track specific types of wildlife habitat.

*Figure B-01. Timber Harvest Schedule Modeling Process Flow Chart.*



## Growth & Yield Modeling

In July 2002, the White Mountain National Forest assembled an interdisciplinary team of resource scientists and specialists including a research forester, three professional foresters, a soil scientist, an operations research analyst, and a database analyst to start the process of developing yield tables for use in timber growth and yield modeling. The team employed a problem solving process designed to determine a set of growth and yield tables, which could then be run in a timber harvest-scheduling model.

Following a review of several published growth and yield models, the group proceeded using a model developed at the U.S. Forest Service Northeastern Research Station, Forest Sciences Laboratory, Durham, NH, named FIBER — version 3.52 (Solomon, Herman, Leak 1995). FIBER is a stand projection growth model that simulates growth and structural development of stands in the Northeast. The advantage FIBER presented over other growth and yield models is that it was developed using the types of forests common to Northern New England, and is related to the Forest's ecological land classifications (ELCs). The source of the data for the softwoods came from plots on the Penobscot Experimental Forest in Maine and the source of the hardwood data came from plots on the Bartlett Experimental Forest, which is located on the White Mountain National Forest. It should be pointed out that one of the three developers of the FIBER model, Bill Leak, was a member of the growth and yield team and played a very active role in assisting the team in using FIBER and in providing his expert opinion on the model's results. His assistance and advice was invaluable throughout the entire growth and yield analysis as well as the timber harvest schedule modeling.

The FIBER model uses six ecological land classifications that consider landform, soils, and typical climax tree species. They are:

1. Sugar maple – ash (SM-WA)
2. Beech – red maple (BE-RM)
3. Oak – white pine (RO-WP)
4. Hemlock – red spruce (HE-RS)
5. Spruce – fir (SP-BF)
6. Cedar – black spruce (CE-BS)

The lands within the Forest allocated for timber management were typed into these ELCs based on a combination of two classifications present in the Forest's Combined Data System (CDS) database, namely forest type (FT) and ecological land type (ELT). Forest type reflects the current type classification of the stand and the ELT considers the soil conditions of the stand which has a strong correlation to the capability of the land to promote a certain type of forest type, either reflecting the current situation or the successional tendency towards a future forest type. These data elements were present at the stand level based on decades worth of silviculture exams conducted on the forest by qualified foresters and forestry technicians, and ecological classification by Forest soil scientists.

Another commonly used source of forest inventory data used in these types of analysis is available from the USDA Forest Service's Forest Inventory and Analysis (FIA) program. The FIA plot data is collected as a result of a scientific collection effort from fixed plots designed to sample forested areas of the country. The number of fixed plots on the Forest is limited and employs scientific sampling. At the time this project was undertaken, FIA inventory data was available for approximately 100 plots, many of which were not in management areas that permit timber management. The decision was made to use the Forest's CDS stand exam data instead of FIA plot data. The Forest CDS stand exam data captured 5,187 plots that were used in this analysis.

After typing the CDS stand level data into ELCs, it became evident that it would not be necessary to use the CE-BS and HE-RS ELC categories due to their very low occurrence on the Forest in areas designated for timber management. This was particularly true for CE-BS. Where there were instances of Hemlock-Red Spruce, the experts on the team felt the SP-BF or BE-RM ELCs could be used to model them. Also, for each of the three ELCs used in the modeling, the Aspen – Paper Birch (AS-PB) component on these ELCs was separated for tracking purposes. This was done by isolating the Aspen – Paper Birch forest types when typing the stands to their respective ELC. Aspen – Paper Birch was important to track separately because it is a successional forest type, and has relevance to measuring the amount of early successional habitat created on the Forest. Ultimately, the RO-WP ELC was rolled into the BE-RM ELC due to the small number of plots typed as RO-WP. BE-RM was determined to be the ELC where White Pine was most likely to occur. It was noted that Red Oak occurs in very small amounts across a variety of ELCs and would best fit within the BE-RM ELC.

The FIBER model uses an input stand that is entered by the user, which contains the stand conditions in terms of the number of trees per acre, by species, by diameter class in diameter breast height (DBH), and by class. Diameter breast height is a standard measurement of tree diameter taken at breast height or 4.5 feet above ground level. Class is characterized as either acceptable growing stock (AGS) or unacceptable growing stock (UGS). The data necessary for the input stands was extracted from CDS and converted for importing into FIBER. In order to maintain consistency and to provide relatively recent data for developing the input stands, stand exams conducted from 1992-1996 were used as the basis for a sample of the of the stand conditions on the Forest. This period was chosen because of the high level of stand exam activity that was accomplished during this five year period. Ten-factor prism plot data was converted to trees per acre using the following conversion:

$$\text{Trees Per Acre} = T(43{,}560/((D*2.75)^2\,\pi))$$

where: T is number of trees

D is diameter breast height

$\pi$ is Pi

These stands were first typed by ELC and then averaged. This resulted in average input stands, for which the stand exam data was, on average, 10 years old. Therefore, the FIBER model growth and yield projections started from 1994. This was accounted for ultimately in the timber harvest schedule model with the first decade of results designed to reflect the past ten years of harvest activity on the Forest.

In the process of developing yield tables that would satisfy all of the possible treatment options, it became evident that the average input stands had to have a stand age that was prior to the desired initial entry age, the age (in years) of the stand when the first treatment, or harvest, is performed. When the treatments were modeled in FIBER, it was important to have an input stand whose age was at or before the first treatment. Since the average age of the stands in the suitable base was approximately 82 years old and the initial entry was 60 years of age for all of the ELCs (except AS-PB ELC), it was necessary to limit the sample to younger stands, with an average age of 60. AS-PB ELCs only have a regeneration treatment option that takes place at age 70 or greater and the average age of the input stand ranges from 50-60 years, or before the initial entry. Therefore, all of the AS-PB plot records were included with no adjustment for stand age.

The input stands developed from this process and used in FIBER modeling are displayed by ELC in Tables B-01 through B-06.

Notes for tables B-01 through B-06:

1. Species: AS – Aspen; BE – Beech; BF – Balsam Fir; HE – Hemlock; OH – Other Hardwoods; PB – Paper Birch; RM - Red Maple; RO – Red Oak; RS - Red Spruce; SM – Sugar Maple; WA – White Ash; WP – White Pine; YB – Yellow Birch
2. Trees smaller than 5" DBH are excluded from the input stand table consistent with the design of FIBER. Most stand exams are based on 2" diameter classes and would include the 5" diameter in the 6" diameter class.

Input stand tables shown in Tables B-01 through B-06 are truncated at 22" DBH for ease of display, actual tables continue past 22" DBH; however, values beyond 22" are very small where present, in the range of hundredths of a tree per acre.

Several other parameters exist in FIBER in order to simulate a variety of harvest techniques that can be introduced in the growth of the stand at selected stand ages. These parameters included stand elevation and stand site index; when a treatment is introduced the user inputs the harvest diameter, treatment type, thinning priority by species, residual basal area desired, growth intervals between treatments. Some of the common parameters used in this FIBER modeling are shown in Table B-07.

Treatment strategies were developed using both even and uneven-aged management techniques. These strategies were combined with intensity levels relating to the frequency of entry into the stands. For uneven-aged treatment, a "normal" intensity generally involved 20-year entries, and "less active" intensity involved 40-year entries. For even-aged treatments, a "less

*Table B-01. Sugar Maple-White Ash ELC (Trees Per Acre).*

| Species | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | 0.6 | 0.9 | 1.1 | 0.7 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | **3.7** |
| BE | 10.3 | 6.5 | 4.8 | 3.7 | 1.9 | 0.9 | 0.5 | 0.2 | 0.1 | **28.9** |
| BF | 5.2 | 2.5 | 0.9 | 0.4 | 0.1 | 0.0 | | | 0.0 | **9.0** |
| HE | 3.9 | 3.2 | 1.9 | 1.4 | 0.9 | 0.6 | 0.4 | 0.1 | 0.1 | **12.5** |
| OH | 3.0 | 0.8 | 0.4 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | **4.5** |
| PB | 4.9 | 4.8 | 3.6 | 2.2 | 1.1 | 0.4 | 0.1 | 0.0 | 0.0 | **17.1** |
| RM | 6.8 | 6.6 | 4.3 | 3.0 | 1.4 | 0.7 | 0.3 | 0.1 | 0.0 | **23.3** |
| RO | 0.3 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | **1.5** |
| RS | 6.0 | 4.5 | 2.6 | 1.6 | 0.7 | 0.3 | 0.1 | 0.0 | 0.0 | **15.8** |
| SM | 9.1 | 8.2 | 7.2 | 5.0 | 3.1 | 1.4 | 0.7 | 0.4 | 0.1 | **35.4** |
| WA | 1.8 | 1.8 | 1.3 | 1.3 | 0.9 | 0.3 | 0.2 | 0.1 | 0.0 | **7.8** |
| WP | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | **1.7** |
| YB | 7.0 | 5.2 | 4.0 | 3.2 | 2.0 | 0.9 | 0.6 | 0.3 | 0.1 | **23.3** |
| **Total:** | **59.0** | **45.7** | **32.6** | **23.1** | **12.7** | **5.8** | **3.2** | **1.3** | **0.5** | **184.4** |

*Table B-02. Aspen-Paper Birch on Sugar Maple-White Ash ELC (Trees Per Acre).*

| Species | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | 11.4 | 9.7 | 4.6 | 3.9 | 1.3 | 0.5 | 0.2 | | 0.0 | **31.7** |
| BE | 3.5 | 4.9 | 1.5 | 0.3 | 0.1 | 0.2 | 0.0 | 0.1 | | **10.5** |
| BF | 8.0 | 2.3 | 0.2 | 0.2 | | | | | | **10.7** |
| HE | 1.7 | 1.9 | 0.5 | 0.7 | 0.4 | 0.1 | | | | **5.4** |
| OH | 2.4 | 0.2 | 0.1 | | | | | | | **2.7** |
| PB | 23.9 | 23.0 | 18.3 | 6.4 | 3.6 | 1.4 | 0.2 | 0.1 | 0.1 | **77.1** |
| RM | 18.4 | 14.8 | 4.5 | 2.6 | 0.7 | 0.4 | 0.1 | 0.1 | | **41.6** |
| RO | 0.7 | | 0.2 | 0.9 | 0.2 | | | | | **2.0** |
| RS | 3.1 | 3.1 | 0.9 | 1.0 | 0.4 | 0.4 | 0.1 | | | **8.9** |
| SM | 4.9 | 3.5 | 3.1 | 2.0 | 0.9 | 0.2 | 0.3 | 0.2 | 0.0 | **15.1** |
| WA | 4.2 | 3.1 | 1.2 | 0.6 | 0.4 | 0.0 | 0.0 | 0.1 | | **9.7** |
| WP | | 0.8 | 0.1 | 0.3 | 0.1 | 0.1 | 0.2 | | 0.2 | **1.7** |
| YB | 4.5 | 5.1 | 1.6 | 1.3 | 0.4 | 0.1 | 0.2 | 0.1 | 0.0 | **13.4** |
| **Total** | **86.6** | **72.5** | **37.0** | **20.1** | **8.3** | **3.5** | **1.3** | **0.6** | **0.3** | **230.7** |

*Table B-03. Beech-Red Maple ELC(Trees Per Acre).*

| Species | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | 1.0 | 0.8 | 0.4 | 0.4 | 0.2 | 0.1 | 0.0 | 0.0 | | **3.0** |
| BE | 16.0 | 12.6 | 6.6 | 4.7 | 2.4 | 1.4 | 0.6 | 0.2 | 0.1 | **44.6** |
| BF | 3.4 | 1.8 | 0.7 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | | **6.3** |
| HE | 5.3 | 4.1 | 2.2 | 1.6 | 0.9 | 0.4 | 0.3 | 0.2 | 0.1 | **15.2** |
| OH | 2.2 | 0.6 | 0.1 | 0.1 | 0.0 | 0.0 | | 0.0 | | **3.1** |
| PB | 5.9 | 4.3 | 2.8 | 2.4 | 1.1 | 0.4 | 0.1 | 0.1 | 0.0 | **17.0** |
| RM | 6.9 | 6.1 | 4.2 | 3.4 | 1.6 | 0.9 | 0.3 | 0.1 | 0.1 | **23.5** |
| RO | 1.1 | 0.8 | 0.7 | 0.6 | 0.4 | 0.3 | 0.3 | 0.1 | 0.1 | **4.3** |
| RS | 5.1 | 4.3 | 2.6 | 1.8 | 0.7 | 0.3 | 0.1 | 0.0 | 0.0 | **14.9** |
| SM | 10.7 | 8.4 | 6.2 | 4.4 | 2.5 | 1.4 | 0.8 | 0.4 | 0.2 | **35.1** |
| WA | 1.1 | 0.8 | 1.0 | 0.7 | 0.5 | 0.3 | 0.2 | 0.1 | 0.0 | **4.7** |
| WP | 0.9 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | **2.2** |
| YB | 8.4 | 8.9 | 5.9 | 4.3 | 2.5 | 1.3 | 0.8 | 0.3 | 0.1 | **32.5** |
| **Total** | **68.1** | **53.6** | **33.6** | **24.8** | **13.1** | **6.9** | **3.5** | **1.5** | **0.6** | **206.3** |

*Table B-04. Aspen-Paper Birch on Beech-Red Maple ELC (Trees Per Acre).*

| Species | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | 15.7 | 16.5 | 6.3 | 2.9 | 0.5 | 0.3 | | | | **42.3** |
| BE | 1.0 | 0.6 | 0.7 | 1.0 | 0.2 | 0.3 | 0.1 | | | **3.8** |
| BF | 2.0 | 1.7 | 1.4 | | 0.2 | | | | | **5.2** |
| HE | 0.0 | 1.1 | | 1.0 | 0.4 | 0.4 | 0.1 | | | **3.0** |
| OH | 1.0 | | | | | | | | | **1.0** |
| PB | 32.8 | 25.3 | 15.5 | 11.3 | 2.9 | 1.2 | 0.1 | 0.1 | | **89.2** |
| RM | 13.7 | 14.3 | 8.1 | 4.2 | | 0.1 | 0.1 | 0.2 | 0.1 | **40.8** |
| RO | 4.3 | | 0.4 | 1.0 | 0.2 | 0.7 | 0.2 | | | **6.8** |
| RS | 8.8 | 2.2 | 1.1 | 1.2 | 0.2 | | | | | **13.5** |
| SM | 10.8 | 7.7 | 1.8 | 1.5 | 0.7 | 0.1 | 0.1 | | | **22.7** |
| WA | 1.0 | | | | | | | | | **1.0** |
| WP | 1.0 | 0.6 | | | | | 0.1 | 0.1 | | **1.7** |
| YB | 4.9 | 2.8 | 0.7 | 1.0 | 0.5 | 0.1 | | | | **10.0** |
| **Total** | **96.8** | **72.7** | **36.0** | **25.0** | **5.8** | **3.3** | **0.9** | **0.4** | **0.1** | **240.9** |

*Table B-05. Spruce-Balsam Fir ELC (Trees Per Acre).*

| Species | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | 1.1 | 1.2 | 1.2 | 0.7 | 0.2 | 0.1 | 0.0 | 0.0 | | **4.4** |
| BE | 10.1 | 7.0 | 3.8 | 2.3 | 0.9 | 0.5 | 0.2 | 0.1 | 0.0 | **24.8** |
| BF | 12.3 | 7.8 | 3.4 | 1.3 | 0.2 | 0.0 | 0.0 | 0.0 | | **25.0** |
| HE | 6.2 | 5.8 | 3.3 | 2.4 | 1.5 | 0.9 | 0.5 | 0.2 | 0.1 | **20.9** |
| OH | 2.6 | 0.6 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | | **3.5** |
| PB | 6.2 | 5.9 | 3.7 | 1.9 | 0.8 | 0.4 | 0.1 | 0.0 | 0.0 | **19.1** |
| RM | 9.9 | 9.6 | 5.2 | 3.4 | 1.8 | 0.8 | 0.4 | 0.2 | 0.0 | **31.1** |
| RO | 0.5 | 0.6 | 0.3 | 0.4 | 0.2 | 0.2 | 0.1 | 0.1 | 0.0 | **2.5** |
| RS | 12.7 | 10.7 | 5.8 | 3.7 | 1.6 | 0.5 | 0.3 | 0.1 | 0.0 | **35.3** |
| SM | 5.4 | 4.5 | 3.0 | 1.9 | 1.2 | 0.6 | 0.4 | 0.2 | 0.1 | **17.4** |
| WA | 1.2 | 0.9 | 0.6 | 0.5 | 0.3 | 0.2 | 0.1 | 0.0 | 0.0 | **3.8** |
| WP | 0.6 | 0.5 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | **3.3** |
| YB | 8.6 | 8.9 | 5.3 | 4.1 | 2.2 | 1.2 | 0.6 | 0.4 | 0.1 | **31.6** |
| **Total** | **77.4** | **63.9** | **36.3** | **22.9** | **11.3** | **5.6** | **3.0** | **1.3** | **0.5** | **222.7** |

*Table B-06. Aspen-Paper Birch on Spruce-Balsam Fir ELC (Trees Per Acre).*

| Species | 6 | 8 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| AS | 3.9 | 4.0 | 3.1 | 6.3 | 0.9 | 0.2 | 0.0 | | | **18.4** |
| BE | 3.6 | 2.2 | 0.6 | 0.6 | 0.1 | 0.1 | 0.0 | | | **7.3** |
| BF | 10.7 | 4.0 | 3.7 | 3.6 | 0.2 | 0.1 | | | | **22.2** |
| HE | 0.0 | | 0.1 | 0.1 | 0.5 | 0.1 | | | | **0.8** |
| OH | 3.2 | 1.2 | 0.1 | 0.4 | | | | | | **4.9** |
| PB | 37.2 | 22.0 | 17.1 | 6.5 | 3.5 | 0.8 | 0.0 | 0.0 | 0.1 | **87.2** |
| RM | 17.1 | 11.0 | 5.9 | 2.9 | 1.6 | 0.5 | 0.1 | 0.0 | | **39.2** |
| RS | 5.3 | 3.8 | 2.2 | 1.1 | 0.2 | 0.3 | | 0.0 | | **12.9** |
| SM | 2.1 | 1.2 | 1.7 | 0.4 | 0.2 | 0.1 | | 0.1 | | **5.7** |
| WA | 0.0 | 1.0 | 0.3 | 0.1 | | | 0.0 | | | **1.4** |
| WP | 0.5 | | 0.1 | 0.3 | 0.3 | 0.1 | 0.2 | 0.0 | | **1.5** |
| YB | 8.9 | 4.8 | 1.8 | 1.0 | 1.1 | 0.3 | 0.4 | 0.2 | 0.0 | **18.6** |
| **Total** | **92.6** | **55.3** | **36.7** | **23.1** | **8.6** | **2.5** | **0.8** | **0.4** | **0.1** | **220.2** |

*Table B-07. FIBER Control File Parameters.*

| Ecological Land Classification | Elevation (feet) | Site Index | Rotation Age* (years) | Harvest Diameter (DBH) |
|---|---|---|---|---|
| Sugar Maple-Ash | 1,500 | 65 | 120 | 20 |
| Beech-Red Maple | 1,300 | 55 | 100 | 18 |
| Spruce-Fir | 1,000 | 53 | 90 | 14 |
| AS-PB on Sugar Maple-Ash | 1,500 | 65 | 70 | 13 |
| AS-PB on Beach-Red Maple | 1,300 | 55 | 70 | 13 |
| AS-PB on Spruce-Fir | 1,000 | 53 | 70 | 13 |

*Applies to even-aged treatment only.

active" intensity was developed for the SMWA ELC that involved an initial entry at 80 years and regeneration harvest at 120 years. Table B-08 shows entry ages that were modeled for the variety of treatment strategies and intensities used in developing the initial sets of yield tables. Even-aged treatments that are not regeneration harvests only (Regen Only) include the entry ages for thinnings leading up to the final entry age, which is the age of the stand at regeneration harvest. Slight deviations in these schedules, normally associated with extending the rotation age by one or two decades were included to provide a robust set of possibilities for the model to optimize. The project record includes a complete display of all of the schedules used in the model.

Aspen – Paper Birch ELCs are shade intolerant and therefore are best maintained through even-aged regeneration harvests. No timber management, or grow only with no harvest, was modeled to establish growth coefficients for all ELCs.

*Table B-08. Entry Ages (Stand Age in Years) by Treatment Strategy and Ecological Land Classification.*

| Ecological Land Classification | Regen Only | Even Age | | Uneven Age* | | No Treat-ment |
|---|---|---|---|---|---|---|
| | | Normal | Less Active | Normal | Less Active | |
| Sugar Maple - Ash | 120 | 60,80,100,120 | 80,120 | 60/20 | 60/40 | ✓ |
| Beech – Red Maple | 100 | 60,80,100 | | 60/20 | 60/40 | ✓ |
| Spruce - Fir | 90 | 60,80,90 | | 60/20 | 60/40 | ✓ |
| AS-PB on Sugar Maple-Ash | 70 | | | | | ✓ |
| AS-PB on Beech-Red Maple | 70 | | | | | ✓ |
| AS-PB on Spruce-Fir | 70 | | | | | ✓ |

* Uneven age normal intensity treatments (60/20) indicates the first entry is at age 60 and subsequent entries are every 20 years thereafter. Uneven age less active (60/40) indicates the first entry is at age 60 and subsequent entries are every 40 years thereafter.

Results of FIBER modeling provided a set of growth and yield coefficients for further examination and validation by the growth and yield team. The coefficients were reviewed by the team for further development and use in the timber harvest-scheduling portion of the analysis.

Figures B-02 through B-04 display the results of this phase of the analysis for the standard set of treatment strategies detailed in Table B-08. Later in the analysis, variants in these strategies were developed to satisfy a variety of situations and conditions encountered in applying the strategies to the Forest.

*Figure B-02. FIBER Model Results — Growth Per Acre by ELC.*

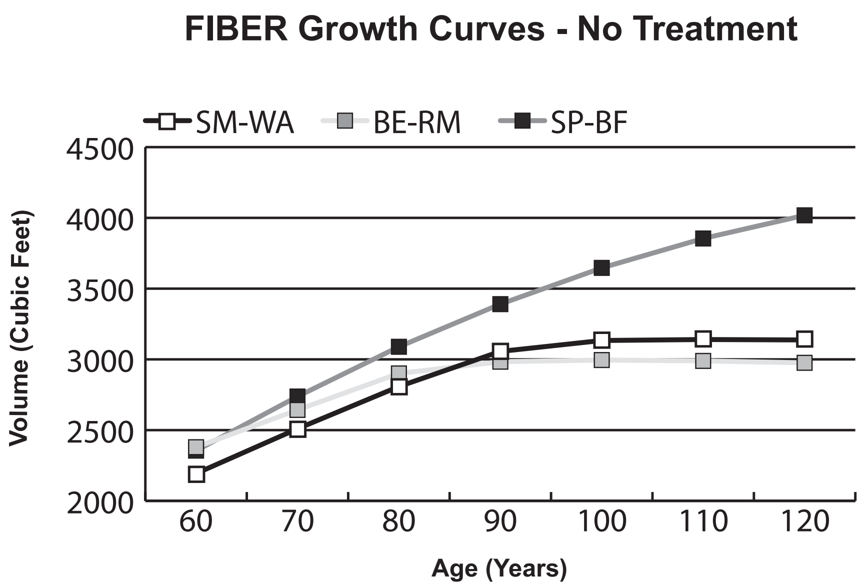



*Figure B-03. FIBER Model Results — Yields Per Acre for Even Age Normal Intensity Treatments by ELC.*

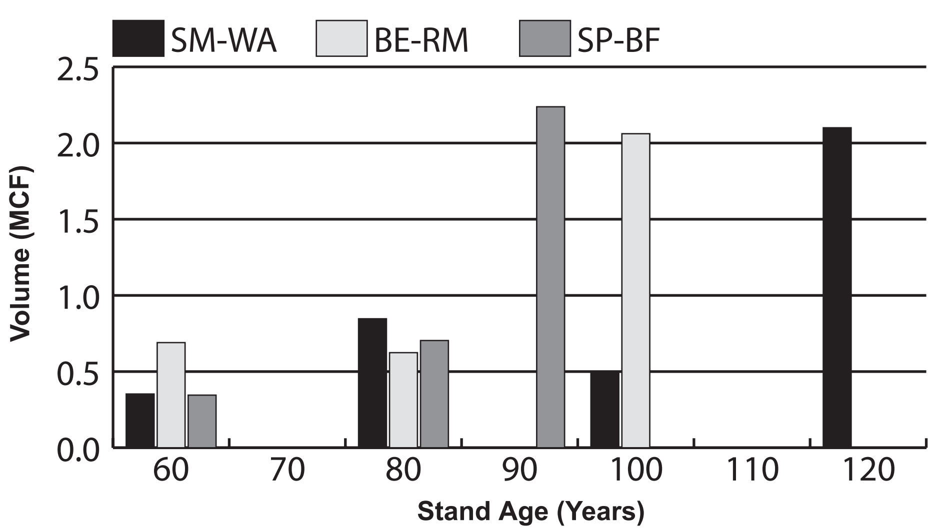
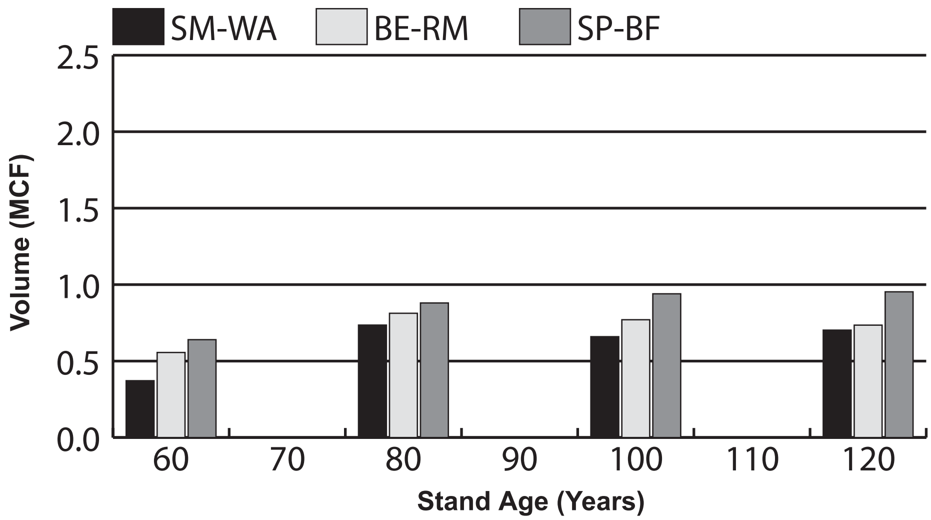


*Figure B-04. FIBER Model Results — Yields Per Acre for Uneven Age Normal Intensity Treatments by ELC.*




Yield projections based on the three primary ELCs using even-aged normal intensity treatments are shown in Figure B-03. Thinnings were designed to achieve specific levels of residual basal area, and vary by ELC and age of the thinning. For SM-WA ELC, residual basal areas were set at 80, 70, and 70 square feet for thinnings at 60, 80, and 100 years of age respectively. For BE-RM ELC, residual basal areas were set at 75 square feet for each of the thinnings at 60 and 80 years of age. For SP-BF ELC, residual basal areas were set at 90 square feet for both thinnings at 60 and 80 years of age. Consequently, the amount thinned is dependent on the residual basal area or the amount of timber left standing following the thinning.

Similarly, for uneven-aged management normal intensity, the yields for the initial entry at age 60 and every 20 years thereafter through age 120 are shown in Figure B-04.

Yield tables were developed from individual FIBER runs to satisfy all of the combinations of ELCs, management actions, management intensities and evaluated in terms of accuracy and reasonableness. A scientific evaluation of four stand growth simulators commonly used in the Northeastern United States concluded that FIBER clearly stands out as the best simulator for the Spruce-Fir forest type, and that FIBER was one of three that performed best in the northern hardwood forest type (Schuler et al., 1993).

# Timber Harvest Schedule Modeling

## *Introduction*

Developing the yield tables provided the foundation for modeling possible timber harvest schedules on the Forest. The timber harvest scheduling problem seeks to provide an optimum solution for how and when to harvest wood consistent with regulatory and user-defined constraints. In order to evaluate all of the possible management techniques, while seeking an optimal solution, the Forest employed computer-based modeling software.

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. The model optimizes management area prescriptions and allocations, and schedules activities and outputs. SPECTRUM chooses among alternative solutions given a set of constraints and an objective such as maximizing income or timber volume.

The model evolved from the FORPLAN optimization model that was used in the initial round of forest planning. SPECTRUM Version 2.6 was used for revising the White Mountain National Forest Plan. As a tool, the model is flexible and can be adapted to the needs of each individual planning problem.

The Forest used SPECTRUM as a timber harvest-scheduling tool that reports timber outputs, costs, and benefits. The model scheduled timber harvesting for 16 decades, the first decade reflecting most recent history (1994-2003), and provided an estimate of long-term sustained yield (LTSY) capability for each of the alternatives.

SPECTRUM is a linear programming model. It assumes that the relationship between outputs and the land base are linear, e.g., twice the number of similar acres yields twice the outputs. Other resource programs such as recreation are not addressed by SPECTRUM because their relationship with the land base is not linear. SPECTRUM builds a matrix of coefficients and transfers the file to a linear programming package for problem solution. Typical size of a matrix generated and solved for an alternative was on the order of 3,700 rows by 44,000 columns. 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.

### Model Design Considerations

Model design identified questions the model needed to answer and assessed what information was available for model input. The Growth and Yield Team identified the following factors that needed to be considered in the SPECTRUM model:

- Dynamic timber markets that involve multiple products with a large range of variability in price.
- Variety of species/product yields.
- Early successional habitat acreage projections by ELC.
- Age class distributions by ELC

## Planning Horizon

The planning horizon defines how far into the future the model is designed to schedule management activities. This is typically set at 150 years, in decadal increments or periods. Since the stand exams that were used in the growth and yield analysis were performed over a five year period from 1992-1996, this data had to be "grown" in FIBER to 2004 to estimate the current condition of the Forest. On average, this ten year growth period accounted for one additional decade, or period, to be added to the planning horizon. Therefore, the planning horizon was set at 160 years or 16 periods in the model; the first period reflecting the past decade of growth. Constraints were introduced to reflect the Forest's actual harvest history in this first period, or past decade, in the model.

## Constraints on the Suitable Base

The baseline for the number of suitable acres can be found in Appendix E. Following a review of some of the assumptions that were necessary to model timber harvesting on the Forest and to be consistent with the standards and guidelines, several constraints were developed on the suitable base. These constraints were developed to recognize the reality of how the Forest will have to conduct timber harvesting within the suitable base.

The constraints that were applied on the suitable base include:

- Not Suitable — land incapable of producing industrial wood; or withdrawn due to inadequate information, or if irreversible damage to soil productivity or watershed condition is likely to occur; or withdrawn for other multiple use objectives that preclude timber management; or timber management would not be cost efficient.
- Riparian Buffer — a 100 foot exclusionary buffer on each side of perennial streams. Designed to recognize limitations on harvest activity within riparian zones consistent with state regulations and Forest standards and guidelines. Actual exclusions vary by type of riparian zone; 100 feet was determined to be a reasonable estimate that safely replicates these exclusions for modeling purposes.
- Wild River and Potentially Eligible Wild River Buffer — A ¼ mile exclusionary buffer each side of Wild or potentially eligible Wild rivers to preserve their Wild characteristics, according to the Wild and Scenic River Inventory.
- Inaccessible Lands — compartments that have outstanding rights-of-way or easements that either directly or indirectly prohibit access to stands for purposes of timber management.

A summary of the acres within the suitable base that are affected by these constraints is shown in Table B-09.

*Table B-09. Analysis Unit Acreage Development — Constraints on the Suitable Base.*

| | Alternatives | | | |
|---|---|---|---|---|
| **Summary:** | **1** | **2** | **3** | **4** |
| Acres 2.1/3.1- Actual | 354,842 | 358,297 | 295,665 | 363,810 |
| Not Suitable | (77,101) | (77,256) | (59,802) | (78,247) |
| Riparian Buffer: | (11,716) | (9,924) | (8,569) | (10,194) |
| Wild/Eligible Wild Buffer | (1,764) | (2,880) | (2,624) | (2,888) |
| *Inaccessible | (12,216) | (12,598) | (10,270) | (12,754) |
| Analysis Units | 252,045 | 255,639 | 214,400 | 259,727 |

* includes approximately 1,300 acres with invalid data coding in CDS database.

## Analysis Units

After establishing the suitable base and applying the model constraints, analysis areas were established. These analysis units are the result of electronically overlaying map layers and merging geographic features (boundaries) in the layers to define new, smaller areas (polygons). These smaller polygons carry with them selected attributes from each of the overlaying layers. A geographic information system (ARCView 3.2) was used to calculate the acreage within each of these smaller areas or polygons. By stringing together character labels that identify the attributes of these variables, it is possible to create a set of unique identifiers for each of the analysis units. The sum total of the acreage in all of the smaller areas that share a common identifier provide the acreage for that analysis unit. Analysis units are therefore made up of numerous polygons that share common attribute labels spread over the area of study.

Layers Considered in Developing Analysis Units:

1. *Management Areas:* serve as a filter. Change by alternative depending on management area boundaries. For the alternatives, the analysis units only considered lands in MA 2.1/3.1. For the benchmarks, the analysis units considered lands in MA 2.1, 3.1, 2.1A, and 9.4.
2. *Land Suitability Class (LSC):* serves as a filter, and does not change by alternative, based on stand boundaries and land suitability code. The benchmarks consider LSC 500 (suitable for timber management) and LSC 810 (other resource uses preclude timber management) within MA 9.4 or 2.1A. The alternatives only consider LSC 500.
3. *Wild and Scenic Rivers:* serve as a filter, but do not change by alternative, and excludes from the analysis units a quarter-mile buffer on each side of rivers currently designated as “Wild,” or as candidates for “Wild” designation.
4. *Riparian Zones:* serve as a filter, do not change by alternative, and excludes a 100 foot buffer on each side of perennial streams.
5. *Ecological Land Classification (ELC):* does not change by alternative, based on stand spatial layer, ecological land type and forest type.

Possible Attributes:

1. Sugar Maple – White Ash (SM-WA)
2. Beech-Red Maple (BE-RM)
3. Spruce-Balsam Fir (SP-BF)
4. Aspen-Paper Birch on SM-WA (ASSMWA)
5. Aspen-Paper Birch on BE-RM (ASBERM)
6. Aspen-Paper Birch on SP-BF (ASSPBF)

6. *Age Class:* does not change by alternative, based on stand boundaries and year of origin. Calculated from current year (2003) to year of origin.

   Possible Attributes: 2003 – year of origin in 20 year increments:

   1. 0-19
   2. 20-39
   3. 40-59
   4. 60-79
   5. 80-99
   6. 100-119
   7. 120+

7. *2000 Roadless Area Inventory:* does not change by alternative. This layer was developed from the 2000 Roadless Area Inventory. Providing this placeholder in the analysis unit formulation will provide a mechanism for future adjustments to the model as necessary.

   Possible Attributes:

   Y: Yes (in an inventoried roadless area)

   N: No (not in an inventoried roadless area)

8. *Acceptable Limits of Visual Change:* a layer developed to control the acres of openings (age class 0-9) within a viewshed. Since viewsheds are not spatially defined, the Forest used 12 digit Hydrological Unit Code (HUC) boundaries as a surrogate for viewsheds. By identifying which watershed (viewshed) the analysis unit is within, the amount of acreage in 0-9 age class could be constrained within the model.

9. *2004 Roadless Area Inventory:* a layer developed from the 2004 Roadless Area Inventory, which defined the inventory's boundaries. Providing this placeholder in the analysis unit formulation will provide a mechanism for future adjustments to the model as necessary.

After this process was complete, all like-type polygons that shared a common set of attribute labels, became one analysis unit. The sum of the acres from each of the polygons within an analysis unit became the acreage for that analysis unit.

### Product Groupings and Stumpage Values

Yields from FIBER are expressed by species for 16 species plus one category termed "Other Hardwoods." However, SPECTRUM has a system limitation of nine product outputs. The decision was made to reserve two of the product outputs in SPECTRUM to track the standing inventory, namely Hardwoods and Softwoods. The other seven possible product outputs in SPECTRUM were allocated to species product groups. These seven SPECTRUM product output groups would only reflect harvested volumes. In order to capture the economics of timber harvesting, it was appropriate to group the 17 FIBER species according to their stumpage value.

Stumpage value is the saleable value of wood as it stands in the forest, or on the stump. Stumpage values and product groupings are shown in Table B-10.

*Table B-10. Stumpage Values and SPECTRUM Product Groupings.*

| Group | Species | AGS/UGS | Average Stumpage Price |
|---|---|---|---|
| 1. RS-BF-WP Swt | RS, BF, WP | AGS | $127/MBF |
| 2. SM-RO Swt | SM, RO | AGS | $362/MBF |
| 3. RM-AS-BE-OH-HE Swt | RM, AS, BE, OH, HE | AGS | $48/MBF |
| 4. YB-WA Swt | YB, WA | AGS | $185/MBF |
| 5. PB Millwood | PB | AGS | $48/cord |
| 6. Softwood Pulp | RS, BF, WP, HE | All | $8/cord |
| 7. Hardwood Pulp | SM, RO, RM, AS, BE, OH, YB, WA, PB | All | $8/cord |

* Sources: "Average Stumpage Value List" for April 1 - September 30, 2003; NH Department of Revenue Administration dated March 24, 2003. The NH DRA presents their stumpage values with a low value (large logging costs, poor accessibility, or low grade timber) and high value (small logging costs, good accessibility, or high grade timber). For purposes of comparison, it was decided to use the midpoint between these high and low values. Using this in combination with the information presented on recent sales on the WMNF and from NH Timberland Owner's Association (Carbee, 2003).

### Timber Management Program Costs

The Forest estimated costs associated with conducting commercial timber sales in terms of sale planning, sale preparation and sale administration. These costs were calculated from recent timber sales on the Forest on an average cost per acre basis. The SPECTRUM model used these values to calculate the financial portion of the outputs. Future costs and revenues are discounted at a rate of 4% per year (Row, C. et al., 1981) to convert future values to present day dollars. Table B-11 shows the current costs per acre associated with conducting timber sales on the Forest, less overhead and cost pools.

*Table B-11. Average Timber Sale Planning, Preparation, and Administration Costs.**

| Activity | Average Costs Per Acre | | |
|---|---|---|---|
| | Clearcut | Uneven Age | Thinning |
| Sale Preparation | $75 | $72 | $64 |
| Sale Administration | $21 | $35 | $35 |
| Sale Planning | $150 | $150 | $150 |
| Total Costs / Acre | $246 | $258 | $250 |

* Does not include overhead costs or cost pools.

## Benchmark Analysis

A benchmark analysis provides baseline data to support formulation of alternatives, and aids 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 unit 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 benchmarks that estimate the maximum present net value of those resources having established market value or an assigned value.

The net present value (NPV) of all benchmarks is listed in Table B-12, along with the timber production associated with each. All NPV calculations share a common annual discount rate of 4% per year (Row, C. et al., 1981).

### *Benchmark 1 - 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 or recreation outputs. 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 (NFS).

*Objectives:*

1) Protect the life, health, and safety of forest users.
2) Conserve soil and water resources.

*Table B-12. Inputs and Outputs Used in the Benchmark Analysis.*

| Input/Output | Benchmarks | | |
|---|---|---|---|
| | B1 Min Mgmt | B2 Max Volume | B3 Max NPV |
| **Timber** | | | |
| **Volume – Total Annual (MCF/Decade)** | | | |
| Decade 1 (Planned) | 0 | 88,860 | 69,970 |
| Decade 2 (Projected) | 0 | 88,860 | 69,970 |
| Decade 3 (Projected) | 0 | 88,860 | 69,970 |
| Decade 4 (Projected) | 0 | 88,860 | 69,970 |
| Decade 5 (Projected) | 0 | 88,860 | 69,970 |
| **Volume - Hardwoods Annual (MCF/Decade)** | | | |
| Decade 1 (Planned) | 0 | 55,010 | 58,790 |
| Decade 2 (Projected) | 0 | 69,850 | 44,340 |
| Decade 3 (Projected) | 0 | 65,430 | 53,400 |
| Decade 4 (Projected) | 0 | 70,620 | 59,280 |
| Decade 5 (Projected) | 0 | 59,440 | 44,570 |
| **Volume - Softwoods Annual (MCF/Decade)** | | | |
| Decade 1 (Planned) | 0 | 33,850 | 11,180 |
| Decade 2 (Projected) | 0 | 19,000 | 25,640 |
| Decade 3 (Projected) | 0 | 23,430 | 16,570 |
| Decade 4 (Projected) | 0 | 18,230 | 10,690 |
| Decade 5 (Projected) | 0 | 29,420 | 25,400 |
| **Long Term Sustained Yield (MCF/Decade)** | N/A | 94,950 | 71,190 |
| **Timber Management (Acres Treated/Yr)** | | | |
| Decade 1 (Planned) | 0 | 7,230 | 2,640 |
| Decade 2 (Projected) | 0 | 7,170 | 3,030 |
| Decade 3 (Projected) | 0 | 10,790 | 2,750 |
| Decade 4 (Projected) | 0 | 8,020 | 2,710 |
| Decade 5 (Projected) | 0 | 11,830 | 2,900 |
| **Even Aged Mgmt (Acres/Yr)** | | | |
| Decade 1 (Planned) | 0 | 630 | 2,640 |
| Decade 2 (Projected) | 0 | 2,990 | 3,030 |
| Decade 3 (Projected) | 0 | 3,480 | 2,750 |
| Decade 4 (Projected) | 0 | 3,170 | 2,710 |
| Decade 5 (Projected) | 0 | 3,540 | 2,900 |
| **Uneven Aged Mgmt (Acres/Yr)** | | | |
| Decade 1 (Planned) | 0 | 6,600 | 0 |
| Decade 2 (Projected) | 0 | 4,190 | 0 |
| Decade 3 (Projected) | 0 | 7,310 | 0 |
| Decade 4 (Projected) | 0 | 4,850 | 0 |
| Decade 5 (Projected) | 0 | 8,290 | 0 |
| **Economic and Financial Efficiency:** | | | |
| NPV of Market Revenue & Costs ($1,000): | $(3,802) | $(167,374) | $(164,816) |
| NPV of Assigned Values ($1,000) | $1,466,897 | $2,456,634 | $2,467,385 |
| Economic NPV [line 1+ 2] ($1,000) | $1,463,095 | $2,289,259 | $2,302,569 |

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.

5) Prevent environmental damage to the land and resources of adjoining and (or) downstream lands under NFS or other ownership.

6) Facility maintenance will be done only to support activities and use that cannot be reasonably discouraged (all other facilities are allowed to deteriorate).

7) Dispersed recreation use will be permitted when and where control activities are not needed.

8) Critical habitat for threatened and endangered species will be protected.

9) Heritage resource management will be limited to the identification and protection of resources associated with proposed ground disturbing activities.

*Assumptions:*

1) Forest service staffing levels would be reduced to a minimum level consistent with meeting the objectives listed above. Remaining staff would serve as contract and permit administrators and volunteer/partner coordinators to achieve the minimum objectives where necessary. Minimum staffing level would consist of a forest supervisor, three district rangers, three assistant rangers, a public affairs officer, an archaeologist, two engineers, a purchasing agent, a biologist, two recreation specialists, two law enforcement officers, and a contract specialist.

2) Long-term special use permits (e.g., ski areas), concessionaire agreements (e.g., developed campgrounds), and partnership agreements (e.g., trail maintenance) remain in effect.

3) Fee-demonstration program remains in effect. Program revenues are retained by the Forest for use on contracted minor maintenance and repair of selected trails and facilities.

4) Critical habitat protection requirements for threatened and endangered species will be minimal and not require timber harvesting.

5) No timber commercial harvesting will occur.

6) Current or similar partnership agreements, special use permits, and agreements will continue indefinitely. Operation of developed campgrounds, ski areas, and the maintenance of snowmobile trails will continue to be, in general, economically self-sustaining operations.

7) Basic trail maintenance will continue on approximately one third of the total miles of trails through partnership agreements, volunteers, and contracted basic trail maintenance. Major trail maintenance would be deferred indefinitely. After 10 years, these trails will be closed due to unacceptable levels of resource damage or severe degradation. The

remaining 66% of trails will be closed immediately as no trail maintenance would be possible. The closure of these trails will result in a proportional reduction in recreational users.

*Results:*

This minimum management benchmark projects significant decreases in hiking and hiking related activity on the Forest due to the eventual closure of all hiking trails. Trails are projected to decline over the period of ten years to an unusable state due to the absence of major trail maintenance activity. Consequently, the assigned value of recreation would decline consistent with the decline in the number of hikers visiting the Forest. Hiking visitation would decline during the first decade, until the projected growth in other recreational activities made up for the loss. Eventually, growth in other recreational activities would place the total number of recreational visitors back into an overall positive growth pattern.

Timber harvesting is not performed on the Forest with a resulting loss of NPV. Staffing levels are brought to a minimum necessary for resource protection. The overall economic NPV of this benchmark of $1,463 million is approximately 36% lower than each of the other two benchmarks. It does serve to illustrate the economically self-supporting nature of some of the special use permits in effect on the Forest with ski areas and some concessionaires.

### *Benchmark 2 - Maximum Timber Benchmark*

This benchmark provides a maximum timber production capability reference. The Maximum Timber Benchmark utilizes the maximum potential area of the Forest that can be classified as suitable for timber production. Forest land not considered as suitable for timber production in this benchmark analysis includes 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).

The 1986 Plan included many of the tentatively suitable lands as part of the acres considered for timber management. A large portion of these tentatively suitable lands were classified as such because there was inadequate information in regards to their suitability. Since then, the Forest has accumulated a large amount of information from surveys and stand exams, improving the accuracy of the land suitability class (LSC) determinations. This results in a clearer picture of the suitable base, which was used in the maximum timber benchmark for this Plan revision.

*Objectives:*

In addition to the objectives for the minimum management benchmark, this benchmark represents the highest possible timber harvest volume consistent with the principles of non-declining flow and harvests that do not exceed the long-term sustained yield.

*Assumptions:*

1. Long-term special use permits (e.g., ski areas), concessionaire agreements (e.g., developed campgrounds), and partnership agreements (e.g., trail maintenance) remain in effect.
2. Fee-demonstration program remains in effect. Program revenues are retained by the Forest for use on contracted maintenance and repair.
3. Current or similar partnership agreements, special use permits, and agreements will continue indefinitely. Operation of developed campgrounds, ski areas, and the maintenance of snowmobile trails will continue to be, in general, economically self-sustaining operations.
4. Staffing levels will adjust to facilitate the expansion of the timber program.

*Results:*

The maximum timber benchmark provides the highest harvest volumes (53.3 MMBF/year) using a mix of even-aged and uneven-aged treatments.

The overall economic NPV of this benchmark of $2,289 million is $826 million higher than the minimum management benchmark. This is due to the value of the timber harvest performed under this benchmark. Harvesting is carried out with the sole objective of maximizing volume, with no regard to value. Notwithstanding, the value of the timber harvested exceeds the costs associated with executing the program and adds to the NPV calculation.

### *Benchmark 3 - Maximum Net Present Value (NPV) Benchmark*

This benchmark produces the most valuable, as defined within a NPV calculation, mix of timber products on the Forest. Its purpose is to determine the level of production that is most efficient based on monetary values for both market (financial) and non-market (assigned value) outputs.

*Objectives:*

This benchmark represents the highest value mix of market and non-market outputs on the Forest consistent with the timber harvest principles of non-declining flow and harvests that do not exceed the long-term sustained yield.

*Assumptions:*

1. Long-term special use permits (e.g. ski areas), concessionaire agreements (e.g. developed campgrounds), and partnership agreements (e.g. trail maintenance) remain in effect.
2. Fee-demonstration program remains in effect. Program revenues are retained by the Forest for use on contracted maintenance and repair.
3. Current or similar partnership agreements, special use permits, and agreements will continue indefinitely. Operation of developed campgrounds, ski areas, and the maintenance of snowmobile trails will continue to be, in general, economically self-sustaining operations.
4. Developed recreation facilities and visitation will grow consistent with the assumptions for road accessible camping found in Alternative 4.

5. Staffing levels will adjust to facilitate the requirements of the timber and recreation programs.

*Results:*

The maximum NPV benchmark provided the highest NPV of timber harvest volumes of the three benchmarks. It seized on the cost efficiency associated with even-aged regeneration harvesting, with all of the harvest performed using this technique. The even-aged thinnings that are developed in the later periods of the planning horizon reflect an intentional design present in the SPECTRUM model which schedules all harvests subsequent to an initial regeneration harvest for thinning treatments to promote the production of high quality sawtimber.

The overall economic NPV of this benchmark of $2,303 million is $839 million higher than the minimum management benchmark and $13.3 million more than the maximum timber benchmark. This is due to the higher values associated with the mix of timber harvested and the lower costs associated with performing the harvest under this benchmark combined with the additional revenue associated with increasing the developed recreation opportunities on the Forest.

The results can appear contrary to what one might expect when looking at the total costs and revenues generated in this benchmark compared to the maximum timber benchmark. Using constant dollars, on a purely cumulative basis, the sum of the costs and revenues is less than the sum of the costs and revenues in the maximum timber benchmark. The NPV calculation discounts future values estimated in constant dollars at the rate of 4 percent per year to convert them into present values. This process, in effect, causes values derived in the near term to have more worth compared to values derived at much later periods in time. The nearer term values present in the stream of annual values used in the maximum NPV benchmark are greater than the values from the same period in the maximum timber benchmark. This causes the NPV calculation to be greater in the maximum NPV benchmark than the maximum volume benchmark.

# Modeling the Alternatives

The conceptual design of the alternatives was established following the analysis of the management situation and using extensive amounts of input from public meetings and local planning groups. The growth and yield team in collaboration with the Interdisciplinary Team established some concepts regarding timber management for each of the alternatives. Some of the timber management concepts are outlined as follows, and form the basis for the design of some constraints in the modeling of the alternatives.

- Alternative 1 will reflect the current Plan's design for timber management in terms of number of regeneration acres per decade (19,000 acres/decade). Allowable sale quantity (ASQ) will reflect the current Plan first decade values, starting with first decade Plan values (350 MMBF/decade) as the first decade of the revised Plan.
- Alternative 2 will generally reflect actual accomplishments since the current Plan was implemented, less the years the Forest ceased timber sales to evaluate threatened and endangered species. This averaged 240 MMBF/decade and would serve as the basis for the first decade's ASQ in the revised Plan. Acres of regeneration harvest would also approximate levels attained for the same period (9,000 acres/decade). This level was adjusted to 10,000 acres/decade, consistent with the Forest biologist's opinion of what would provide an optimal level of early successional habitat.
- Alternative 3 would have the lowest ASQ of the four alternatives, and the smallest numbers of acres of regeneration harvest, reflecting changes in land allocation. The initial target for acres of regeneration harvest was set at 4,000 acres/decade. This was determined to be the minimum necessary to effectively perform wildlife habitat management.
- Alternative 4 would have an ASQ between what the current Plan (Alternative 1) calls for and what the Forest's harvest history has been, less the years timber sales were halted to study threatened and endangered species (Alternative 2). Similarly, acres of regeneration harvest would be between Alternative 1 and 2, and was set initially at 14,000 acres/decade.

## Assumptions and Constraints

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

- Forest-wide and resource specific standards and guidelines are used for all even and uneven-aged prescriptions.
- Aspen and Paper Birch stands will convert to other long-lived species if they are not maintained with regeneration harvests or natural disturbance.

- The Combined Data System's stand exam data is sufficiently accurate to use in determining average input stands for the ELCs used in the modeling.
- Reserve tree guidelines are satisfied within the model with a residual basal area of 7 square feet per acre included in all regeneration harvest prescriptions.
- The "regeneration only" treatment option is available for all stands past rotation age.
- Emphasize maintenance of Aspen – Paper Birch habitat through regeneration harvest.
- ASQ applies only to areas that permit commercial timber harvest by management area assignment.
- ASQ will not decrease between successive decades.
- Once lands are entered under a particular management strategy (uneven- vs. even-aged) and intensity (frequency of entry to harvest), that strategy and intensity will continue indefinitely on those lands without interruption. The only exception is in the case of the "regeneration only" management strategy.
- Even-aged prescriptions that initially involve a regeneration harvest will be followed by an even-aged treatment strategy that includes thinnings, consistent with the goal of producing high quality sawlogs.
- The application of the SPECTRUM model on this Forest has a very limited spatial component, which does not consider adjacency and sale layout considerations. The model results will have to be adjusted in order to make the results better reflect actual practice.
- Treatment schedules will be constructed to allow for one or two decade extensions from the optimally designed treatment strategy in order to provide a robust set of modeling options consistent with maintaining non-declining yield.
- Timber road reopening/construction/improvement costs will continue to be paid by the successful bidder and is reflected as part of the stumpage value.
- Twelve digit hydrological unit class (HUC) boundaries are reasonable approximations of viewsheds given the topography of the White Mountain National Forest.

Constraints common to all alternatives as well as alternative specific constraints are shown in Table B-13 through B-17.

*Table B-13. Constraints Common to All Alternatives.*

| Description | Values | Reason |
|---|---|---|
| Volume (ccf) previous decade harvest (per. 1) | =30,561 | Replicate previous decade |
| Percent acres treated in even age mgmt (per. 1) | =35% | Replicate previous decade |
| Acres treated with regeneration harvest (per. 1) | =3,560 | Replicate previous decade |
| Harvested Volumes <= Long Term Sustained Yield (LTSY) | <=LTSY | Ensure LTSY is not exceeded |
| Perpetual harvest inventory (per.16) | >=avg. inventory | Inventory in last period is >= average per. 1-15 |
| Nondeclining yield (per. 1-16) | yield>=prev. yield | Prevents the ASQ from decreasing per. to per. |
| Riparian buffer (per. 1-16) | 100 ft each side | General level of protection for riparian areas |
| Wild River buffer (per. 1-16) | ¼ mile each side | Protect designated and eligible Wild Rivers |
| Inaccessible lands (per. 1-16) | excluded | Rights of way and easements preclude harvest |

*Table B-14. Alternative 1 Constraints.*

| Description | Values | Reason |
|---|---|---|
| Acres treated with regeneration harvest (per. 2-3) | <=22,800 | Prescribed in current Plan (+20%) |
| Acres treated with regeneration harvest (per. 2-3) | >=15,200 | Prescribed in current Plan (-20%) |
| Acres treated with regeneration harvest (per. 4-16) | <=24,000 | Prescribed in current Plan (+20%) |
| Acres treated with regeneration harvest (per. 4-16) | >=14,800 | Min. necessary to achieve solution |
| Percent acres SP-BF treated with uneven age mgmt | >=85% | Preserve softwood component |
| Acres of AS-PB treated with regen harvest (per. 2-3) | >=2,200 | Achieve habitat objectives |
| Percent of even age treated acres in thinnings (per. 1-16) | >=30% | Maintain high quality component |
| Percent regen acres in SM-WA ELC (per. 2-16) | <=50% | Limit tendency to favor SM-WA |
| Percent acres treated in SM-WA ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| Percent acres treated in BE-RM ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |

*Table B-15. Alternative 2 Constraints.*

| Description | Values | Reason |
|---|---|---|
| Acres treated with regeneration harvest (per. 2-16) | <=12,000 | Targets recent history (+20%) |
| Acres treated with regeneration harvest (per. 2-16) | >=8,000 | Targets recent history (-20%) |
| Percent acres SP-BF treated with uneven age mgmt | >=90% | Preserve softwood component |
| Acres of AS-PB treated with regen harvest (per. 2-3) | >=2,200 | Achieve habitat objectives |
| Percent of even age treated acres in thinnings (per. 1-16) | >=30% | Maintain high quality component |
| Percent regen acres in SM-WA ELC (per. 2-16) | <=75% | Limit tendency to favor SM-WA |
| Percent acres treated in SM-WA ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| Percent acres treated in BE-RM ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| HUC6 010801010707 limit acres regen (per. 2-16) | <=335 | Limit regen to 6% of watershed |
| HUC6 010801010705 limit acres regen (per. 2-16) | <=290 | Limit regen to 6% of watershed |
| HUC6 010801010702 limit acres regen (per. 2-16) | <=342 | Limit regen to 6% of watershed |
| HUC6 010801010805 limit acres regen (per. 2-16) | <=28 | Limit regen to 6% of watershed |
| HUC6 010801010701 limit acres regen (per. 2-16) | <=949 | Limit regen to 6% of watershed |
| HUC6 010400020206 limit acres regen (per. 2-16) | <=145 | Limit regen to 6% of watershed |
| HUC6 010400010606 limit acres regen (per. 2-16) | <=9 | Limit regen to 6% of watershed |
| HUC6 010801010804 limit acres regen (per. 2-16) | <=35 | Limit regen to 6% of watershed |
| HUC6 010801010806 limit acres regen (per. 2-16) | <=22 | Limit regen to 6% of watershed |
| HUC6 010400020104 limit acres regen (per. 2-16) | <=203 | Limit regen to 6% of watershed |
| HUC6 010801030102 limit acres regen (per. 2-16) | <=21 | Limit regen to 6% of watershed |
| HUC6 010400020101 limit acres regen (per. 2-16) | <=144 | Limit regen to 6% of watershed |
| HUC6 010801010803 limit acres regen (per. 2-16) | <=34 | Limit regen to 6% of watershed |
| HUC6 010400020102 limit acres regen (per. 2-16) | <=349 | Limit regen to 6% of watershed |
| HUC6 010400020201 limit acres regen (per. 2-16) | <=164 | Limit regen to 6% of watershed |
| HUC6 010400020103 limit acres regen (per. 2-16) | <=579 | Limit regen to 6% of watershed |
| HUC6 010600010101 limit acres regen (per. 2-16) | <=392 | Limit regen to 6% of watershed |

*Table B-15. Alternative 2 Constraints ( continued).*

| Description | Values | Reason |
|---|---|---|
| HUC6 010801010802 limit acres regen (per. 2-16) | <=286 | Limit regen to 6% of watershed |
| HUC6 010801010801 limit acres regen (per. 2-16) | <=241 | Limit regen to 6% of watershed |
| HUC6 010801030403 limit acres regen (per. 2-16) | <=18 | Limit regen to 6% of watershed |
| HUC6 010600020402 limit acres regen (per. 2-16) | <=249 | Limit regen to 6% of watershed |
| HUC6 010801030402 limit acres regen (per. 2-16) | <=738 | Limit regen to 6% of watershed |
| HUC6 010600020401 limit acres regen (per. 2-16) | <=1002 | Limit regen to 6% of watershed |
| HUC6 010801030401 limit acres regen (per. 2-16) | <=533 | Limit regen to 6% of watershed |
| HUC6 010600020105 limit acres regen (per. 2-16) | <=406 | Limit regen to 6% of watershed |
| HUC6 010801030302 limit acres regen (per. 2-16) | <=256 | Limit regen to 6% of watershed |
| HUC6 010600020104 limit acres regen (per. 2-16) | <=252 | Limit regen to 6% of watershed |
| HUC6 010600020101 limit acres regen (per. 2-16) | <=20 | Limit regen to 6% of watershed |
| HUC6 010801030301 limit acres regen (per. 2-16) | <=435 | Limit regen to 6% of watershed |
| HUC6 010600020103 limit acres regen (per. 2-16) | <=251 | Limit regen to 6% of watershed |
| HUC6 010600020107 limit acres regen (per. 2-16) | <=893 | Limit regen to 6% of watershed |
| HUC6 010801030503 limit acres regen (per. 2-16) | <=4 | Limit regen to 6% of watershed |
| HUC6 010801030303 limit acres regen (per. 2-16) | <=178 | Limit regen to 6% of watershed |
| HUC6 010700010201 limit acres regen (per. 2-16) | <=13 | Limit regen to 6% of watershed |
| HUC6 010801030505 limit acres regen (per. 2-16) | <=480 | Limit regen to 6% of watershed |
| HUC6 010801030703 limit acres regen (per. 2-16) | <=16 | Limit regen to 6% of watershed |
| HUC6 010600020106 limit acres regen (per. 2-16) | <=137 | Limit regen to 6% of watershed |
| HUC6 010801030504 limit acres regen (per. 2-16) | <=413 | Limit regen to 6% of watershed |
| HUC6 010700010104 limit acres regen (per. 2-16) | <=111 | Limit regen to 6% of watershed |
| HUC6 010600020102 limit acres regen (per. 2-16) | <=174 | Limit regen to 6% of watershed |
| HUC6 010600020304 limit acres regen (per. 2-16) | <=57 | Limit regen to 6% of watershed |
| | | |

*Table B-15. Alternative 2 Constraints (continued).*

| Description | Values | Reason |
|---|---|---|
| HUC6 010600020301 limit acres regen (per. 2-16) | <=167 | Limit regen to 6% of watershed |
| HUC6 010801030701 limit acres regen (per. 2-16) | <=250 | Limit regen to 6% of watershed |
| HUC6 010700010202 limit acres regen (per. 2-16) | <=382 | Limit regen to 6% of watershed |
| HUC6 010600020202 limit acres regen (per. 2-16) | <=665 | Limit regen to 6% of watershed |
| HUC6 010600020201 limit acres regen (per. 2-16) | <=576 | Limit regen to 6% of watershed |
| HUC6 010600020203 limit acres regen (per. 2-16) | <=354 | Limit regen to 6% of watershed |
| HUC6 010700010204 limit acres regen (per. 2-16) | <=313 | Limit regen to 6% of watershed |
| HUC6 010700010401 limit acres regen (per. 2-16) | <=261 | Limit regen to 6% of watershed |
| HUC6 010700010203 limit acres regen (per. 2-16) | <=71 | Limit regen to 6% of watershed |
| HUC6 010801040201 limit acres regen (per. 2-16) | <=97 | Limit regen to 6% of watershed |
| HUC6 010700010301 limit acres regen (per. 2-16) | <=444 | Limit regen to 6% of watershed |
| HUC6 010700010402 limit acres regen (per. 2-16) | <=99 | Limit regen to 6% of watershed |
| HUC6 010600020302 limit acres regen (per. 2-16) | <=113 | Limit regen to 6% of watershed |
| HUC6 010700010205 limit acres regen (per. 2-16) | <=227 | Limit regen to 6% of watershed |
| HUC6 010600020603 limit acres regen (per. 2-16) | <=172 | Limit regen to 6% of watershed |
| HUC6 010600020604 limit acres regen (per. 2-16) | <=6 | Limit regen to 6% of watershed |
| HUC6 010600020602 limit acres regen (per. 2-16) | <=88 | Limit regen to 6% of watershed |
| HUC6 010700010206 limit acres regen (per. 2-16) | <=297 | Limit regen to 6% of watershed |
| HUC6 010700010406 limit acres regen (per. 2-16) | <=70 | Limit regen to 6% of watershed |
| HUC6 010700010302 limit acres regen (per. 2-16) | <=134 | Limit regen to 6% of watershed |
| HUC6 010700010405 limit acres regen (per. 2-16) | <=20 | Limit regen to 6% of watershed |
| HUC6 010600020601 limit acres regen (per. 2-16) | <=41 | Limit regen to 6% of watershed |
| HUC6 010700010303 limit acres regen (per. 2-16) | <=30 | Limit regen to 6% of watershed |
| HUC6 010700010407 limit acres regen (per. 2-16) | <=12 | Limit regen to 6% of watershed |
| | | |

*Table B-16. Alternative 3 Constraints.*

| Description | Values | Reason |
|---|---|---|
| Acres treated with regeneration harvest (per. 2-16) | <=4,800 | Min.for desired pop. levels (+20%) |
| Acres treated with regeneration harvest (per. 2-16) | >=3,200 | Min.for desired pop. levels (-20%) |
| Percent acres SP-BF treated with uneven age mgmt | >=90% | Preserve softwood component |
| Acres of AS-PB treated with regen harvest (per. 2-3) | >=1,660 | Achieve habitat objectives |
| Percent of even age treated acres in thinnings (per. 1-16) | >=30% | Maintain high quality component |
| Percent regen acres in SM-WA ELC (per. 2-16) | <=75% | Limit tendency to favor SM-WA |
| Percent acres treated in SM-WA ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| Percent acres treated in BE-RM ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| Acres harvested with 2000 Inventoried Roadless Areas | =0 | Restricts timber mgmt in 2000 IRA |
| HUC6 010801010707 limit acres regen (per. 2-16) | <=335 | Limit regen to 6% of watershed |
| HUC6 010801010705 limit acres regen (per. 2-16) | <=130 | Limit regen to 6% of watershed |
| HUC6 010801010702 limit acres regen (per. 2-16) | <=311 | Limit regen to 6% of watershed |
| HUC6 010801010805 limit acres regen (per. 2-16) | <=28 | Limit regen to 6% of watershed |
| HUC6 010801010701 limit acres regen (per. 2-16) | <=849 | Limit regen to 6% of watershed |
| HUC6 010400020206 limit acres regen (per. 2-16) | <=101 | Limit regen to 6% of watershed |
| HUC6 010400010606 limit acres regen (per. 2-16) | <=9 | Limit regen to 6% of watershed |
| HUC6 010801010804 limit acres regen (per. 2-16) | <=35 | Limit regen to 6% of watershed |
| HUC6 010801010806 limit acres regen (per. 2-16) | <=22 | Limit regen to 6% of watershed |
| HUC6 010400020104 limit acres regen (per. 2-16) | <=184 | Limit regen to 6% of watershed |
| HUC6 010801030102 limit acres regen (per. 2-16) | <=21 | Limit regen to 6% of watershed |
| HUC6 010400020101 limit acres regen (per. 2-16) | <=88 | Limit regen to 6% of watershed |
| HUC6 010801010803 limit acres regen (per. 2-16) | <=19 | Limit regen to 6% of watershed |
| HUC6 010400020102 limit acres regen (per. 2-16) | <=282 | Limit regen to 6% of watershed |
| HUC6 010400020201 limit acres regen (per. 2-16) | <=141 | Limit regen to 6% of watershed |
| HUC6 010400020103 limit acres regen (per. 2-16) | <=282 | Limit regen to 6% of watershed |
| HUC6 010600010101 limit acres regen (per. 2-16) | <=392 | Limit regen to 6% of watershed |
| HUC6 010801010802 limit acres regen (per. 2-16) | <=113 | Limit regen to 6% of watershed |
| HUC6 010801010801 limit acres regen (per. 2-16) | <=226 | Limit regen to 6% of watershed |
| HUC6 010801030403 limit acres regen (per. 2-16) | <=18 | Limit regen to 6% of watershed |
| HUC6 010600020402 limit acres regen (per. 2-16) | <=246 | Limit regen to 6% of watershed |
| HUC6 010801030402 limit acres regen (per. 2-16) | <=393 | Limit regen to 6% of watershed |
| HUC6 010600020401 limit acres regen (per. 2-16) | <=888 | Limit regen to 6% of watershed |
| HUC6 010801030401 limit acres regen (per. 2-16) | <=333 | Limit regen to 6% of watershed |
| HUC6 010600020105 limit acres regen (per. 2-16) | <=406 | Limit regen to 6% of watershed |
| HUC6 010801030302 limit acres regen (per. 2-16) | <=217 | Limit regen to 6% of watershed |
| HUC6 010600020104 limit acres regen (per. 2-16) | <=210 | Limit regen to 6% of watershed |
| HUC6 010600020101 limit acres regen (per. 2-16) | <=8 | Limit regen to 6% of watershed |
| HUC6 010801030301 limit acres regen (per. 2-16) | <=435 | Limit regen to 6% of watershed |
| HUC6 010600020103 limit acres regen (per. 2-16) | <=186 | Limit regen to 6% of watershed |
| HUC6 010600020107 limit acres regen (per. 2-16) | <=759 | Limit regen to 6% of watershed |
| HUC6 010801030503 limit acres regen (per. 2-16) | <=4 | Limit regen to 6% of watershed |
| HUC6 010801030303 limit acres regen (per. 2-16) | <=81 | Limit regen to 6% of watershed |
| HUC6 010700010201 limit acres regen (per. 2-16) | <=10 | Limit regen to 6% of watershed |
| HUC6 010801030505 limit acres regen (per. 2-16) | <=480 | Limit regen to 6% of watershed |
| HUC6 010801030703 limit acres regen (per. 2-16) | <=16 | Limit regen to 6% of watershed |
| HUC6 010600020106 limit acres regen (per. 2-16) | <=100 | Limit regen to 6% of watershed |
| HUC6 010801030504 limit acres regen (per. 2-16) | <=253 | Limit regen to 6% of watershed |
| HUC6 010700010104 limit acres regen (per. 2-16) | <=60 | Limit regen to 6% of watershed |
| HUC6 010600020102 limit acres regen (per. 2-16) | <=163 | Limit regen to 6% of watershed |

*Table B-16. Alternative 3 Constraints (continued).*

| Description | Values | Reason |
|---|---|---|
| HUC6 010600020304 limit acres regen (per. 2-16) | <=57 | Limit regen to 6% of watershed |
| HUC6 010600020301 limit acres regen (per. 2-16) | <=166 | Limit regen to 6% of watershed |
| HUC6 010801030701 limit acres regen (per. 2-16) | <=250 | Limit regen to 6% of watershed |
| HUC6 010700010202 limit acres regen (per. 2-16) | <=267 | Limit regen to 6% of watershed |
| HUC6 010600020202 limit acres regen (per. 2-16) | <=665 | Limit regen to 6% of watershed |
| HUC6 010600020201 limit acres regen (per. 2-16) | <=540 | Limit regen to 6% of watershed |
| HUC6 010600020203 limit acres regen (per. 2-16) | <=354 | Limit regen to 6% of watershed |
| HUC6 010700010204 limit acres regen (per. 2-16) | <=309 | Limit regen to 6% of watershed |
| HUC6 010700010401 limit acres regen (per. 2-16) | <=248 | Limit regen to 6% of watershed |
| HUC6 010700010203 limit acres regen (per. 2-16) | <=31 | Limit regen to 6% of watershed |
| HUC6 010801040201 limit acres regen (per. 2-16) | <=97 | Limit regen to 6% of watershed |
| HUC6 010700010301 limit acres regen (per. 2-16) | <=428 | Limit regen to 6% of watershed |
| HUC6 010700010402 limit acres regen (per. 2-16) | <=92 | Limit regen to 6% of watershed |
| HUC6 010600020302 limit acres regen (per. 2-16) | <=113 | Limit regen to 6% of watershed |
| HUC6 010700010205 limit acres regen (per. 2-16) | <=170 | Limit regen to 6% of watershed |
| HUC6 010600020603 limit acres regen (per. 2-16) | <=172 | Limit regen to 6% of watershed |
| HUC6 010600020604 limit acres regen (per. 2-16) | <=6 | Limit regen to 6% of watershed |
| HUC6 010600020602 limit acres regen (per. 2-16) | <=86 | Limit regen to 6% of watershed |
| HUC6 010700010206 limit acres regen (per. 2-16) | <=291 | Limit regen to 6% of watershed |
| HUC6 010700010406 limit acres regen (per. 2-16) | <=70 | Limit regen to 6% of watershed |
| HUC6 010700010302 limit acres regen (per. 2-16) | <=128 | Limit regen to 6% of watershed |
| HUC6 010700010405 limit acres regen (per. 2-16) | <=20 | Limit regen to 6% of watershed |
| HUC6 010600020601 limit acres regen (per. 2-16) | <=41 | Limit regen to 6% of watershed |
| HUC6 010700010303 limit acres regen (per. 2-16) | <=30 | Limit regen to 6% of watershed |
| HUC6 010700010407 limit acres regen (per. 2-16) | <=12 | Limit regen to 6% of watershed |

*Table B-17. Alternative 4 Constraints.*

| Description | Values | Reason |
|---|---|---|
| Acres treated with regeneration harvest (per. 2-16) | <=12,000 | Targets recent history (+20%) |
| Acres treated with regeneration harvest (per. 2-16) | >=8,000 | Targets recent history (-20%) |
| Percent acres SP-BF treated with uneven age mgmt | >=90% | Preserve softwood component |
| Acres of AS-PB treated with regen harvest (per. 2-3) | >=2,200 | Achieve habitat objectives |
| Percent of acres treated in even age mgmt (per. 2-16) | =60% | |
| Percent of even age treated acres in thinnings (per. 1-16) | >=30% | Maintain high quality component |
| Percent regen acres in SM-WA ELC (per. 2-16) | <=75% | Limit tendency to favor SM-WA |
| Percent acres treated in SM-WA ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| Percent acres treated in BE-RM ELC (per. 1-16) | >=10% | Spread harvest to all ELCs |
| HUC6 010801010707 limit acres regen (per. 2-16) | <=335 | Limit regen to 6% of watershed |
| HUC6 010801010705 limit acres regen (per. 2-16) | <=293 | Limit regen to 6% of watershed |
| HUC6 010801010702 limit acres regen (per. 2-16) | <=341 | Limit regen to 6% of watershed |
| HUC6 010801010805 limit acres regen (per. 2-16) | <=28 | Limit regen to 6% of watershed |
| HUC6 010801010701 limit acres regen (per. 2-16) | <=955 | Limit regen to 6% of watershed |
| HUC6 010400020206 limit acres regen (per. 2-16) | <=145 | Limit regen to 6% of watershed |
| HUC6 010400010606 limit acres regen (per. 2-16) | <=9 | Limit regen to 6% of watershed |
| HUC6 010801010804 limit acres regen (per. 2-16) | <=35 | Limit regen to 6% of watershed |
| HUC6 010801010806 limit acres regen (per. 2-16) | <=22 | Limit regen to 6% of watershed |
| HUC6 010400020104 limit acres regen (per. 2-16) | <=203 | Limit regen to 6% of watershed |
| HUC6 010801030102 limit acres regen (per. 2-16) | <=21 | Limit regen to 6% of watershed |
| HUC6 010400020101 limit acres regen (per. 2-16) | <=144 | Limit regen to 6% of watershed |
| HUC6 010801010803 limit acres regen (per. 2-16) | <=34 | Limit regen to 6% of watershed |
| HUC6 010400020102 limit acres regen (per. 2-16) | <=349 | Limit regen to 6% of watershed |
| HUC6 010400020201 limit acres regen (per. 2-16) | <=164 | Limit regen to 6% of watershed |
| HUC6 010400020103 limit acres regen (per. 2-16) | <=691 | Limit regen to 6% of watershed |
| HUC6 010600010101 limit acres regen (per. 2-16) | <=392 | Limit regen to 6% of watershed |
| HUC6 010801010802 limit acres regen (per. 2-16) | <=286 | Limit regen to 6% of watershed |
| HUC6 010801010801 limit acres regen (per. 2-16) | <=241 | Limit regen to 6% of watershed |
| HUC6 010801030403 limit acres regen (per. 2-16) | <=18 | Limit regen to 6% of watershed |
| HUC6 010600020402 limit acres regen (per. 2-16) | <=248 | Limit regen to 6% of watershed |
| HUC6 010801030402 limit acres regen (per. 2-16) | <=738 | Limit regen to 6% of watershed |
| HUC6 010600020401 limit acres regen (per. 2-16) | <=1002 | Limit regen to 6% of watershed |
| HUC6 010801030401 limit acres regen (per. 2-16) | <=533 | Limit regen to 6% of watershed |
| HUC6 010600020105 limit acres regen (per. 2-16) | <=406 | Limit regen to 6% of watershed |
| HUC6 010801030302 limit acres regen (per. 2-16) | <=256 | Limit regen to 6% of watershed |
| HUC6 010600020104 limit acres regen (per. 2-16) | <=252 | Limit regen to 6% of watershed |
| HUC6 010600020101 limit acres regen (per. 2-16) | <=21 | Limit regen to 6% of watershed |
| HUC6 010801030301 limit acres regen (per. 2-16) | <=435 | Limit regen to 6% of watershed |
| HUC6 010600020103 limit acres regen (per. 2-16) | <=251 | Limit regen to 6% of watershed |
| HUC6 010600020107 limit acres regen (per. 2-16) | <=893 | Limit regen to 6% of watershed |
| HUC6 010801030503 limit acres regen (per. 2-16) | <=4 | Limit regen to 6% of watershed |
| HUC6 010801030303 limit acres regen (per. 2-16) | <=180 | Limit regen to 6% of watershed |
| HUC6 010700010201 limit acres regen (per. 2-16) | <=13 | Limit regen to 6% of watershed |
| HUC6 010801030505 limit acres regen (per. 2-16) | <=480 | Limit regen to 6% of watershed |
| HUC6 010801030703 limit acres regen (per. 2-16) | <=16 | Limit regen to 6% of watershed |
| HUC6 010600020106 limit acres regen (per. 2-16) | <=137 | Limit regen to 6% of watershed |
| HUC6 010801030504 limit acres regen (per. 2-16) | <=413 | Limit regen to 6% of watershed |
| HUC6 010700010104 limit acres regen (per. 2-16) | <=111 | Limit regen to 6% of watershed |
| HUC6 010600020102 limit acres regen (per. 2-16) | <=174 | Limit regen to 6% of watershed |
| HUC6 010600020304 limit acres regen (per. 2-16) | <=57 | Limit regen to 6% of watershed |

*Table B-17. Alternative 4 Constraints (continued).*

| Description | Values | Reason |
|---|---|---|
| HUC6 010600020301 limit acres regen (per. 2-16) | <=167 | Limit regen to 6% of watershed |
| HUC6 010801030701 limit acres regen (per. 2-16) | <=250 | Limit regen to 6% of watershed |
| HUC6 010700010202 limit acres regen (per. 2-16) | <=383 | Limit regen to 6% of watershed |
| HUC6 010600020202 limit acres regen (per. 2-16) | <=737 | Limit regen to 6% of watershed |
| HUC6 010600020201 limit acres regen (per. 2-16) | <=583 | Limit regen to 6% of watershed |
| HUC6 010600020203 limit acres regen (per. 2-16) | <=354 | Limit regen to 6% of watershed |
| HUC6 010700010204 limit acres regen (per. 2-16) | <=313 | Limit regen to 6% of watershed |
| HUC6 010700010401 limit acres regen (per. 2-16) | <=261 | Limit regen to 6% of watershed |
| HUC6 010700010203 limit acres regen (per. 2-16) | <=71 | Limit regen to 6% of watershed |
| HUC6 010801040201 limit acres regen (per. 2-16) | <=97 | Limit regen to 6% of watershed |
| HUC6 010700010301 limit acres regen (per. 2-16) | <=486 | Limit regen to 6% of watershed |
| HUC6 010700010402 limit acres regen (per. 2-16) | <=99 | Limit regen to 6% of watershed |
| HUC6 010600020302 limit acres regen (per. 2-16) | <=113 | Limit regen to 6% of watershed |
| HUC6 010700010205 limit acres regen (per. 2-16) | <=227 | Limit regen to 6% of watershed |
| HUC6 010600020603 limit acres regen (per. 2-16) | <=172 | Limit regen to 6% of watershed |
| HUC6 010600020604 limit acres regen (per. 2-16) | <=6 | Limit regen to 6% of watershed |
| HUC6 010600020602 limit acres regen (per. 2-16) | <=88 | Limit regen to 6% of watershed |
| HUC6 010700010206 limit acres regen (per. 2-16) | <=297 | Limit regen to 6% of watershed |
| HUC6 010700010406 limit acres regen (per. 2-16) | <=70 | Limit regen to 6% of watershed |
| HUC6 010700010302 limit acres regen (per. 2-16) | <=137 | Limit regen to 6% of watershed |
| HUC6 010700010405 limit acres regen (per. 2-16) | <=20 | Limit regen to 6% of watershed |
| HUC6 010600020601 limit acres regen (per. 2-16) | <=41 | Limit regen to 6% of watershed |
| HUC6 010700010303 limit acres regen (per. 2-16) | <=30 | Limit regen to 6% of watershed |
| HUC6 010700010407 limit acres regen (per. 2-16) | <=12 | Limit regen to 6% of watershed |
| | | |

## Results of Modeling the Alternatives

The Forest Leadership Team reviewed the SPECTRUM timber harvest schedule modeling results and recommendations from the interdisciplinary team for a timber sale schedule and ASQ for each of the four alternatives. The SPECTRUM model results, by design, show the maximum biological capability within the suitable base of each alternative, within the modeled constraints. There was no internal "adjustment factor" within the model to account for some of the known limitations inherent in the model design mentioned previously in the assumptions and described below in "SPECTRUM Model Calibration." Absent any calibration, the SPECTRUM model results for the maximum biological capability in the first decade of implementation are shown in Table B-18.

*Table B-18. Pre-Calibrated SPECTRUM Model Results.*

| | Alternatives | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| SPECTRUM Maximum Timber Capability (MMBF/decade) | 470 | 400 | 240 | 450 |
| Analysis Unit Acres (Acres) | 252K | 256K | 214K | 260K |

### *SPECTRUM Model Calibrations*

During the design phase of developing the timber harvest schedule model, the interdisciplinary team identified some shortcomings that would ultimately have to be considered when evaluating the model results. First, the SPECTRUM model was not intended to be a spatial model and therefore it evaluates analysis units without regard to adjacency or relative size. While some of the design that evolved attempted to address this shortcoming, the design was by no means sufficient to satisfy all of the considerations that would go into laying out a timber sale on the ground. Second, the model seeks to maximize objective functions that are not easily achieved on the ground. Maximizing timber volume or present net value is not consistent with all of the considerations that go into designing a timber sale. It is not possible to lay out a sale so that only the highest value or highest volume stands are harvested in a given period. The interdisciplinary team evaluated these shortcomings in the model's design in light of the results. By comparing the model results for Alternative 1 (reflecting the current management design) to the highest levels of harvest experienced since the Plan was adopted, it was possible to calibrate the model. This comparison resulted in a 0.74 calibration factor, which would be applied to each of the SPECTRUM model results for the first decade of implementation ASQ.

### Alternative 1

This alternative is intended to reflect the intent of the 1986 Management Plan as written. The second decade in the 1986 Plan was originally set at 390 MMBF/decade, and the third decade at 420 MMBF/decade. It could be argued that using the current Plan as written, the Forest will actually enter the third decade of plan implementation in the year 2006, roughly the first year that the Forest expects to implement the revised Plan. It light of this, it is worth discussing the merit of using the current plan's third decade ASQ of 420 MMBF/decade versus the 350 MMBF/decade envisioned in the conceptual alternatives originally, and subsequently presented to the public on March 29, 2003.

In the 18 years since the plan was written, the Forest has not achieved the 350 MMBF/decade the plan originally prescribed for the first decade. If the Forest had come close to achieving 350 MMBF/decade, it would be worth considering the higher levels projected in the plan for later decades. An important part of developing alternatives is being able to execute them as described. Placing a higher level than was projected for the first decade would not be prudent and could be perceived as ignoring what has been the Forest's experience on the ground. Therefore, the decision was made to establish the first decade ASQ for Alternative 1 at 350 MMBF/decade.

### Alternative 2

In alternative 2, the Forest reviewed the original intent of the alternative's design. Timber harvest in alternative 2 was intended to approximate current levels. In looking back at the past 10 years, it was noted that the Forest actually harvested 183 MMBF/decade. This includes a period of several years at the end of the last decade when harvesting was curtailed to evaluate Threatened and Endangered Species (TES). Had the Forest not experienced this interruption, trends indicate it would have harvested approximately 240 MMBF/decade. Since it is impossible to predict if there will be any future mandates that would curtail harvesting, the Forest assumes it will be able to carry out its timber harvest as planned. Therefore, in keeping with the original expressed intent of Alternative 2, the ASQ was set at 240 MMBF/decade.

Comparing this ASQ to the calibrated model result of 300 MMBF/decade provided assurance that this alternative will support 240 MMBF/decade.

### Alternative 3

The expressed intent of alternative 3 was to have the smallest timber harvest of the four alternatives. This is complemented by the fact that it has the smallest suitable base of the four alternatives from which to harvest. Another important characteristic is that this alternative incorporates a significantly smaller number of acres of even-aged regeneration harvest. This is in keeping with the overall design of the alternative and helps establish the range of timber harvest levels in the alternatives. Therefore, the calibrated model result of 180 MMBF/decade was accepted as the first decade ASQ for Alternative 3.

### Alternative 4

The expressed intent of the timber harvest in alternative 4 was to have higher timber harvest levels than alternatives 2 and 3, but less than alternative 1. This was in recognition of the need to provide an adequate range of timber harvest levels within the design of the alternatives. In evaluating the intent of this alternative, one approach is to consider the result of what the Forest has accomplished (Alternative 2), which is 240 MMBF/decade and comparing it to Alternative 1, the alternative with the highest ASQ at 350 MMBF/decade. The halfway point between these alternatives is 300 MMBF/decade, which is consistent with the intent of the alternative's design — it is greater than Alternatives 2 and 3 and less than Alternative 1.

The Forest evaluated the possibility of using the calibrated model result of 330 MMBF for Alternative 4. This would place the alternative very close to Alternative 1 at 350 MMBF/decade — a difference of only 20 MMBF/decade. This would also create a 60 MMBF/decade difference between the next lowest alternative (Alternative 2 at 240 MMBF/decade). By using the half the difference between Alternative 2 and Alternative 1, or 300 MMBF/decade these differences become much more balanced at 60 MMBF/decade and 50 MMBF/decade respectively.

In keeping with the intent of the design of Alternative 4 and in order to preserve an adequate range of harvest levels between the alternatives, the first decade ASQ for Alternative 4 was set at 300 MMBF/decade.

## *Final SPECTRUM Model Runs*

Following the determination of the first decade ASQs, these levels were then placed back into each of the alternative models as a volume constraint for period 2, the first decade of implementation. The models were then rerun and the results were reviewed and recorded. The results reflect incremental increases in the ASQ in future decades, consistent with the requirement to produce non-declining yields. The conversion from cubic feet to board feet through out this analysis has been 1 cubic foot = 6 board feet. SPECTRUM modeling results are detailed in the description of the alternatives and in the vegetation affected environment and effects analysis portion of this document.

# Economic Impact Analysis

## Introduction

This portion of the appendix is intended to provide additional details regarding the economic impact analysis. It should provide the reader with a general understanding of the methodology used and some of the models employed in the process. In this context, economic impacts refer to the effect, or impact, a change in the economic environment will have on jobs and income. The changes that are introduced to the economic environment reflect the changes in activity levels, such as recreational use and levels of timber harvest, that are present in each of the alternatives. These various levels of activity cause the number of jobs and income to change. Comparing the levels of change in income and employment from current and between alternatives provide the basis for most of the economic effects analysis in Chapter 3.

## Defining the Economic Impact Analysis Area

The economic impact analysis area was defined as the four counties that the White Mountain National Forest lies within: Coos, Grafton and Carroll Counties in New Hampshire, and Oxford County in Maine. Since the Forest is fairly geographically centered within these four counties and the counties are well connected through public road networks, it is reasonable to consider the counties as a whole area rather than individually. Activities on the Forest are generally spread throughout the Forest fairly evenly and any one county does not tend to have disproportionate shares of an activity on the Forest compared to the others.

Additionally, much of the data available for economic research is available at the county level and therefore the four county area provided a reasonable area in which to examine the economic activity and measure the Forest's economic impact. Researchers also concluded it was appropriate to measure local effects, since the most significant economic impacts of activities on the Forest can often be felt by communities adjacent to or in close proximity to the Forest. The four county area captures all of the towns adjacent to the Forest and includes some other larger communities that are geographically separated from the Forest but tend be a primary source for goods and services for the adjacent communities.

By defining the economic impact analysis as the four county region, the data is therefore grouped together with no geographical distinction or sub area categorization made within the models except where the activities on the Forest are isolated for the impact analysis. As the Socio-economic affected environment section of Chapter 3 recognized, there are some economic qualitative differences present between the southern counties (Grafton and Carroll) and the northern counties (Coos and Oxford).

## Economic Impact Analysis Method

### *IMPLAN Model*

The economic effects to the four county region were estimated using an economic input-output model developed with IMPLAN Professional 2.0. The early version of this software was originally developed by the Forest Service and has since been taken over by a private company, Minnesota IMPLAN Group, Inc. (MIG, Inc.). The model uses national input-output tables from the Bureau of Economic Analysis (BEA), 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 Regional Economist assisted the White Mountain National Forest in developing the IMPLAN model. The income and employment data was derived from 2002 data, the most recent available data at the time this was completed. Resource Systems Group, Inc. also assisted in the development of the model, providing the first set of analysis performed as part of analyzing the current situation in the Socioeconomic Assessment (High, C., et. al. 2004). Subsequent analysis was performed using an electronic worksheet tool (FEAST). FEAST was developed by the Forest Service's Inventory and Monitoring Institute to apply the coefficients and multipliers generated in IMPLAN to varying levels of inputs by alternative and display the outputs in terms of impacts on employment and labor income.

One of the areas resolved in the development of the model was the June 2002 reopening of the Berlin-Gorham integrated pulp and paper mill complex, currently owned and operated by Fraser Papers, Inc. The data in the development files for 2002 did not include this integrated mill since it had closed in September, 2001. A similar integrated pulp and paper mill sector was located and added to the model in order to capture the contribution the mill makes to the local economy.

The impacts to local economies in the model are expressed in terms of 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 in 2002 dollars. Labor includes both employee compensation (pay plus benefits) and proprietor's income (e.g. profits by self-employed).

### *Timber*

Information on timber stumpage values was provided from a combination of three sources. The "Average Stumpage Value List" for April 1 - September 30, 2003 Northern Section; NH Department of Revenue Administration (DRA) dated March 24, 2003 provided one source. The NH DRA presents their stumpage values with a low value (large logging costs, poor accessibility, or low grade timber) and high value (small logging costs, good accessibility, or high grade timber). For purposes of comparison, it was decided to use the midpoint between these high and low values. This was used in combination with the information presented on recent sales on the

WMNF and NH Timberland Owner's Association (NHTOA) report of stumpage values to determine the stumpage values shown in Table B-10.

### *Recreation*

Estimating the economic impacts of recreation on the Forest involved the following steps:

1. Determine how many visitors by recreational activity recreate on the Forest in a year. The number of visitors is converted to a standardized unit of measure termed a Recreational Visitor Day (RVD) using an activity dependent length-of-stay factor.
2. Determine how much money the average visitor spends within the analysis area, by recreational activity, on a daily basis. This is referred to as a spending profile.
3. By recreational activity, multiply the number of RVDs by the activity's spending profile to estimate the amount of money recreational visitors spend in the course of a recreational visit to the Forest.

Spending profiles by recreational activity were developed pursuant to "A Socioeconomic Assessment to Provide a Context for the White Mountain Forest Plan Revision." (High et al., 2004) These profiles are shown in Table B-19.

*Table B-19. Spending Profiles of WMNF Visitors.*

| Recreation Type | Expenditure per Visitor Day |
|---|---|
| Hiking | $14.68 |
| Nordic Skiing, including Tuckerman | $32.04 |
| Hunting | $17.67 |
| Fishing | $21.71 |
| Snowmobiling | $81.14 |
| Driving and Viewing | $58.30 |
| Road Access Day Use & Camping | $29.07 |
| Alpine Ski Area Use | $82.54 |

Recreational trends indicate some activities will grow and some will remain relatively constant. Assumptions for each activity are provided as follows:

**Picnicking**

- Projected annual growth equal to 2% of the 2002 base year visits of 416,000 (+8,320 visits/year).
- Length of stay factor: 0.14.
- Used as a proxy for day use areas in general.
- Forest has the capacity in existing facilities to meet projected growth.
- Average annual visits for first decade of implementation: 478,400 visits.

**Road Accessible Camping (Developed Campgrounds)**

- Projected annual growth equal to 1% of the 2002 base year visits of 265,000 (+2,650 visits/year).
- Length of stay factor: 1.0.
- Maximum capacities by alternative (2002 base year is 265,000 visits):
  - Alternative 1: 276,300 visits based on addition of 54 new sites.
  - Alternatives 2 & 3: 269,500 visits based on 10 new sites.
  - Alternative 4: 305,000 visits based on 99 new sites.
- Average annual visits for first decade of implementation by alternative:
  - Alternative 1: 275,055 visits.
  - Alternatives 2 & 3: 269,500 visits.
  - Alternative 4: 281,425 visits.

**Alpine Ski Area Use**

- Projects no annual growth or decline, 2002 base year visits of 919,833.
- Length of stay factor: 0.41.
- Average annual visits for first decade of implementation: 919,833 visits.

**Fishing**

- Projects no annual growth or decline, 2002 base year visits of 225,000.
- Length of stay factor: 0.35.
- Average annual visits for first decade of implementation: 225,000 visits.

**Hiking and Backcountry Camping:**

- Projected annual growth equal to 8.57% of the 2002 base year visits of 1,692,185 (+145,020 visits/year).
- Length of stay factor: 0.43.
- Maximum capacity is not established. Projected increases in hiking will cause shifts from high use areas to low use areas. Possible expansion of trail miles in some alternatives will serve to help disperse use and not affect the overall use numbers. Backcountry camping at developed backcountry facilities will overflow to dispersed campsites.
- Average annual visits for first decade of implementation: 2,779,837 visits.

**Rock and Ice Climbing**

- Included in hiking and backcountry camping.

**Hunting**

- Projects no annual growth or decline, 2002 base year visits of 172,000.
- Length of stay factor: 0.65.
- Average annual visits for first decade of implementation: 172,000 visits.

**Summer OHRV**

- Projected annual growth equal to 10% if a summer OHRV trail system is established.
- Length of stay factor: 0.30.
- Maximum capacities by alternative (visitation estimated at 4,800 visits per system in first year of establishing a trail system):
  - Alternative 1: 12,800 visits based on the addition of two new trail systems.
  - Alternatives 2 & 3: zero capacity, not permitted.
  - Alternative 4: 6,400 visits based on the addition of one new trail system.
- Average annual visits for first decade of implementation by alternative:
  - Alternative 1: 7,424 visits, assuming the first trail system is established in the third year of implementation and a second system is established in the sixth year of Plan implementation.
  - Alternative 4: 4,640 visits, assuming establishing a trail system in the third year of implementation.

**Nordic Skiing including Tuckerman Ravine**

- Projected annual growth in Nordic skiing equal to 4% of the 2002 base year visits of 194,998 (+7,800 visits/year). Base year visits are broken down by Nordic skiing in permitted areas (83,440 visits) and on Forest trails (111,558 visits). No projected growth or decline in skiing at Tuckerman Ravine, base year visits of 15,000 visits.
- Length of stay factor: Nordic skiing: 0.34; Tuckerman Ravine: 0.41.
- Forest has the capacity in existing facilities to meet projected growth.
- Average annual visits for first decade of implementation 268,497 visits.

**Snowmobiling**

- Projected annual growth equal to 9% of the 2002 base year visits of 108,013 (+9,721 visits/year).
- Length of stay factor: 0.30.
- Forest has the capacity on existing or projected trail system to meet projected growth.
- Average annual visits for first decade of implementation 180,922 visits.

**Driving and Viewing**

- Projected annual growth equal to 2% of the 2002 base year visits of 700,000 (+14,000 visits/year).
- Length of stay factor: 0.13.
- Forest has the capacity to meet projected growth.
- Average annual visits for first decade of implementation 805,000 visits.

### *Inputs and Outputs*

Table B-20 provides a display of some of the inputs that were used in the economic impact analysis. Both the current situation and each of the alternatives is shown. The values for the alternatives display the average annual for the first decade and the current reflects 2002.

## Economic Impact Analysis Results

The results of the economic impact analysis are expressed in terms of jobs and income. The analysis looks at this from two perspectives. One perspective is the impact the activities occurring on the Forest have on sectors of the local economy, in terms of jobs and income. Another perspective looks back, at the Forest Service, and uses some general categories of resource management within the Forest Service's functional organization and attributes the changes in jobs and income to those resource areas. In a loosely defined fashion, this sets up a cause and effect relationship between the changes by resource area (e.g., timber or recreation) and their associated sectors of the economy (e.g., manufacturing or services). This cause and effect relationship oversimplifies the complexity of all of the impacts that an activity actually has within the IMPLAN model. In fact, the impacts are often spread over hundreds of sectors and sub-sectors. Therefore, the cause and effect is not a one to one relationship, however general cause and effect relations are evident in the results.

The economic effects analysis section of chapter 3 provides detailed tables and interpretation of the results by alternative. Comparison tables that show the magnitude of the changes by alternatives in comparison to the current situation are provided in Table B-21 through Table B-26.

*Table B-20. Inputs Used in the Economic Impact Analysis.*

| Input/Output | Current (2002) | Alternatives (Avg. Annual 1st Decade) Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|---|
| **Recreation (RVD*/Year)** | | | | | |
| Road Access Camping & Day Use | 323,000 | 342,031 | 336,476 | 336,476 | 348,401 |
| Alpine Ski Area Use | 377,000 | 377,132 | 377,132 | 377,132 | 377,132 |
| Fishing | 79,000 | 78,750 | 78,750 | 78,750 | 78,750 |
| Hiking | 728,000 | 1,195,330 | 1,195,330 | 1,195,330 | 1,195,330 |
| Hunting | 112,000 | 111,800 | 111,800 | 111,800 | 111,800 |
| OHRV | | 2,227 | | | 1,392 |
| Nordic Skiing Inc. Tuckerman | 72,000 | 92,339 | 92,339 | 92,339 | 92,339 |
| Snowmobiling | 32,000 | 54,277 | 54,277 | 54,277 | 54,277 |
| Driving and Viewing | 91,000 | 104,650 | 104,650 | 104,650 | 104,650 |
| **Timber Harvested (CCF**/Year)** | | | | | |
| Softwood Sawtimber | 1,991 | 7,652 | 8,290 | 1,989 | 6,491 |
| Softwood Pulp | 1,494 | 3,270 | 2,765 | 2,423 | 2,902 |
| Hardwood Sawtimber | 3,704 | 18,397 | 12,155 | 6,735 | 14,903 |
| Hardwood Pulp | 10,251 | 25,345 | 14,532 | 17,123 | 22,207 |
| Firewood | 285 | 300 | 300 | 300 | 300 |
| PB Sawtimber | 823 | 3,369 | 1,958 | 1,431 | 3,197 |
| **Recreation Revenues ($1,000/Year)** | | | | | |
| Road Access Camping & Day Use | 67 | 71 | 74 | 77 | 83 |
| Alpine Ski Areas | 521 | 521 | 521 | 521 | 521 |
| Nordic Skiing | 6 | 6 | 6 | 6 | 6 |
| **Timber Revenues ($1,000/Year)** | | | | | |
| Timber & Roads | 403 | 3,203 | 2,291 | 1,284 | 2,455 |
| Knutson Vandenberg Act Funds | 24 | 188 | 135 | 76 | 144 |
| Salvage Sales | 386 | 386 | 386 | 386 | 386 |
| **Protection Revenues ($1,000/Year)** | | | | | |
| Land Uses | 11 | 11 | 11 | 11 | 11 |
| Power | 5 | 5 | 5 | 5 | 5 |
| **NF Budget Expenditures ($1,000/Yr)** | | | | | |
| Recreation | 4,416 | 4,885 | 4,545 | 4,560 | 4,836 |
| Timber | 3,018 | 4,120 | 3,424 | 3,366 | 3,830 |
| Soil, Water & Air | 1,084 | 1,084 | 1,084 | 1,084 | 1,084 |
| Minerals | 28 | 28 | 28 | 28 | 28 |
| Protection (Fires, EM, Lands) | 766 | 766 | 766 | 766 | 766 |
| Wildlife & Fish | 1,722 | 1,722 | 1,722 | 1,722 | 1,722 |
| **FS Employment** | | | | | |
| Permanent | 110 | 128 | 117 | 117 | 124 |
| Other than Permanent | 140 | 144 | 142 | 141 | 143 |

* RVD: recreation Visitor Day (one RVD=one 12 hour visit)
**CCF=100 cubic feet of timber volume

*Table B-21. Income ($ Million) Attributed to Activity on the Forest in the Four County Region.*

| Industry | Current | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|---|
| Agriculture | $ 0.3 | $ 0.4 | $ 0.4 | $ 0.4 | $ 0.4 |
| Mining | $ 0.0 | $ 0.0 | $ 0.0 | $ 0.0 | $ 0.0 |
| Construction | $ 1.0 | $ 1.4 | $ 1.3 | $ 1.2 | $ 1.3 |
| Manufacturing | $ 2.2 | $ 6.5 | $ 5.2 | $ 3.8 | $ 5.5 |
| Transportation, Communication, & Utilities | $ 1.3 | $ 1.8 | $ 1.6 | $ 1.5 | $ 1.7 |
| Wholesale trade | $ 1.2 | $ 1.8 | $ 1.7 | $ 1.6 | $ 1.7 |
| Retail trade | $ 8.5 | $ 10.4 | $ 10.2 | $ 10.0 | $ 10.3 |
| Finance, Insurance, & Real Estate | $ 1.0 | $ 1.3 | $ 1.2 | $ 1.1 | $ 1.2 |
| Services | $ 17.9 | $ 20.6 | $ 20.0 | $ 19.5 | $ 20.3 |
| Government (Federal, State, & Local) | $ 13.0 | $ 15.7 | $ 14.5 | $ 14.1 | $ 15.2 |
| Miscellaneous | $ 0.1 | $ 0.1 | $ 0.1 | $ 0.1 | $ 0.1 |
| **Total Forest Management** | **$ 46.5** | **$ 60.0** | **$ 56.2** | **$ 53.3** | **$ 57.7** |

*Table B-22. Income ($ Million)— Changes from Current.*

| Industry | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|
| Agriculture | 0.1 | 0.1 | 0.1 | 0.1 |
| Mining | — | — | — | — |
| Construction | 0.4 | 0.3 | 0.2 | 0.3 |
| Manufacturing | 4.3 | 3.0 | 1.6 | 3.3 |
| Transportation, Communication, & Utilities | 0.5 | 0.3 | 0.2 | 0.4 |
| Wholesale trade | 0.6 | 0.5 | 0.4 | 0.5 |
| Retail trade | 1.9 | 1.7 | 1.5 | 1.8 |
| Finance, Insurance, & Real Estate | 0.3 | 0.2 | 0.1 | 0.2 |
| Services | 2.7 | 2.1 | 1.6 | 2.4 |
| Government (Federal, State, & Local) | 2.7 | 1.5 | 1.1 | 2.2 |
| Miscellaneous | — | — | — | — |
| **Total Forest Management** | **13.5** | **9.7** | **6.8** | **11.2** |

*Table B-23. Employment Attributed to Activity on the Forest in the Four County Region.*

| Industry | Current | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|---|
| Agriculture | 20 | 27 | 26 | 26 | 26 |
| Mining | 0 | 0 | 0 | 0 | 0 |
| Construction | 27 | 38 | 35 | 32 | 36 |
| Manufacturing | 61 | 178 | 144 | 102 | 149 |
| Transportation, Communication, & Utilities | 33 | 45 | 43 | 40 | 43 |
| Wholesale trade | 27 | 39 | 37 | 34 | 37 |
| Retail trade | 483 | 584 | 571 | 564 | 578 |
| Finance, Insurance, & Real Estate | 37 | 47 | 44 | 42 | 45 |
| Services | 998 | 1,108 | 1,087 | 1,070 | 1,096 |
| Government (Federal, State, & Local) | 359 | 421 | 397 | 387 | 408 |
| Miscellaneous | 5 | 7 | 7 | 6 | 7 |
| **Total Forest Management** | **2,050** | **2,494** | **2,391** | **2,303** | **2,425** |

*Table B-24. Jobs — Changes from Current.*

| Industry | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|
| Agriculture | 7 | 6 | 6 | 6 |
| Mining | 0 | 0 | 0 | 0 |
| Construction | 11 | 8 | 5 | 9 |
| Manufacturing | 117 | 83 | 41 | 88 |
| Transportation, Communication, & Utilities | 12 | 10 | 7 | 10 |
| Wholesale trade | 12 | 10 | 7 | 10 |
| Retail trade | 101 | 88 | 81 | 95 |
| Finance, Insurance, & Real Estate | 10 | 7 | 5 | 8 |
| Services | 110 | 89 | 72 | 98 |
| Government (Federal, State, & Local) | 62 | 38 | 28 | 49 |
| Miscellaneous | 2 | 2 | 1 | 2 |
| **Total Forest Management** | **444** | **341** | **253** | **375** |

*Table B-25. Income ($) per Job Attributed to Activity on the Forest.*

| Industry | Current | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|---|
| Agriculture | $15,000 | $14,815 | $15,385 | $15,385 | $15,385 |
| Mining | — | — | — | — | — |
| Construction | $37,037 | $36,842 | $37,143 | $37,500 | $36,111 |
| Manufacturing | $36,066 | $36,517 | $36,111 | $37,255 | $36,913 |
| Transportation, Communication, & Utilities | $39,394 | $40,000 | $37,209 | $37,500 | $39,535 |
| Wholesale trade | $44,444 | $46,154 | $45,946 | $47,059 | $45,946 |
| Retail trade | $17,598 | $17,808 | $17,863 | $17,730 | $17,820 |
| Finance, Insurance, & Real Estate | $27,027 | $27,660 | $27,273 | $26,190 | $26,667 |
| Services | $17,936 | $18,592 | $18,399 | $18,224 | $18,522 |
| Government (Federal, State, & Local) | $36,212 | $37,292 | $36,524 | $36,434 | $37,255 |
| Miscellaneous | $20,000 | $14,286 | $14,286 | $16,667 | $14,286 |
| **Total Forest Management** | **$29,071** | **$28,997** | **$28,614** | **$28,994** | **$28,844** |

*Table B-26. Income ($) per Job — Changes from Current.*

| Industry | Alt. 1 | Alt. 2 | Alt. 3 | Alt. 4 |
|---|---|---|---|---|
| Agriculture | $ (185) | $ 385 | $ 385 | $ 385 |
| Mining | $ — | $ — | $ — | $ – |
| Construction | $ (195) | $ 106 | $ 463 | $ (926) |
| Manufacturing | $ 451 | $ 46 | $ 1,189 | $ 847 |
| Transportation, Communication, & Utilities | $ 606 | $(2,185) | $(1,894) | $ 141 |
| Wholesale trade | $ 1,709 | $ 1,502 | $ 2,614 | $ 1,502 |
| Retail trade | $ 210 | $ 265 | $ 132 | $ 222 |
| Finance, Insurance, & Real Estate | $ 633 | $ 246 | $ (837) | $ (360) |
| Services | $ 656 | $ 463 | $ 288 | $ 586 |
| Government (Federal, State, & Local) | $ 1,080 | $ 312 | $ 222 | $ 1,043 |
| Miscellaneous | $(5,714) | $(5,714) | $(3,333) | $(5,714) |
| **Total Forest Management** | **(75)** | **(458)** | **(77)** | **(228)** |

# Economic and Financial Efficiency Analysis

## Introduction

The economic and financial efficiency analysis evaluates the alternatives in terms of their net public benefit. Net public benefit is defined as the "…overall long-term value to the nation of all outputs and positive effects (benefits) less all associated inputs and negative effects (costs) whether they can be quantitatively valued or not. Net public benefits are measured by both quantitative and qualitative criteria rather than a single measure or index." (36 CFR 219.3) The first measurement in net public benefit uses quantitative criteria and is included in the **financial efficiency** analysis. Financial efficiency considers the values of activities and products that have a market cost or value. Essentially, financial efficiency considers things that can be bought or sold. The qualitative criteria are included as part of the **economic efficiency** analysis and considered the public's perceived worth of various activities. In this context, these various activities are generally recreational activities. The final economic analysis combines the qualitative criteria with the quantitative analysis using their **net present value** (NPV) to estimate an alternative's overall net public benefit.

## Method

The economic and financial efficiency analysis uses many of the inputs used in the economic impact analysis for the first two decades. The economic and financial efficiency analysis extends the time horizon on these inputs to a period of 100 years instead of the average annual for the first decade of implementation, which was used in the economic impact analysis. The NPV calculation, using an annual discount rate of 4%, is then calculated over the entire 100 year period to estimate the long-term value.

## NPV Inputs and Assumptions

### *Recreation*

The first two decade of inputs by recreation activity follow the values and assumptions for visitation and RVDs detailed previously in this appendix in the economic impact analysis section. Beyond the first two decades, looking at the longer term projected growth in recreation, growth rates were obtained from Chapter VI of "Outdoor Recreation in American Life: A National Assessment of demand and Supply Trends"" (Cordell, H. K. 1999).

### *Timber*

Revenue from timber sales were obtained from SPECTRUM model outputs gross revenue by decade. Timber program costs were developed assuming the staffing levels would adjust to execute the maximum harvest permitted under the ASQ for each alternative.

### *Other Programs*

Costs for other programs are assumed constant through the alternatives. Any changes in costs for one of these programs are assumed to be offset by another program and would not affect the cumulative results.

## Economic and Financial Efficiency Results

### *Financial Efficiency*

The results of the financial efficiency estimates are shown in Table B-27. Negative NPV results are typically interpreted to not be a worthwhile investment; the important distinction one must realize is that financial efficiency does not consider the value of non monetary activities on the Forest, something which is considered as part of the economic efficiency.

*Table B-27. Financial Efficiency Present Net Value of Plan Alternatives.*

| Alternative | 1st Decade Revenue ($1,000) | 1st Decade Costs ($1,000) | Market Cost and Revenue NPV* ($1,000) |
|---|---|---|---|
| 1 | 50,893 | 126,050 | -180,600 |
| 2 | 41,082 | 115,690 | -177,177 |
| 3 | 30,418 | 115,260 | -198,722 |
| 4 | 43,114 | 122,660 | -187,989 |

*NPV calculated over 100 years at a 4% discount rate

Notwithstanding, the financial efficiency can explain some of the differences in recreation and timber. These two resource areas define the most significant differences in financial efficiency between the alternatives.

In the timber program, Alternative 2 is the least financially inefficient of the alternatives when considered over a 100 year period. This is due to a more efficient mix of treatment strategies that produces a relatively steady flow of net revenue. Alternative 1 contains the second least financially inefficient timber program. Alternative 1 has the highest ASQ and produces the most net revenue in the first eight decades by employing the highest levels of regeneration harvest. These harvests are followed by commercial thinnings (even-aged intermediate treatments), which increases the timber management costs and becomes less efficient in the ninth and tenth decades than Alternative 2. Alternative 3 is the most inefficient timber program of the alternatives. This is primarily due to its higher reliance on uneven aged treatments, which are the most costly to manage. Alternative 4 produces the third highest net revenue in its timber program, primarily due to its higher percentage of uneven age treated acres than Alternatives 1 and 2, but lower percentage than Alternative 3.

The recreation program revenues change by alternative according to the amount of visitation and corresponding revenues collected as part of the fee demonstration program. Fees collected at developed recreation sites, such as developed campgrounds, are managed under a concessionaire agreement, where most special use permit fees collected are reinvested into the facility. The expense associated with constructing OHRV trail system(s) in Alternatives 1 and 4 causes the costs to grow in these alternatives. From a financial efficiency standpoint, the recreation program is the most expensive program on the Forest. The amount of revenue received from the program underscores the need to consider the non quantitative or assigned values that recreation opportunities offer the public on the Forest. These assigned values are considered in the economic efficiency analysis.

### *Economic Efficiency*

In addition to financial efficiency, the economic efficiency considers the assigned values for various recreation activities to the number of RVDs expected for that activity. Assigned values by activity were established using values from a U.S. Forest Service report "Resource Pricing and Valuation Procedures for the Recommended 1990 RPA Program." This report evaluated the "market-clearing price," which approximates the price a good would sell for in a competitive market. This valuation technique was applied to "goods" not normally marketed. The "goods" in this case are recreational visitor days (a twelve hour equivalent stay or visit) by recreational activity of the Forest. These values were adjusted from 1989 values, when the study was completed, to 2002 values using a gross domestic product (GDP) deflator inflation index value of 1.3246 (NASA, 2004). The 1990 RPA Program values are shown in Table B-28.

*Table B-28. Market Clearing Prices for Recreational Activities in USFS Region 9.*

| **WMNF Activity** | **1989** | **2002*** |
|---|---|---|
| Road Accessible Camping and Day Use Activities (e.g. Picnicking, Swimming) | 14.02 | 18.57 |
| Driving for Pleasure and Scenery Viewing | 10.53 | 13.95 |
| Hiking (Non-Wilderness), Horseback Riding and Water Travel (e.g. Canoeing, Kayaking) | 16.27 | 21.55 |
| Winter Sports (e.g. Alpine and Nordic Skiing) | 42.62 | 56.45 |
| Hiking (Wilderness) | 20.94 | 27.74 |
| Hunting | 45.05 | 59.67 |
| Fishing | 76.20 | 100.93 |

*2002 values estimated by applying GDP deflator inflation index (NASA. 2004) to 1989 values.

This has a very significant effect on the economic value of the alternatives. The assigned values (Table B-29), when combined with the high numbers of visitors to the Forest, create a NPV for assigned value that is the order of 14 to 15 times larger than the NPV of the market values. However the range of difference between the NPVs of the alternative's financial efficiency ($21.5 million) is greater than the range of difference in the NPVs of the alternative's assigned values ($10.7 million). Hence, the difference expressed in the financial efficiency has a greater effect on the cumulative economic NPV ranking. The efficiencies that are present in the financial efficiency calculations in Alternative 2 overcome the lower ranking of the alternative's assigned NPV.

*Table B-29. Economic Present Net Value of Plan Alternatives with Rankings.*

| **Assigned Values / Costs / NPV*** | **Alternatives ($1,000)** | | | |
|---|---|---|---|---|
| | **1** | **2** | **3** | **4** |
| Assigned Value NPV | 2,456,634 | 2,462,731 | 2,464,101 | 2,467,385 |
| Assigned Value NPV Ranking | 4 | 3 | 2 | 1 |
| Financial Efficiency NPV | -180,600 | -177,177 | -198,722 | -187,989 |
| Financial Efficiency NPV Ranking | 2 | 1 | 4 | 3 |
| **Economic Net Present Value** | **2,276,034** | **2,285,553** | **2,265,379** | **2,279,396** |
| **Economic NPV Ranking** | **3** | **1** | **4** | **2** |

*Cumulative NPV calculated over 100 years, discounted at 4% annually.

# Literature Cited and Referenced


Agiropolus, M. and P.S. Bartlett. 2003. New Hampshire Employment Projections by Industry and Occupation: Base Year 2000 to Projected Year 2010. United States Department of Labor.

Carbee, H. 2003. "Market Pulse" in *Timber Crier,* New Hampshire Timberland Owners Association, Spring 2003.

Consulate General of Canada. 2003. "New Hampshire." *http://www.canadianembassy.org/statetrade/nh-en.asp* reported March 23, 2004.

Cordell, H. Ken, principal investigator. 1999. Outdoor Recreation in American Life: A National Assessment of Demand and Supply Trends. Champaign, IL: Sagamore Publishing. Ch. 6.

Economic and Labor Market Information Bureau. 2003. "Economic Conditions in New Hampshire." (June, Vol. 103, Number 06): 2.

Economic and Labor Market Information Bureau. 2004. *Vital Signs 2004, Economic and Social Indicators for New Hampshire, 1999-2002*, State of New Hampshire, January.

Griffith, D.M. and Laustsen, K.M. 2001. Second Annual Inventory Report on Maine's Forests, U.S. Department of Agriculture Forest Service: Northeastern Research Station and Department of Conservation: Maine Forest Service. 23 p.

High, C., K. Hathaway, J. Hinckley, B. Risk. 2004. *A Socio-Economic Assessment to Provide a Context for the White Mountain Forest Plan Revision.* White River Junction, VT: Resource Systems Group, Inc.

Ireland, L.C., P. E. Sendak, and R.H. Widmann. 2001. Hardwood Pulpwood Stumpage Price Trends in Northeast. USDA Forest Service: Northeast Research Station. 27 pp.

Leak, W.B. and P. Sendak. 2002. "Changes in Species, Grade, and Structure Over 48 Years in a Managed New England Northern Hardwood Stand." Northern Journal of Applied Forestry, Vol. 19, No. 1.

Leak, W.B., D.S. Solomon, P.S. DeBald. 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. 36 p.

NASA, Cost Estimating Web Site. 2004. http://www.jsc.nasa.gov/bu2/inflateGDP.html

New Hampshire Department of Revenue Administration. 2003. *Average Stumpage Value List Suggested for the Middle Section of N.H. April 1 – September 30, 2003.* http://www.state.nh.us/revenue

Row, C., H.F. Kaiser, and J. Sessions. 1981. "Discount Rate for Long-Term Forest Service Investments." *Journal of Forestry*. 79 (6): 367-69, 376.

Schuler, T., D. Marquis, R. Ernst, B. Simpson. 1993. "Test of Four Stand Growth Simulators for the Northeastern United States." United States Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Research Paper NE-676.

Solomon, D., D. Herman, W. Leak. 1995. "FIBER 3.0: An Ecological Growth Model for Northeastern Forest Types." General Technical Report NE-204, USDA Forest Service Northeastern Forest Experiment Station. 24 p.

Solomon, D. and R. Frank. 1983. "Growth Response of Managed Uneven-aged Northern Conifer Stands." United States Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, Research Paper NE-517.

Staff Reports. 2004. "North Country's Fraser Papers is Spun off by Parent Company." *The Union Leader New Hampshire Sunday News*, March 12.

Thorne, S. and D. Sunquist. 2001. New Hampshire's Vanishing Forests: Conversion, Fragmentation and Parcelization of Forests in the Granite State. Society for the Protection of New Hampshire Forests, Concord, NH. 114 p.