Management Alternatives for New Brunswick's Public Forest

Report of the New Brunswick Task Force on Forest Diversity and Wood Supply

Summary

Submitted to:
The Honourable Donald Arseneault
New Brunswick Minister of Natural Resources

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2008

The Honourable Donald Arseneault,
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Dear Minister Arseneault:

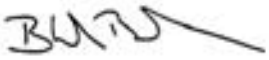
We are pleased to present to you the final report of the Task Force on Forest Diversity and Wood Supply.

Our mandate was to design forest management alternatives aimed at meeting forest diversity and wood supply objectives for New Brunswick's public forest and to characterize the probable outcomes of those alternatives in terms meaningful from environmental, economic, and social perspectives. We have addressed that mandate to the best of our ability and with a level of effort commensurate with the great importance of New Brunswick's forest to the well-being of the Province.

We believe this report reflects a reasonable range of forest management alternatives for the New Brunswick public forest. Interested parties will vary in their views regarding what alternatives are preferable, but this report should assist them in understanding the short- and long-term consequences of each alternative.

Our overarching goal with this report is to provide information that makes an important contribution in the difficult decision about how best to manage New Brunswick's forest. We hope that you and others interested in the state of our forest find that we have succeeded in our effort.

Respectfully submitted,



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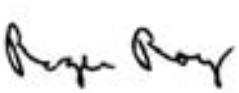

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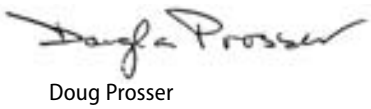

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April 2008

ACKNOWLEDGMENTS

We would like to acknowledge the many individuals who contributed time, ideas, and knowledge to this undertaking. Their interest in our task and willingness to share ideas is greatly appreciated.

All contributors are listed in Appendix 2 of the full report. In particular, we would like to acknowledge and thank:

Raj Chaini of the Canadian Forest Service and Van Lantz of the University of New Brunswick, who developed the procedure for calculating socio-economic indicators; their assistance is greatly appreciated.

Chris Norfolk and Scott Makepeace of the New Brunswick Department of Natural Resources, who developed the stand development forecasts used in the design of forest management alternatives.

We also owe a special thanks to Chris Norfolk for his thorough and accurate recording of minutes at all task force meetings.

Finally, we acknowledge and thank Chris Ward of the University of New Brunswick, who played an instrumental role in conducting analyses, summarizing results, and assembling this report. The task force effort benefitted substantially from his skillful, tireless, and enthusiastic contribution.

The Task Force on Forest Diversity and Wood Supply:

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Important Note to Readers:
This report is derived from the full report of the New Brunswick Task Force on Forest Diversity and Wood Supply. The full report presents methods, results, and explanations in significantly greater detail than provided here and should be consulted by those interested in obtaining a deeper and more complete understanding of the task force study.

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EXECUTIVE SUMMARY

BACKGROUND

Forest management is about influencing forest condition, development, and productivity through actions taken on the ground. Forest management decision-making is about choosing among alternative actions. Therefore, decisions about management of New Brunswick's public (Crown) forest will determine what conditions exist in the forest and what is produced from the forest; and will thereby have profound impact on the environmental, social, and economic well-being of the province now and in the future. Making the "right" decisions about how to manage the forest is of obvious importance, but is particularly challenging for at least four reasons:

- the number of possible forest management alternatives is large;
- the range of forest-derived values is broad, encompassing environmental, social, and economic benefits;
- trade-offs between forest-derived values exist, and managing the forest in a way that enhances some values may negatively affect others; and
- views within society vary regarding the relative importance of the many values the forest provides.

Given these challenges, making sound forest management decisions first requires an understanding of the various alternatives by which the forest can be managed; and, second, an understanding of the probable short- and long-term environmental, social and economic consequences of those alternatives. In recognition of this, the New Brunswick Minister of Natural Resources formed the Task Force on Forest Diversity and Wood Supply. He charged it with the mandate to develop a set of realistic and practical forest management alternatives that would encompass a broad range of ways by which to manage New Brunswick's public forest. Those alternatives were to:

- generate increasing yields of a wider variety of commercial tree species and products to provide a diverse raw material base enabling wood-based forest industries to capitalize on current and future market opportunities;
- maintain the diversity and important ecological features of New Brunswick's Acadian Forest so that timber management practices do not simplify the forest through excessive reductions in species diversity and the abundance of old and biologically complex forest conditions characteristic of the natural Acadian Forest; and
- be characterized in terms of their probable environmental, social, and economic consequences to allow a reasonably full evaluation of their relative performance.

The task force was not asked to make recommendations about how to manage the forest, but rather to inform the decision-making process by identifying and characterizing workable forest management alternatives.

MANAGEMENT ALTERNATIVES

In accordance with that mandate, the task force defined a set of eight forest management alternatives, each defined in terms of options regarding seven cornerstone forest management issues. These cornerstone issues and their associated options are:

- wood supply priorities in terms of species and products, with options including production priority placed on spruce/fir versus non-spruce/fir tree species;
- area designated as permanently protected from timber harvesting, with options ranging from four per cent to 22 per cent of the total Crown forest area ;
- area managed primarily for conservation objectives, with options ranging from 20 per cent to 37 per cent of the total Crown forest area;
- area in old forest condition, with options ranging from 25 per cent to 40 per cent of the total Crown forest area;

- area in plantations, with options ranging from zero per cent to 37 per cent of the total Crown forest area (by the year 2062);
- proportion of harvesting conducted by non-clearcut prescriptions, with options ranging from 20 per cent to 60 per cent of the area harvested in existing mature forest; and
- area of stand types (defined by tree species composition) which have declined in abundance over the last half century, with options ranging from maintaining areas of those types at current levels to increasing them above current levels.

The range of options across all seven cornerstone issues combine to create many distinct management alternatives, from which the task force chose eight for detailed analysis. These eight varied in terms of their relative emphasis on provision of wood supply and maintenance of forest diversity. In all eight alternatives silviculture expenditures were capped at the current annual budget amount of $24.5 million.

Modern forest development models were used to forecast forest development under each of the eight alternatives. Short- and long-term consequences were assessed for each alternative using a set of 19 measures encompassing a range of environmental, social, and economic values. These measures were identified as being important by knowledgeable parties in each of the three domains.

MANAGEMENT OUTCOMES

The levels attained for these 19 measures varied greatly among the eight examined alternatives; and the alternatives rank very differently depending upon the output measure in question (Table ES-1). Those management alternatives producing high values for one measure often produce low ones for another. On the one hand, this reveals a great range of possibilities in what can be attained in terms of wood supply and forest diversity. On the other hand, it reveals inescapable trade-offs between outcomes that must be made when deciding which is the preferred alternative. That decision will depend largely upon which trade-offs are deemed acceptable.

Wood Supply

Under all alternatives except the status quo, total and log-potential wood supply is constant or increasing through time for all major species groups, including spruce/fir, white pine, cedar, tolerant hardwood (sugar maple and yellow birch), intolerant hardwood (white birch and red maple), and poplar. However, the absolute supply levels vary considerably between alternatives, ranging from low to high by a factor of almost two (Table ES-1). Differences between management alternatives result in wood supply outcomes that differ in the short-term, in the long-term, and in species composition.

The short-term (the next 25 years) wood supply of all species decreases with increased area in protected areas, conservation forest, and old forest. Since these factors vary considerably across alternatives, so, too, does wood supply.

In the long-term, spruce/fir and white pine wood supplies increase with area planted. Under alternatives with the highest area in plantations, spruce/fir supply more than doubles over the next 50 years. Cedar and tolerant hardwood supplies increase with the amount of area treated by non-clearcut harvest prescriptions, as such prescriptions create conditions which favour regeneration of these species. Conversely, intolerant hardwood supplies increase with clearcutting.

Wood Cost

Wood cost is largely affected by the harvest prescriptions used. Because clearcutting is the least expensive harvest prescription, costs are generally lowest under alternatives which use it the most. Across the alternatives, the highest wood cost exceeds the lowest by six per cent.

Forest Condition

Forest condition in terms of old forest abundance, species composition, and area of stands receiving different types of management is heavily influenced by choices made regarding all seven cornerstone issues. As a consequence, the alternatives collectively generate a wide range of resulting forest conditions. The abundance of conditions, at year 2062 and expressed as a per cent of total forest area, varies across alternatives as follows:

- plantation area varies from five per cent to 37 per cent;
- unmanipulated forest area (defined as unharvested stands greater than 70 years old) varies from 15 per cent to 29 per cent;
- uneven-aged forest area (created by non-clearcut harvesting) varies from seven per cent to 19 per cent;
- spacing area (young, naturally regenerating stands which have been thinned) varies from eight per cent to 29 per cent; and
- area of old forest varies from 31 per cent to 51 per cent.

Harvest Treatments

Use of clearcutting varies two-fold across alternatives; the area clearcut as a per cent of total area harvested during the next 25 years varies from 45 per cent to 81 per cent. Area harvested by prescriptions that maintain stand conditions similar in key respects to those created by natural disturbances varies from 23 per cent to 100 per cent of total area harvested over the next 25 years. Harvesting in a way that creates such conditions is seen by many forest ecologists as a way to maintain forest diversity.

Socio-Economics

Value of shipments, timber royalties paid to government, contribution to gross domestic product, and employment levels (in primary industries of logging, sawmilling, and pulp production) relate closely to absolute harvest levels. Thus, assuming full utilization of available wood supply, the economic output and employment under the alternatives producing the highest wood supply are roughly twice those under alternatives which produce the lowest wood supply.

IMPORTANT CONSIDERATIONS

In addition to the management alternatives and consequences discussed in this report, readers should bear in mind a number of additional matters when examining the task force findings.

- Although eight management alternatives were examined in detail, various other alternatives can be explored using the modeling framework that was developed. Such analysis can also be conducted to evaluate the impacts of alternate management decisions and assumptions about forest development. Sensitivity analysis of this sort are presented in the full task force report and include varying silvicultural investment (increasing it to $30 million/year), product specifications, forest growth rates, and stand response following harvest.

- Potential losses from wildfire, insect outbreaks, or windstorm were not accounted for. New Brunswick's management has and will continue to deal with these agents adaptively by forest protection, salvage, and adjusting plans as necessary.

- Impacts of climate change on forest development are exceedingly complex and uncertain. Thus, climate change was only addressed indirectly in the management alternatives by controlling the tree species composition of the forest. By evaluating forest composition resulting under each alternative, the ability of the forest to adapt to climate change can be partially assessed.

- Given the task force mandate, economics were considered only in relation to primary wood products manufacturing. Secondary value-added manufacturing, such as paper production, was not included in the analysis, as the nature of such manufacturing is a matter of industrial strategy. Such manufacturing opportunities, and the many other forest-derived economic benefits, should be considered when evaluating alternatives, including those provided by eco-tourism, consumptive and non-consumptive recreation, and non-timber forest products.

- A number of important forest management impacts could not be easily quantified and thus are not explicitly accounted for in the report. These include forest values that are assessed by personal, subjective interpretation, such as aesthetics, and some ecological services provided by the forest. Partial inferences about management impacts on these important values can be made from the quantitative measures which are reported.

- There exist many unavoidable uncertainties and unknowns relating to future economic conditions, environmental conditions, forest products markets, and social values and preferences. While the effects of uncertainty can be explored through sensitivity analysis, no amount of research or analysis can render the future certain. Adaptability is thus important, and the flexibility afforded by the forest condition to adapt as the future unfolds should be thoroughly considered when evaluating alternatives.

New Brunswickers treasure their public forest for many reasons, but not all values can be simultaneously maximized. Trade-offs cannot be avoided, but they can be understood, explicitly recognized, and consciously factored into management decisions. The decision-making challenge is to thoroughly evaluate possibilities and implement a management strategy that best provides the balance of values sought through time. The task force hopes that its efforts help the province in that important and formidable task.

Table ES-1 - Summary of selected outcomes under eight forest management alternatives for New Brunswick Crown forest

Indicator and Units		Alternative [1]							
		SQ	A	B	C	D	E	F	G
WOOD SUPPLY	**Spruce/fir Log-Potential** [2] (million m^3/yr)	2.7 4.2	*1.7* *2.2*	*1.7* 2.3	2.3 3.5	2.5 5.1	**2.8** **5.3**	2.6 4.4	2.5 4.8
	Spruce/fir Total [2] (million m^3/yr)	4.0 6.1	*2.5* *3.1*	2.7 3.4	3.6 5.1	3.8 7.0	**4.2** **7.3**	3.9 6.1	3.7 6.8
	Other Softwood Log-Potential [2] (thousand m^3/yr)								
	Cedar	**89** *39*	43 49	*35* *39*	62 69	60 66	72 76	75 **83**	62 68
	White Pine	**133** 128	67 136	*51* *112*	95 141	118 189	130 200	131 **212**	113 173
	Other Softwood Total [2] (thousand m^3/yr)								
	Cedar	**146** 58	70 70	*55* *55*	99 99	96 96	113 113	119 **119**	98 98
	White Pine	**229** 349	125 300	*101* *266*	174 372	196 469	212 478	207 **546**	187 455
	Hardwood Log-Potential [2] (thousand m^3/yr)								
	Sugar Maple and Yellow Birch	210 239	*129* *217*	171 **320**	183 261	202 270	**246** 278	212 270	202 233
	White Birch and Red Maple	**234** *110*	*113* 127	128 170	158 158	158 158	179 **179**	171 171	159 159
	Poplar	**194** *75*	90 90	*86* 107	111 111	113 113	132 **132**	117 117	105 105
	Hardwood Total [2] (thousand m^3/yr)								
	Sugar Maple and Yellow Birch	417 **662**	*259* *490*	326 661	348 526	373 535	**451** 542	392 570	377 496
	White Birch and Red Maple	**848** 603	*453* *499*	503 585	615 627	608 608	677 **677**	650 669	608 616
	Poplar	**386** 384	198 *218*	*193* 237	240 303	242 270	279 306	245 317	229 282
Wood Cost ($/$m^3$ years 1-25 in constant dollars)		*43.3*	44.5	44.9	44.6	45.1	43.7	**45.7**	44.8
Land Allocation (% of total forest) [4]									
General forest		68	*62*	68	75	75	79	**82**	72
Protected natural area (PNA)		*4*	**22**	10	13	13	10	10	16
Conservation forest outside PNA		**28**	16	22	12	12	11	*8*	12
Forest Condition (% of total forest area in 2062)									
Even-aged Planted [5]		22	*5*	13	19	**37**	**37**	23	23
Spaced		21	**29**	25	23	9	*8*	22	22
No silviculture treatment		**27**	25	*20*	21	23	**27**	21	22
Uneven-aged (created by harvest)		*7*	12	16	16	10	9	**19**	10
Unmanipulated		23	**29**	26	21	21	19	*15*	23
Old Forest (% of total forest area in 2062)		34	49	**51**	34	33	*31*	37	34
Forest Composition (% of total forest area in 2092)									
Fir and Spruce/fir		**54**	53	*41*	47	49	52	51	52
Tolerant (pure and mixed)		*21*	26	**37**	30	25	23	26	24
Pine (combined)		*4*	*4*	**6**	5	**6**	**6**	*4*	*4*
Intolerant Mixedwood		**21**	17	*16*	18	20	19	19	20
Area clearcut (% of total area harvested over years 1-25)		**81**	49	52	50	66	72	*45*	63
Natural Disturbance-based Harvest (% of total area harvested over years 1-25)		*23*	**100**	58	63	40	34	**100**	73
Employment [6] (jobs/yr)		**7600**	*3900*	4000	6000	6500	7200	6700	6300
Net Value of Shipments [6] (billion $/yr)		**1.44**	*0.72*	*0.72*	1.07	1.14	1.30	1.19	1.11
Contribution to GDP [6] (billion $/yr)		**0.80**	*0.40*	*0.40*	0.59	0.64	0.72	0.66	0.62
Royalties [6] (million $/yr)		**61**	31	*30*	48	54	60	55	51

1 **Highest values for each indicator are in bold**; *lowest values are underlined and italicized.*

2 Leftmost value in cell is average for years one-25; right value is average for years 26-100. Higher precision in values is used for calculating percentages stated in text.

3 Stand types are described in more detail in main text.

4 Land allocation to conservation forest varies slightly from the options defined for some alternatives because of inoperable forest and non-spatial inventory compilation.

5 Plantation area changes through time in accordance with limits for each alternative; limits are not met until after year 50 for some alternatives.

6 Average for years one-10 (constant $).

BACKGROUND

The forest is critically important to New Brunswick's social, economic, and environmental well-being. It provides a source of employment and wealth-creation; it provides a setting for recreational and spiritual fulfilment; it performs a myriad of ecological services and functions; and it harbours thousands of plant and animal species.

Given this importance of the forest to the province, most people would agree that the overarching management goal should be to create a forest that will be economically valuable, ecologically healthy, and socially desirable in the future, while deriving economic, environmental and social benefit today. Fewer people would agree about how best to do this.

Forest values are the reasons people deem the forest important; they are why people consider the forest to be an invaluable part of the New Brunswick economy and way of life. They are many and varied. They are interconnected, and managing in a way that enhances some values may negatively affect others. Tradeoffs between values inevitably result; thus, the desirability of any one management scheme depends upon the relative importance one places on the various values the forest provides. And so, because individuals and interested parties weight forest values differently and favour different mixes of values, there exist different views about how best to manage the forest.

This poses an especially difficult decision-making challenge regarding the public (Crown) forest where management must be designed with consideration of the diversity of views held by the forest owners - the citizens of New Brunswick. More specifically, the decision-making challenge is to select from amongst workable alternatives the management strategy that best balances the provision of values derived from the forest, now and in the future. Making a sound choice in this respect first requires a full awareness of what those alternative management strategies are, and second, an understanding of their probable short- and long-term consequences in economic, environmental, and social terms.

With the objective of having precisely this information on hand in support of decision-making for management of the public forest, the Minister of Natural Resources struck the Task Force on Forest Diversity and Wood Supply (Appendix 1). He gave it the mandate to develop a set of realistic and practical forest management alternatives that would encompass a broad range of possible ways of managing New Brunswick's public forest. These alternatives were to:

- generate increasing yields of a wider variety of commercial tree species and products; and
- do so in a manner that recognizes and maintains the diversity and important ecological features of New Brunswick's Acadian Forest.

The task force members were not asked to make recommendations or judgments, but rather to present what can realistically be done in the public forest and with what probable result. The effort is intended to promote a fuller awareness of alternatives and consequences, and thereby contribute to the process by which management of New Brunswick's public forest is determined.

The task force completed its work during the past two years and recently presented its detailed findings in the document entitled *Management Alternatives for New Brunswick's Public Forest*. That report should be consulted by parties interested in specifics of the analyses, including full details of all alternatives, methods, underpinning information, and the complete set of quantitative outcomes of the forest management alternatives. For those with a more general interest in forest management alternatives, this abbreviated report of the task force work has been prepared. It provides a general overview of the issues at stake, a review of the management alternatives explored, and a summary of key findings.

CONTEXT

Central to the task force mandate are the dual goals of increasing and diversifying wood supply and maintaining important ecological features of the New Brunswick Acadian Forest. Before dealing with management alternatives that address these goals, it is worth briefly discussing why they are at issue.

ACADIAN FOREST

The Acadian Forest is the name given to the forest region which encompasses northern Maine and most of the Maritime provinces (Figure 1).

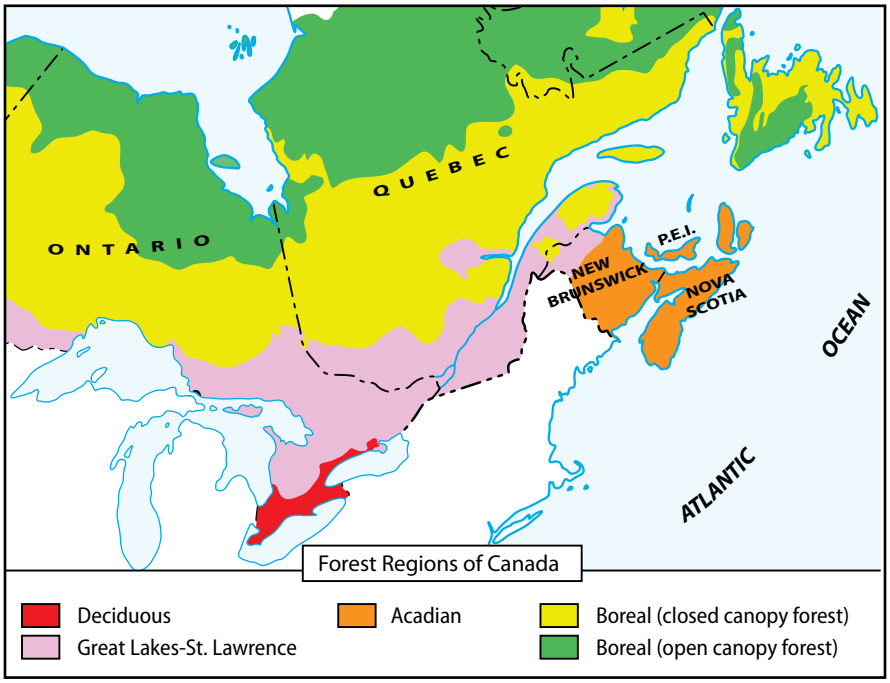

Figure 1 - *Location of Acadian forest region (derived from Forest Regions of Canada, J. Rowe, 1972, Canadian Forestry Service Pub. 1300).*

The Acadian Forest has a unique set of climatic influences, geophysical variation, and natural disturbance forces which, in combination, give rise to the high degree of biological diversity that characterizes the forest (Figures 2 and 3). This diversity exists at several levels.

Figure 2 - *Burned forest area in which most trees are killed creating open conditions for a new generation of trees to develop. "Stand-replacing" natural disturbances of this type generally result in simpler stand structures with one canopy layer and trees of similar age.*

Figure 3 - *Area in which a single tree is killed creating a gap in which shade tolerant species will develop. "Gap-replacing" natural disturbances of this type generally result in complex stands structures with multiple canopy layers and trees of many ages.*

The Acadian Forest is highly diverse in tree species composition, containing some 20 commercial tree species present in varying levels of abundance. It is highly diverse in the degree of species intermixing which results in stand conditions ranging from pure tolerant hardwoods, to mixes of hardwood and softwood species in various combinations, to stands of near-pure balsam fir, black spruce, or jack pine.

It is also diverse in terms of within-stand structure, with some stands being highly uniform in tree size and age, and others being highly complex, containing trees of a wide variety of sizes and ages (Figures 4 and 5).

Figure 4 - *A fire-origin jack pine stand showing uniform structure and simple species composition that commonly results from stand-replacing disturbances.*

Figure 5 - *A mixedwood stand showing complex structure, multiple age classes, and a broad range of tree sizes that commonly result from gap-replacing disturbances.*

Natural forces and human influence have changed the Acadian Forest significantly over time, and there is concern that aggressive management for timber production may result in simplification of the forest in the future. That simplification could include reduced abundance of certain species, fewer large and old trees, and less area of stands with complex, multi-aged structures.

Managing the forest in a way which avoids excessive simplification is seen as not only necessary to maintain a healthy, diverse forest, but also as important to support a healthy, diverse forest economy.

WOOD SUPPLY

Much uncertainty exists regarding forest products markets, world competition, economic conditions, and social values that will prevail in the future. It is thus difficult to specify the exact nature of forestry enterprises best adapted to that future and to specify the exact nature of wood supply they will require.

In light of this, providing a diverse wood supply may afford the flexibility necessary for forest industry to respond, adapt, and prosper as that uncertain future unfolds. Such diversity can provide a hedge against uncertainty in the forestry sector, much as portfolio diversity provides a hedge against uncertainty in the investment world.

In specific terms, this means managing the forest to produce a sustainable, or increasing wood supply, comprising a wide array of species that is predominantly of a quality suited for manufacturing high value products. This may offer the greatest potential for New Brunswick's forest economy to capitalize on the many and varied opportunities that will emerge and the greatest latitude to use the forest in ways that best benefit the province.

Designing forest management alternatives that address these dual goals - maintaining important ecological characteristics of the forest, while generating a diverse and high quality future wood supply - was the challenge posed to the Task Force on Forest Diversity and Wood Supply.

Figure 6 - *Forest ownership in New Brunswick.*

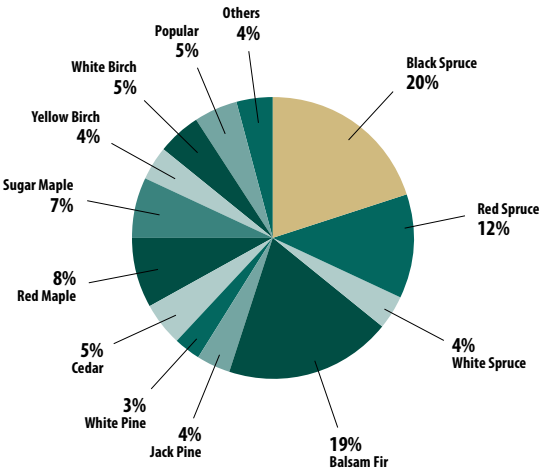

Figure 7 - *Current tree species composition (by volume) of New Brunswick Crown forest.*

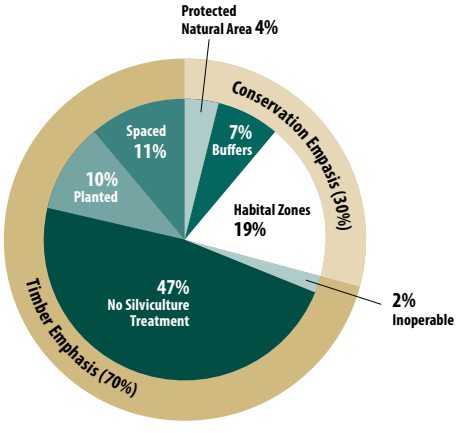

Figure 9 - *Area distribution (%) of Crown forest by management zone.*

NEW BRUNSWICK'S CROWN FOREST

The provincial Crown forest covers three million hectares, roughly half of the total forest area in the province. Private woodlots, industrial freehold, and federal land make up the balance, at 30 per cent, 20 per cent, two per cent of the total forest area, respectively (Figure 6).

Diversity in the Crown forest is partly evidenced by the array of tree species present (Figure 7). The composition of the current forest (measured by tree volume) is 68 per cent softwood (evergreen) and 32 per cent hardwood (deciduous) species.

Spruces and fir together make up more than half of the timber volume (55 per cent). Red and sugar maple are the next largest species group (15 per cent), followed by the birches (nine per cent). Lesser, but significant volumes exist of white and jack pine, cedar, and poplar. Numerous other species are less abundant, but important elements in the forest, including, beech, hemlock, oak, and ash.

The age structure of the forest reflects the pattern of past human and natural disturbances. Some 25 per cent of the forest is less than 20 years old as a result of recent harvesting, while roughly 45 per cent is greater than 60 years old (Figure 8). The harvest must be carefully regulated in this older forest to ensure a continual wood supply until the younger forest matures into a harvestable state.

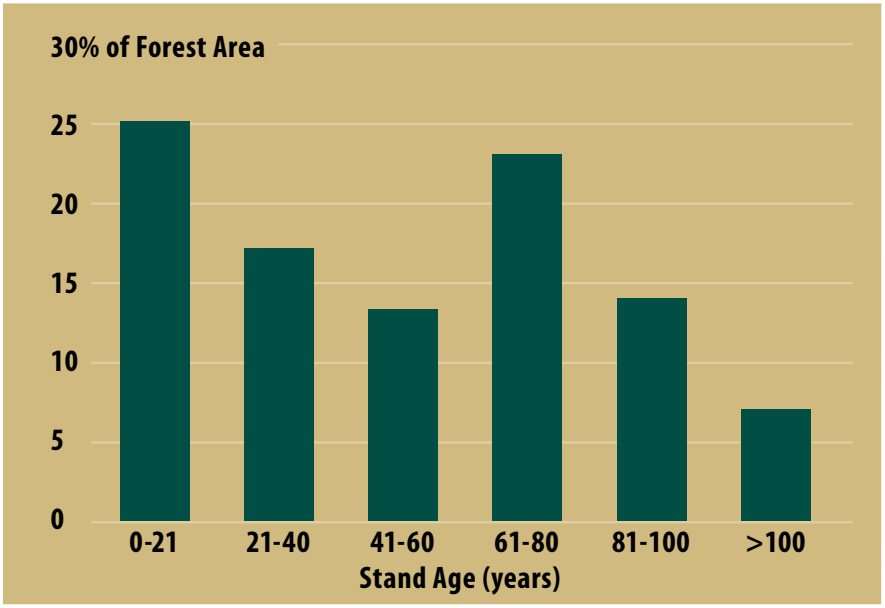

Figure 8 - *New Brunswick Crown forest age class structure.*

To provide a mix of economic, environmental, and social values, government policy divides the Crown forest into two zones (Figure 9). Thirty per cent of the forest area is designated as conservation forest. Here conservation objectives prevail and limited harvesting can occur, provided it does not compromise conservation goals. Within this is four per cent of the forest which is designated as "protected natural areas." In protected areas no timber harvesting occurs and natural forces of change prevail.

Also within the conservation forest are riparian buffers and special habitat areas. These are established to achieve various objectives, including protection of water quality and maintenance of habitat conditions required by an array of plant and animal species.

In the remaining 70 per cent of the forest (termed general forest) timber objectives are emphasized and the forest is managed accordingly, while ensuring soil protection and renewal of tree cover following harvest.

Planting and spacing (in which stand growth and composition is improved by selectively removing sapling trees to control species and density of naturally regenerating stands) has been conducted in the Crown forest since the 1970s as a means to control species composition and accelerate the growth of young stands. This makes stands available for harvest sooner and at higher volumes than would result without treatment, and thereby increases the available wood supply. At present, 10 per cent of the forest area is in plantations and 11 per cent is in spacings.

Overall, today's New Brunswick Crown forest is a result of the combined impact of nature and humans. It is a mixed product of the natural processes which have shaped the natural Acadian Forest over time, and the many and varied human interventions conducted over several decades as means to both use the forest and to influence its future development.

MANAGEMENT ALTERNATIVES FRAMEWORK

Forest management decision-making is subject to five realities.

First, numerous management alternatives exist. Even within the bounds of the task force mandate many alternatives exist. These may be differentiated by the relative importance placed on wood supply and forest diversity values, the specific objectives sought for those values, and the means by which those objectives are achieved. There is no single "correct" strategy for realizing wood supply and diversity goals, and decision-making boils down to choosing from amongst many alternatives.

Second, the outcomes under any contemplated alternative are multi-faceted; single measures do not tell the whole story. Responsible decision-making requires consideration of a comprehensive and revealing set of measures that addresses a variety of social, economic, and environmental values.

Third, tradeoffs between values will inevitably exist and alternatives will be distinguished by the nature and degree of those tradeoffs. In contemplating what tradeoffs are acceptable, it is important to know "how much" of one benefit is lost to gain "how much" of another. Defining the "how much" necessary for evaluating tradeoffs requires quantifying outcomes in measurable units.

Fourth, notwithstanding the need for quantitative outcomes in decision-making, some forest values are gauged through subjective, personal interpretation and do not lend themselves to direct and objective measure. Aesthetic, wilderness, and spiritual values, and perception of risk are examples. That they are subjectively assessed does not render them unimportant, and such values should not be excluded from consideration in decision-making simply because they are difficult to measure.

Fifth, most of the important outcomes under any management alternative will occur in the future. Accounting for future outcomes can only be done by forecasting, a process which has an inherent and unavoidable element of uncertainty. Thus, choices must be made on the basis of likely or probable outcomes, not on the basis of outcomes that can be known with certainty.

The task force effort dealt with these realities in an analytical process by which:

- alternative management strategies were designed;
- a set of measures to express consequences of those alternatives was defined; and
- quantitative forecasts of those likely consequences were made and presented to reveal tradeoffs.

Included were forest condition measures intended, in part, to allow subjective personal interpretation of outcomes for non-objective values.

DESIGNING MANAGEMENT ALTERNATIVES

Seven forest management issues stand out as focal points of concern and pose some of the most contentious forest management questions in New Brunswick. Disagreements about forest management in the province are frequently disagreements about decisions regarding one or more of these issues. Further, important on the ground impacts of management are driven by choices made regarding one or more of these issues. Further still, each of these issues has direct bearing on wood supply and forest diversity, the dual objectives in the task force mandate. Given their fundamental importance in these various respects, the seven cornerstone issues have been used as the common terms by which to design management alternatives examined by the task force.

Cornerstone Issues

- **Wood Supply**
- **Protected Area**
- **Conservation Forest**
- **Old Forest**
- **Plantations**
- **Harvest Treatments**
- **Forest Composition**

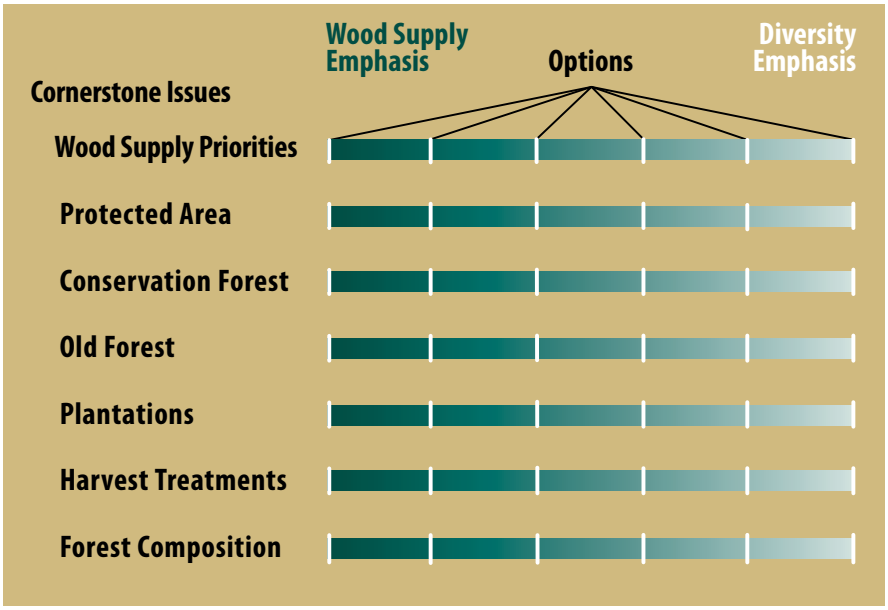

Figure 10 - *Conceptual framework for defining management alternatives. A range of options is defined for each of seven cornerstone issues. A management alternative is specified by choosing options across all cornerstone issues.*

A choice must be made for each of these cornerstone issues from a set of possible options. The options for each issue can span a range from emphasizing forest diversity and ecological values to emphasizing wood supply (Figure 10).

Given a specified set of options for each of the seven issues, forest management alternatives can be designed by defining a collective set of options across all issues. The overall emphasis on wood supply or forest diversity of a particular strategy will depend upon the specific options chosen for each issue.

Given this framework, it is important to then ask: *"what questions must be answered about each issue?"* and *"what are the possible answers or options from which to choose for each issue?"*

The task force identified several options for each issue, taking care to span a reasonable range of possibilities in each case (Table 1). Complete details of the options and the rationale for them are presented in the full task force report, and they are briefly discussed below.

Wood Supply
What volume of wood can and should be harvested, in what quality and species mix, and at what cost?

All wood supply options, except the status quo employed in current management, maximized wood supply of log-potential trees (those dimensionally suitable as sawlogs) and sustained or increased supply over time of all species groups. Options for species priority in managing wood supply included spruce/fir/jack pine (henceforth referred to as spruce/fir) as top priority, non-spruce/fir species as top priority, and equal priority across all species.

Protected Area
How much area, and in what location and configuration, should be given protected area status?

The forest in protected areas cannot be harvested and develops through time only as influenced by natural dynamics. Protected forest has important ecological, scientific, and social value, but is unavailable as a source of wood. Options for the per cent of total Crown forest area designated as protected ranged from the current level of four per cent to 22 per cent, the latter being deemed by some conservation agencies as the amount needed to provide full ecological representation on Crown forest in the province.

Conservation Forest
How much area should be designated as conservation forest?

Conservation forest, which includes protected area, has numerous primary objectives, including provision of habitat to support wildlife populations, maintenance of water quality, protection of riparian and wetland habitats, and representation of natural conditions. Except in protected area, some timber harvesting is permitted, but only on a restricted and limited basis that does not compromise the over-riding conservation objectives. Options for conservation forest area included maintaining it at the current level of 30 per cent of the forest, increasing it to 37 per cent, and decreasing it to 25 per cent and 20 per cent. The latter value was proposed by the Task Force on Self-sufficiency[1].

Old Forest
How much forest area should be maintained across the landscape in stands in old age condition?

The unique physical conditions and ecological functions of old forest make it ecologically important and socially significant. Management strategies emphasizing wood supply frequently target old stands for harvest because of their high timber value, and can preclude growth of stands into old forest condition. Options for the forest area in old forest conditions ranged from 25 per cent to 40 per cent.

Plantations
How much area should be established in plantations which are managed intensively to maximize timber yield?

Plantations are highly productive sources of wood supply, but their establishment involves practises and creates conditions deemed by some as ecologically damaging or otherwise undesirable. Plantation area options ranged from reducing plantation area to zero, to increasing it to 37 per cent of the total forest over the next 50 years. The latter value was set in recognition of recommendations of the Task Force on Self-sufficiency[1].

Harvest Treatments

To what extent and in what stand conditions should clearcut harvesting be implemented versus some form of partial harvesting?

The treatments, or prescriptions, by which stands are harvested shapes forest condition, controls species composition and stand structure, and affects wood supply quantity, quality, and cost. Views vary widely about the acceptability of different harvest treatments. Treatment options were defined by the nature of stand types in which harvesting must be by non-clearcut prescriptions, and by the amount of area left permanently unharvested (termed retention) within harvested stands to provide structural diversity. Although treatment options were defined based on stand composition, they can be roughly expressed in terms of the per cent of harvesting in existing mature forest that is to be conducted using non-clearcut prescriptions. The options range from approximately 20 per cent to 60 per cent of the area harvested of existing mature forest.

Forest composition

How much area should be maintained across the landscape in stand types of various species compositions?

Stand types, defined by the mixture of tree species growing in association, are the building blocks of forest landscapes and their relative abundance influences both forest and wood supply diversity. Forest composition options were defined in terms of area of stand types deemed less abundant today than at the onset of industrial forestry practice (approximately 1940). Options ranged from preventing future decline of these types to increasing them to equal and to exceed past levels of abundance.

Table 1 - *Options defined for the seven cornerstone forest management issues. (Details are provided in the full task force report).*

Issue	Option Description	Option Settings [a]				
Wood Supply	species groups given priority for increased future wood supply	spruce/fir	equal priority to all	non-spruce/fir		
Protected Area	% area of forest assigned to protected area status	4	10	13	16	22
Conservation Forest	% area of forest managed primarily for conservation values	20	25	30	37	
Old Forest	minimum % area of forest maintained in old condition	25 *sq* [c]	25	40		
Plantations	maximum % area of forest in plantations	0 [b]	13	19	25	37
Harvest Treatments [d]	% of harvested area in existing mature forest to be by non-clearcut prescriptions	20	30	50	60	
Forest Composition	long-term goal for area of stand types less abundant today than in 1940	maintain vegetation communities [c]	maintain at current levels	restore to 1940 levels	increase above 1940 levels	

a Settings employed in current Crown land management are **highlighted in darker beige.** Status quo management is fully described in the reports *Our Shared Future*[2] and *Objectives and Standards for the New Brunswick Crown Forest for the 2007-2012 Period*[3].

b No new plantations are created; area falls gradually to zero as existing plantations are harvested.

c Objectives for old forest and forest composition under the status quo management cannot be expressed in terms fully compatible with those devised by the Task Force for defining other management alternatives. Under the status quo, forest composition objectives are set to maintain the abundance of eight mature vegetation communities at 12 per cent of their abundance as estimated in the 1982 provincial inventory. The abundance of old forest thus results indirectly from objectives set to maintain habitats and mature vegetation communities and remains at or above 25 per cent. However, unlike the other old forest options, this level is not directly controlled under the status quo; thus, it is differentiated by the subscript (25sq).

d Harvest treatment options were defined for stands based on their content of tree species silviculturally suited to non-clearcut prescriptions. Tree species content thresholds varied across options and resulted in the percentages shown in the table. See full report for details.

INDICATORS OF MANAGEMENT OUTCOMES

Evaluating the desirability of forest management alternatives involves consideration of the expected outcomes of alternatives in terms relating to social, economic, and environmental values. The task force sought input from parties knowledgeable in wood products, environmental, and socio-economic aspects of forestry to help define measures by which to define those outcomes (Table 2).

While the 19 quantitative indicators listed in Table 2 relate to a broad set of values, they do not account for all important considerations. Due to time and resource constraints, it was not possible to undertake the research required to create reliable measures of the socio-economic value of ecosystem services and non-timber forest products. Nonetheless, such benefits warrant consideration in deciding how to manage the forest.

Further, numerous subjectively assessed aspects of management outcomes are not accounted for here. These include aspects such as spirituality, aesthetics, and risk perception, all of which require subjective interpretation that can vary markedly between individuals. The intent is that the measurable outcomes reported here will help informed readers make the personal interpretations of such matters as they deem necessary to evaluate the desirability of the presented alternatives.

Table 2 - *Indicators of management outcomes.*

Wood-based Business Opportunity	Biological Diversity and Environment
wood supply by species and product delivered wood cost potential wood loss from spruce budworm	forest area by age class area of mature and "old growth" forest abundance of snags (dead standing trees) area of wildlife habitat types area harvested in accordance with natural disturbance area of clearcut harvesting area regenerated to non-native species area of forest by management history area by stand type size and location of protected areas quantity of carbon stored in the forest buffer width in riparian areas
Socio-economic	
levels and type of employment opportunity royalty revenue value of shipments contribution to gross domestic product	

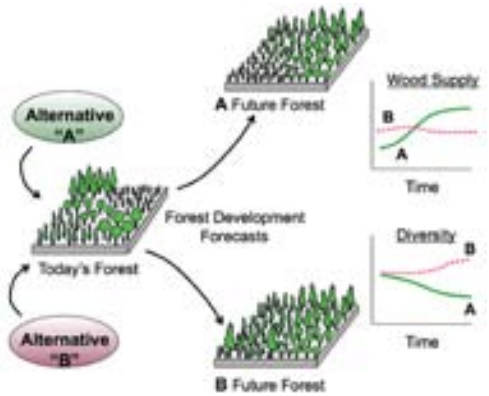

Figure 11 - *Conceptual process for forecasting outcomes of forest management alternatives.*

FORECASTING FOREST CONDITION

Forecasting forest development is necessary to reveal likely future outcomes of management alternatives. This was performed using a well-established process which employs detailed computer models in combination with quantitative descriptions of the forest and forest dynamics.

The process begins with a description of today's forest condition and a management alternative of interest, which is defined in terms of objectives sought for the forest and possible actions to be taken. A computer model is then used to simulate implementation of that management alternative in the forest and to forecast forest conditions that result. Important outcomes of interest (such as the indicators in Table 2) are then calculated based on the forecast forest conditions (Figure 11).

A different management alternative can be formulated, and the process repeated, to provide a comparison of outcomes expressed in common measure for the set of alternatives considered. The preferred alternative can be chosen with knowledge of its outcomes relative to the others whose outcomes are forecast in the same terms.

Such forecasts are of an inherently uncertain future and those employed to guide forest management might best be viewed in the same fashion one views financial forecasts employed to guide personal retirement planning. Informed users of such forecasts do not take them as flawless predictions of the future, and do not ignore that they are based on inherently uncertain assumptions; but rather glean from them important insight about relative outcomes likely to result from alternate strategies and thereby obtain guidance regarding preferred choice of action.

MANAGEMENT ALTERNATIVES

The seven cornerstone issues and their associated options combine to generate thousands of unique possible management alternatives for the Crown forest. From the large set of possibilities, the task force selected eight, including the status quo (SQ), for detailed analysis (Table 3). These eight represent a broad range of alternatives in terms of wood supply and forest diversity emphasis. Brief descriptions of each are summarized below.

STATUS QUO

This alternative reflects forest management on Crown land as conducted under current government policy and includes both diversity and wood supply objectives (Figure 12). These objectives have evolved over time and are fully described in the government's documents *Our Shared Future*[2] and *Objectives and Standards for the New Brunswick Crown Forest for the 2007-2012 Period*[3]. Its key elements include:

- maximizing the sustainable supply of spruce/fir and of hardwood (there are no wood supply objectives for white pine, cedar, or individual hardwood species or species groups);
- allocating four per cent of Crown forest area to a network of protected areas where no timber harvesting occurs;
- managing 30 per cent of the forest area primarily for conservation objectives including protection of specific wildlife habitats, riparian areas, and water quality; and
- using non-clearcut harvesting in stands where 50 per cent or more of the volume is individually composed of either tolerant hardwood, cedar, white pine, red spruce, or red pine (which equals approximately 20 per cent of the area harvested in existing mature forest).

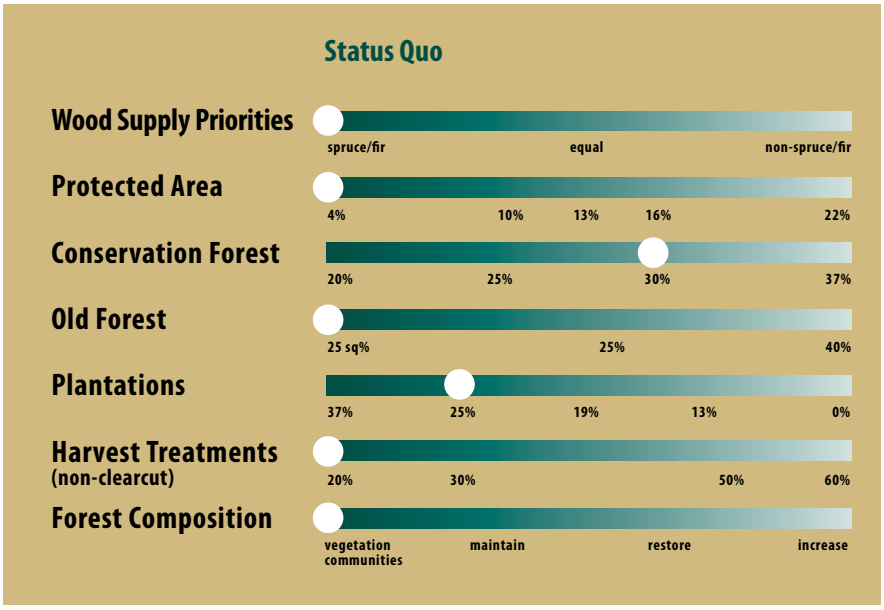

Figure 12 - *Options employed in the Status Quo management alternative.*

ALTERNATIVE A

This alternative has conservation as the over-riding objective, which it achieves primarily through increased allocation of forest to conservation zones and implementation of low-intensity management regimes on the portion of the forest managed for timber production (Figure 13). Its key elements include:

- increasing protected area from the present four per cent of the Crown forest to 22 per cent;
- increasing conservation forest area from the present 30 per cent of the total forest to 37 per cent;
- reducing plantation area over time to zero; and
- maximizing use of non-clearcut harvesting where silviculturally appropriate (which equals approximately 60 per cent of the area harvested in existing mature forest) and conducting all harvest treatments to maintain key within-stand characteristics as would exist following natural disturbances.

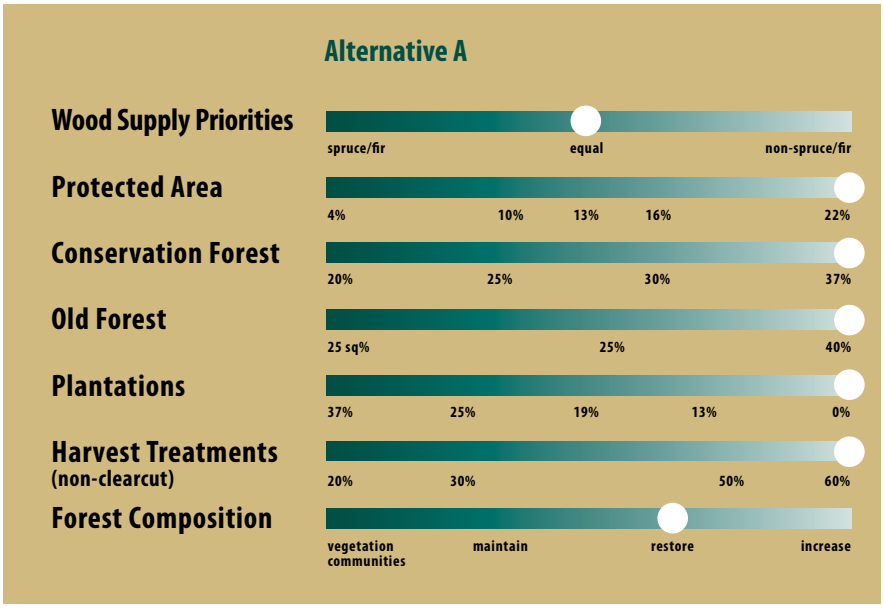

Figure 13 - *Options employed in Alternative **A**.*

ALTERNATIVE B

This alternative focuses on changing the forest condition to increase forest diversity in all its dimensions, including wood supply, species composition, stand type abundance, and amount of old forest (Figure 14). Change in forest condition is brought about through active management, and conservation values are enhanced across the entire forest by resulting increases in the diversity, complexity, and age of stands which exist in the forest. Its key elements include:

- increasing protected area from four per cent to 10 per cent;
- maintaining at least 40 per cent of the forest in old forest conditions;
- limiting plantations to 13 per cent of the forest area (their abundance in 2012, which is the end of the current planning cycle);
- extensive use of non-clearcut harvesting where silviculturally appropriate (which equals approximately 50 per cent of the area harvested in existing mature forest); and
- increasing the area of stand types which have declined in abundance over the past half-century.

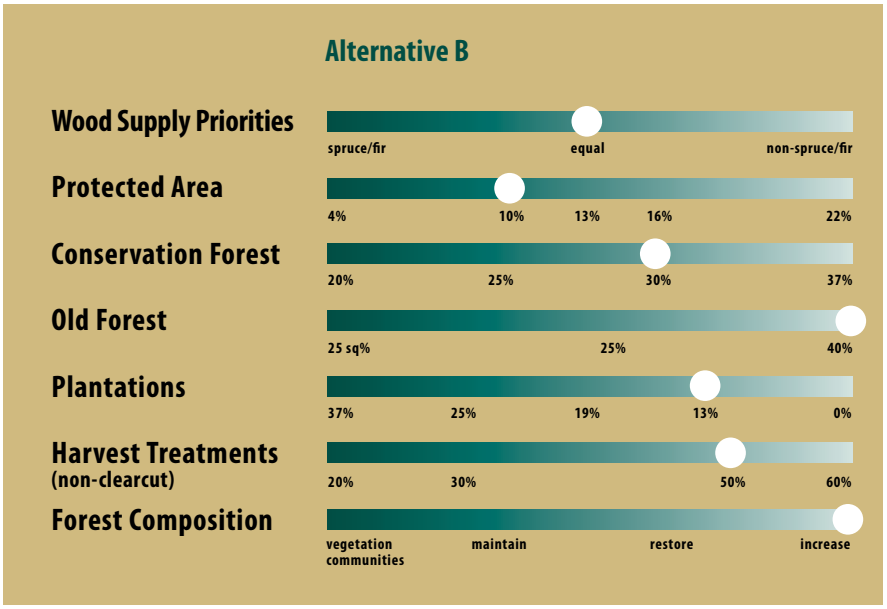

Figure 14 - *Options employed in Alternative **B**.*

ALTERNATIVE C

This alternative increases the emphasis on diversity objectives relating to the amount of old forest and protected area, and to the abundance of late-successional species* and stand types (Figure 15). This alternative partly offsets the wood supply impacts by reducing the conservation forest area. Its key features include:

- increasing protected area from four per cent to 13 per cent;
- reducing conservation forest area from 30 per cent to 25 per cent;
- allowing plantation area to increase to 19 per cent over the next 50 years; and
- extensive use of non-clearcut harvesting where silviculturally appropriate (which equals approximately 50 per cent of the area harvested in existing mature forest).

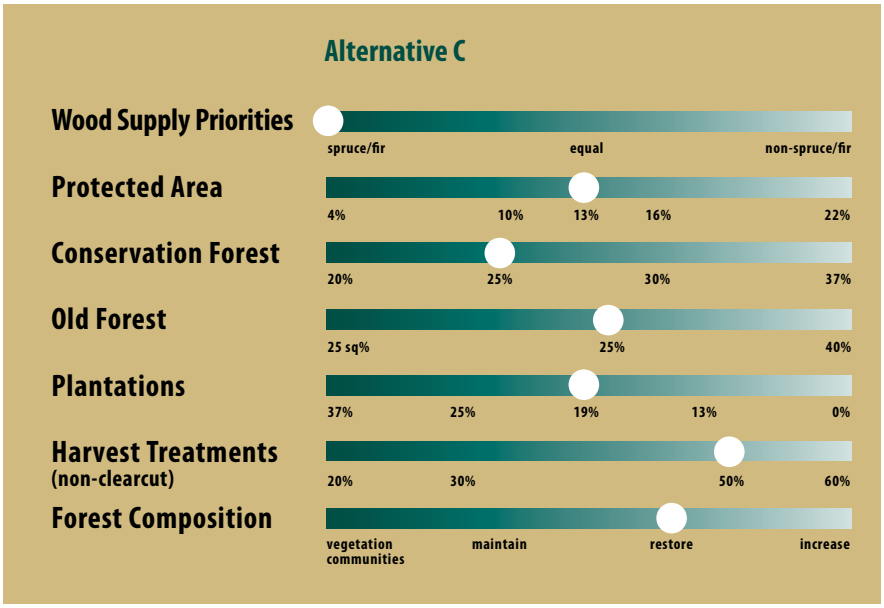

Figure 15 - *Options employed in Alternative* ***C****.*

** "Late-successional" refers to species that are generally long-lived, and regenerate and grow in partial shade created by canopy gap disturbances (for example, cedar, hemlock, red spruce, sugar maple).*

ALTERNATIVE D

This alternative includes objectives to increase forest diversity, while introducing measures to mitigate the negative wood supply consequences of those objectives (Figure 16). Its key features include:

- increasing protected area from four per cent to 13 per cent;
- reducing conservation forest area from 30 per cent to 25 per cent;
- allowing plantation area to increase to 37 per cent over the next 50 years; and
- conducting non-clearcut harvesting in stands where late-successional species currently dominate (which equals approximately 30 per cent of the area harvested in existing mature forest).

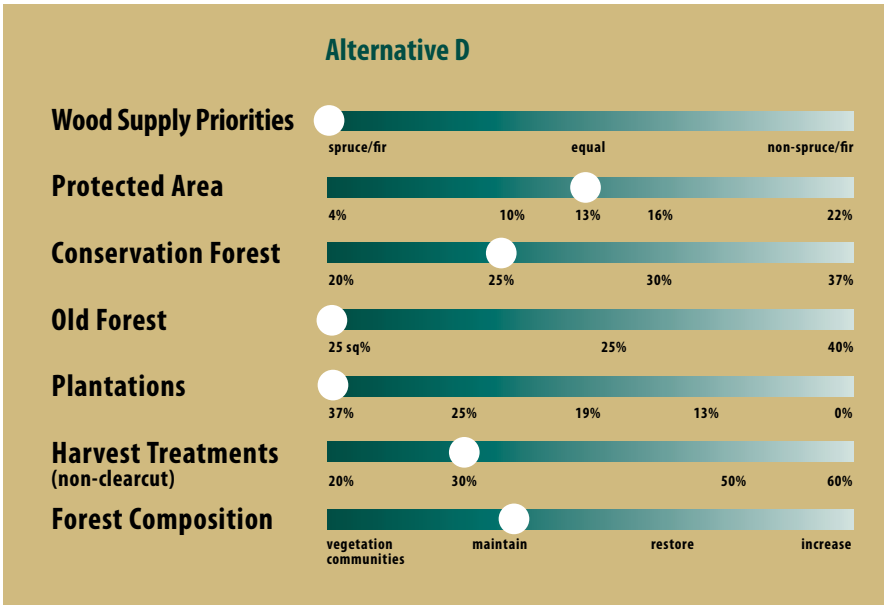

Figure 16 - *Options employed in Alternative **D**.*

ALTERNATIVE E

This alternative reflects the recommendations of the report by the New Brunswick Task Force on Self-Sufficiency[1]. It has the primary objectives of increasing current and future wood supply through reducing conservation forest area and increasing the area in plantations (Figure 17). Its key features include:

- increasing protected area from four per cent to 10 per cent, all of which is drawn from the current conservation forest so that no reduction results in the area managed with a timber emphasis;
- reducing the conservation forest area from 30 per cent to 20 per cent;
- allowing plantation area to increase to 37 per cent over the next 50 years; and
- maintaining the current proportions of harvesting by clearcut and non-clearcut prescriptions, that is, using non-clearcut harvesting in stands where 50 per cent or more of the volume is individually composed of either tolerant hardwood, cedar, white pine, red spruce, or red pine (which equals approximately 20 per cent of the area harvested in existing mature forest).

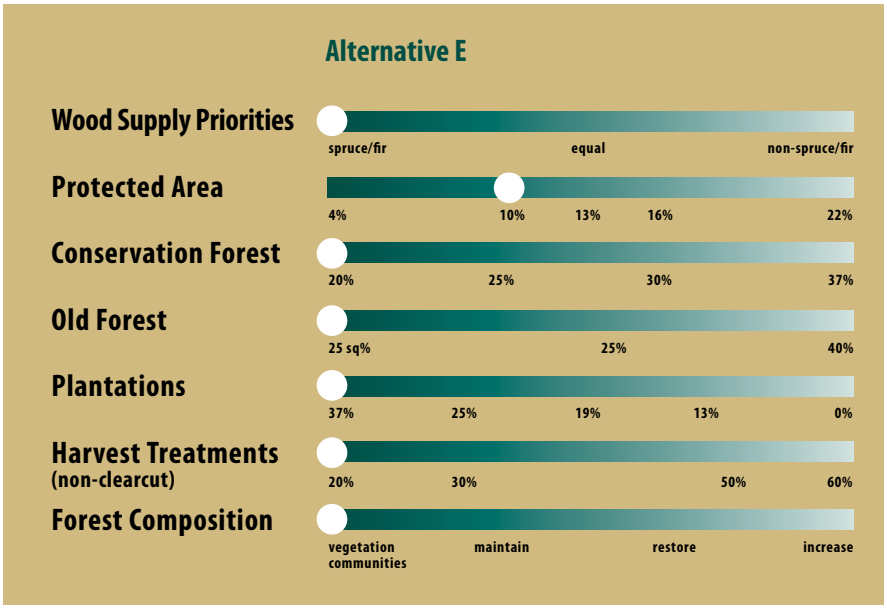

Figure 17 - *Options employed in Alternative **E**.*

ALTERNATIVE F

This alternative is designed so that most stands in the forest are managed to jointly satisfy diversity and timber supply objectives. It achieves this by reducing the forest area in conservation zones and making extensive use of low-intensity harvesting across a much larger proportion of the forest (Figure 18). It is in contrast to a zoning strategy, where the forest is divided into zones, each with specialized objectives. Its key elements include:

- allowing plantation area to increase to 25 per cent of the forest over the next 50 years;
- maximizing use of non-clearcut harvesting where silviculturally appropriate (which equals approximately 60 per cent of the area harvested in existing mature forest) and conducting all harvest treatments to maintain key within-stand characteristics as would exist following natural disturbances;
- retaining 10 per cent to 20 per cent of each harvested stand in a permanently unharvested state (including areas to be planted); and
- with the exception of protected areas, riparian buffers, and deer wintering areas, making all conservation forest eligible for low intensity harvest prescriptions.

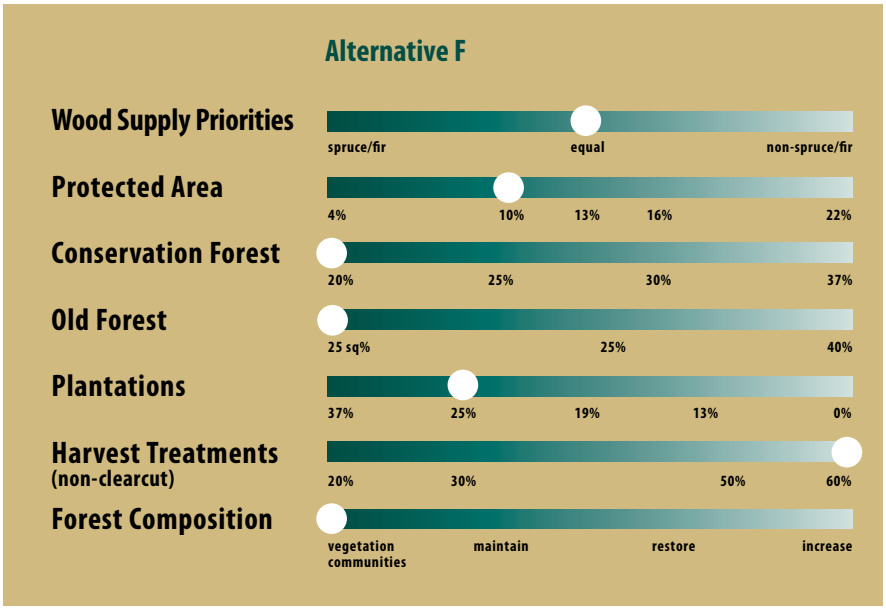

Figure 18 - *Options employed in Alternative **F**.*

ALTERNATIVE G

This option divides the forest into three zones; one primarily to provide diversity values; one primarily to provide wood supply values; and one to provide both (Figure 19). This is intended to combine the benefits of single objective management in the first two zones with those of multiple-objective management in the third, as an alternate means to meet overall wood supply and diversity objectives. It is similar in some respects to the status quo alternative, except the intensive management zone is preselected to include high productivity sites not subject to objectives for non-timber forest values. Its key elements include:

- increasing protected area from four per cent to 16 per cent;
- maintaining conservation forest at 30 per cent;
- allocating 25 per cent of the forest to intensive management of plantations established on sites of above average productivity; and
- managing the balance of the forest with low-intensity prescriptions to maintain key within-stand characteristics as would exist following natural disturbances (includes non-clearcut harvesting in all eligible types not in the intensive management area (which equals approximately 50 per cent of the area harvested in existing mature forest), and permanent within-stand retention of 10 per cent to 20 per cent in all harvested areas).

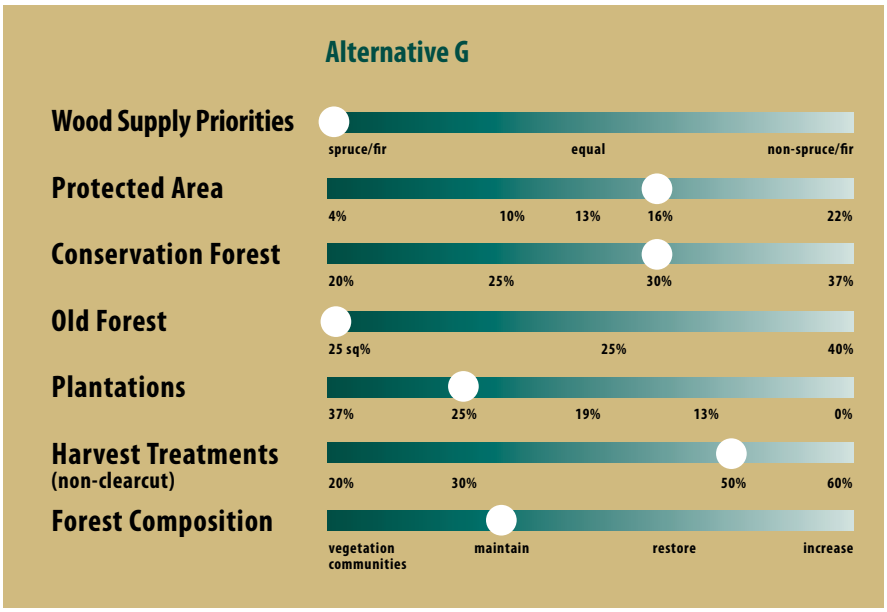

Figure 19 - *Options employed in Alternative* ***G****.*

Table 3 - *Summary of options for each of the eight selected management alternatives.*

Alternative	Wood Supply Priority	Protected [1] Area (%)	Conservation [1,3] Area (%)	Minimum [1] Old Forest Area (%)	Maximum [1] Plantation Area (%)	Harvest Treatments [2] (% mature forest area harvested by non-clearcutting)	Forest Composition
SQ	spruce/fir	4	30	25 *sq*	25	20	maintain vegetation communities [4]
A	equal	22	37	40	0	60	restore under-represented types
B	equal	10	30	40	13	50	increase under-represented types
C	spruce/fir	13	25	25	19	50	restore under-represented types
D	spruce/fir	13	25	25 *sq* [5]	37	30	maintain under-represented types
E	spruce/fir	10	20	25 *sq* [5]	37	20	maintain vegetation communities [4]
F	equal	10	20	25 *sq* [5]	25 [6]	60	maintain vegetation communities [4]
G	spruce/fir	16	30	25 *sq* [5]	25	50	maintain under-represented types

1 Expressed as per cent of the total Crown forest area of 2.99 million ha.

2 The area eligible for non-clearcut harvesting is based on the per cent of stand volume made up by late-successional species. Species classified as "late-successional" in this report include cedar, hemlock, red spruce, white pine, sugar maple, and yellow birch.

3 Includes protected area.

4 Vegetation communities, which are groups of stand types defined by species composition, are the basis for objectives used in current management strategies. See the reports *Our Shared Future*[2] and *Objectives and Standards for the New Brunswick Crown Forest for the 2007-2012 Period*[3] for details.

5 These alternatives do not have explicit old forest targets as old forest is defined under other alternatives. Indirectly, through the options for other issues, old forest is maintained at or above 25 per cent of the forest area under these alternatives.

6 Gross plantation area is set at 25 per cent, but under this alternative 10 per cent of all harvest areas is left as permanent retention; thus actual area planted equals 22.5 per cent of total forest.

FORECAST OUTCOMES OF MANAGEMENT ALTERNATIVES

The options chosen for each management alternative generate outcomes that vary substantially across the eight examined alternatives. All outcomes are presented and discussed in the full task force report and a detailed table of results is presented in Table 4, page 37.

Five key outcomes are presented below. In each case, alternatives are ranked by magnitude to provide a general overview of their relative performance. The outcomes reveal a very broad range of wood supplies and future forest conditions which can result depending upon how the New Brunswick Crown forest is managed.

LAND ALLOCATION

The allocation of land between areas receiving timber emphasis (general forest) and conservation emphasis (habitat and protected area), each with specific management objectives and treatment controls, is a fundamental and highly important decision that has profound impact on the forest.

This allocation strongly differentiates the management alternatives (Figure 20), and, as revealed in various outcomes, greatly influences resulting forest condition and wood supply.

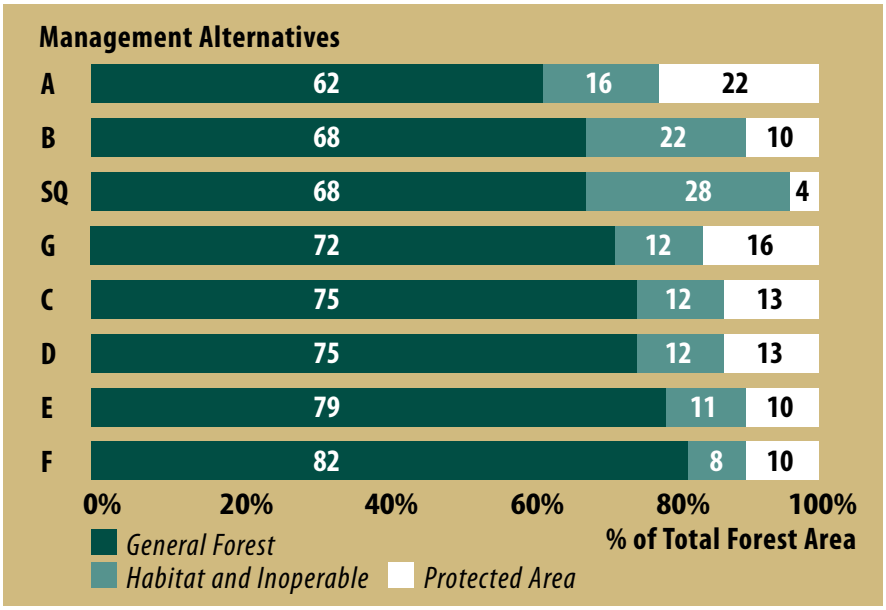

Figure 20 - *Land allocation.*

Protected area is set highest (22 per cent of the forest) and general forest area set lowest (62 per cent) under alternative **A**. General forest area is set highest under alternative **F** (82 per cent - *but only low intensity harvest treatments can be employed in it*) and under alternative **E** (79 per cent).

WOOD SUPPLY

Wood supply characteristics of cost, volume, quality, and species mix will directly govern the nature, size, and competitiveness of New Brunswick's wood processing forest industry. Wood supply is most strongly affected by land allocation (Figure 20), choice of harvest prescriptions, use of planting and spacing, and long-term wood supply goals. These factors combine to affect wood supply of different species in different ways. Generally speaking:

- the greater the area managed with a timber emphasis, the higher the short-term wood supply, as more area is available for harvest;

- the greater the area allocated to protected status, the lower the wood supply, as less area is available for harvest;
- the greater the reliance on clearcut harvesting, the lower the wood supply of species ill-adapted to grow in clearcut conditions (for example, cedar and tolerant hardwood);
- the greater the use of planting, the higher the long-term spruce/fir wood supply because the superior yields in plantations become available for harvest as plantations mature; and
- the more emphasis placed on long-term wood supply, the lower the short-term wood supply, as lower initial harvest levels allow more timber growth in the forest to support wood supply in the future.

The quantitative impacts of these relationships result in very different wood supply outcomes for different species under each of the eight alternatives.

Spruce/fir

The short-term sustainable spruce/fir log-potential supply (next 25 years) ranges across alternatives from 1.7 to 2.8 million m^3/yr (Figure 21-1). Only alternative **E** provides a supply above that of the status quo, primarily because of its high amount of area managed with a timber emphasis. Alternatives **F** and **D** produce slightly less than the status quo (99 per cent and 94 per cent, respectively). As the inclusion of diversity objectives increases, the spruce/fir wood supply drops, and it is thus lowest under alternatives **A** and **B** (at 62 per cent of the status quo supply).

The long-term spruce/fir log-potential supply (beyond the next 25 years) also varies significantly between alternatives and relates directly to the amount of area managed as plantations, in which spruces are the primary species planted. Alternatives **E** and **D** allow plantations to make up 37 per cent of the future forest, which results in very high future wood supplies, nearly doubling from the short-term level in both cases. The future supply drops progressively from alternatives **F** to **C** to **B** to **A** in step with the reduction of plantation area from 25 per cent to zero per cent.

Other Species

The status quo results in the highest short-term supply of cedar, white pine, intolerant hardwood, and poplar, but the log-potential wood supply of each declines in the future because the status quo contains no long-term sustainability objectives for wood supply of these particular species (Figures 21-2 to 21-6). All other alternatives produce sustainable, non-declining wood supply of all major species groups, including spruce/fir, white pine, cedar, tolerant hardwood (sugar maple and yellow birch), intolerant hardwood (red maple and white birch), and poplar. This non-declining goal for these species reduces the immediate supply of each to ensure long-term sustainability and has a negative effect on short-term spruce/fir wood supply of approximately six per cent, as it restricts harvesting in some mixed stands that would otherwise be harvested to capture their spruce/fir content.

Excluding the status quo, the supply of cedar and white pine is highest in both the short-term and long-terms under alternatives **E** and **F**, because they reduce conservation forest area (Figures 21-2 and 21-3). Long-term supply of pine is favoured with planting, because pine is part of the standard planting mix; thus, the future pine supply increases most under alternatives with high planting levels. Because of its relatively slow growth and limited silviculture options, cedar shows only modest increases in supply (six to14 per cent) over the long-term under all alternatives.

The supply of tolerant hardwood is sustainable under the status quo because of the long-standing tolerant hardwood policy for Crown licences (Figure 21-5). It is highest in the short-term under alternative **E** because of the reduced area of conservation forest. It is highest in the long-term under alternative **B** because an objective of that alternative is to increase the future abundance of stand types in which tolerant hardwood is a main component.

Intolerant hardwood and poplar log-potential supplies are generally highest under alternatives **E** and **F**, and lowest under **A** and **B**, again owing to the land allocation under those alternatives (Figures 21-4 and 21-6). Under the status quo, which has no objectives to sustain wood supply of intolerant hardwood and poplar, the log-potential supply of these species drops by approximately 50 per cent in the long-term. Under the other seven alternatives, supplies of poplar and intolerant hardwood are sustained at constant levels or increase slightly over time.

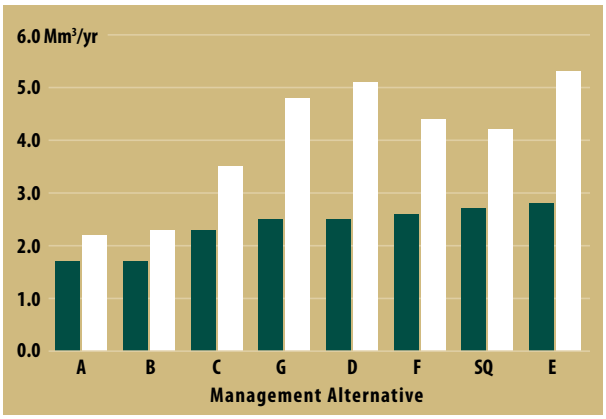

Figure 21-1 - *Spruce / Fir Wood Supply*

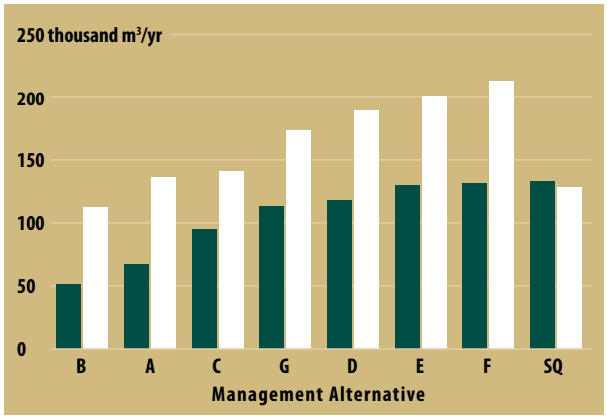

Figure 21-2 - *White Pine Wood Supply*

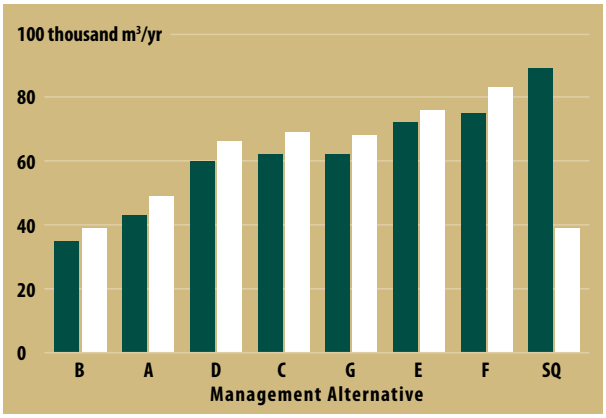

Figure 21-3 - *Eastern Cedar Wood Supply*

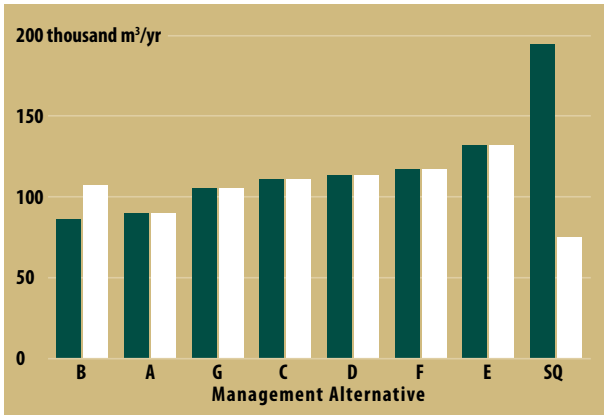

Figure 21-4 - *Poplar Wood Supply*

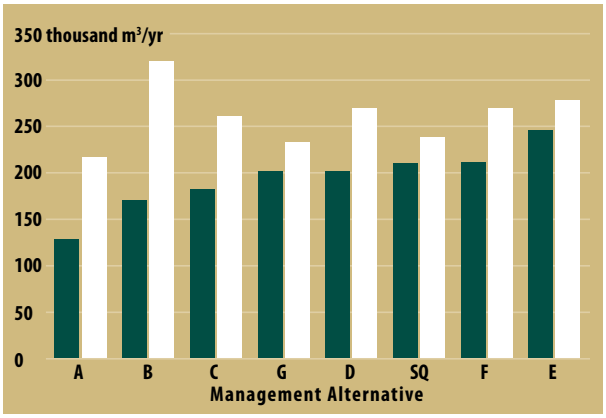

Figure 21-5 - *Tolerant Hardwood Wood Supply*

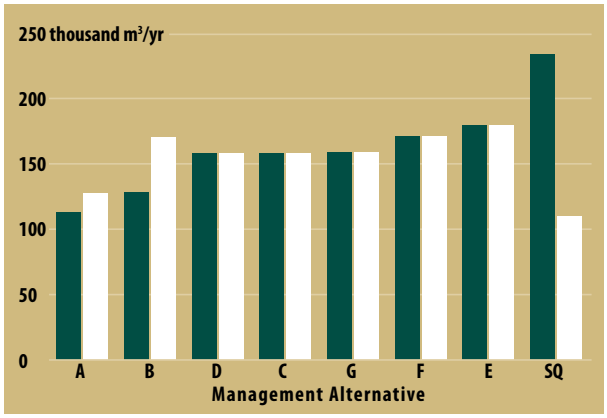

Figure 21-6 - *Intolerant Hardwood Wood Supply*

1-25 year average *26-100 year average.*

Figure 21 - *Short and long-term log-potential wood supply for six species groups under eight management alternatives. Short-term wood supply is the average over forecast years 1-25. Long-term supply is the average over forecast years 26-100. Log-potential volume is defined by log dimensions suitable as sawlog material and is a subset of total volume.*

Wood Costs

Wood cost is a combined function of harvest and silviculture costs. Harvest cost is governed largely by harvest prescription, with clearcutting being the least costly. Silviculture cost is governed by the absolute amount of area planted and spaced.

One or both factors cause average wood costs over the next 25 years to be higher than the status quo under all scenarios (Figure 22). Wood costs are highest under alternative **F** (six per cent above status quo) because most of the harvesting is by higher cost, low intensity prescriptions, and because it includes a large silviculture program. Alternative **A** also results in greater use of more costly non-clearcut prescriptions, but the silviculture program is smaller and the associated costs are lower. Costs are lowest under the status quo and alternative **E** because those alternatives result in the greatest use of clearcut harvesting.

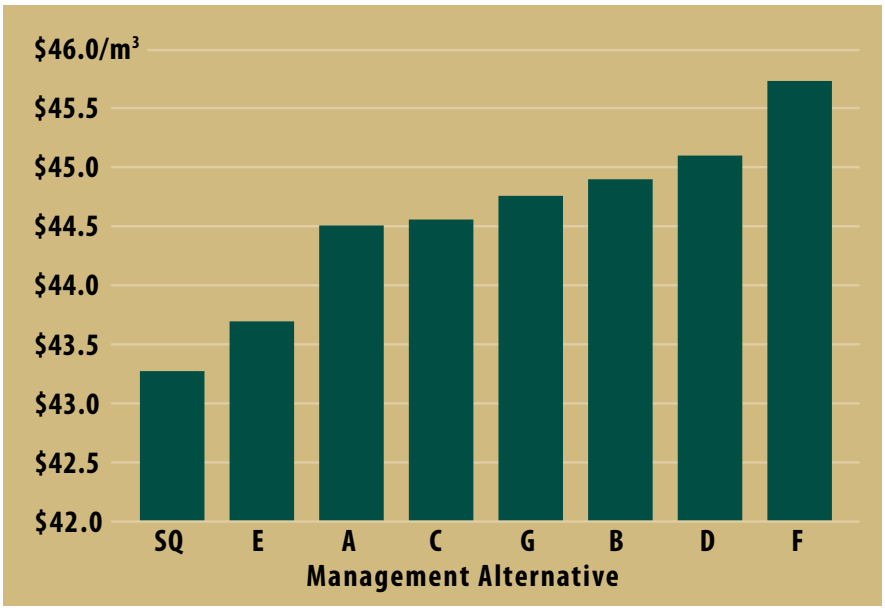

Figure 22 - *Average wood cost (delivered cost plus silviculture cost).*

FOREST CONDITION

Forest condition is of fundamental importance because it essentially defines diversity, both directly in terms of tree species, stand composition and structure, and indirectly, in terms of the flora and fauna that inhabit those conditions.

Forest condition is multi-faceted and is characterized here in three ways. First is the relative amount of area in the forest by the management history of stands, which is defined by the type of intervention conducted in them. Second is the relative amount of old forest, comprising stands which have acquired characteristics, including old and large trees, and other structural attributes that develop at advanced ages. Third is the relative abundance of stand types, defined by tree species composition.

By Management History

Area by management history is affected by land allocation, rate of harvest, choice of harvest prescription, and use of planting and spacing. It will change over time as progressively more forest area is affected by management. The results presented here are for forest conditions forecast under each alternative in the year 2062.

The unmanipulated area (defined by the absence of harvesting) is largely influenced by the area of conservation and protected forest. It thus doubles across alternatives (Figure 23-1) and is highest under alternatives **A** and **B** (almost 30 per cent of the total forest area) and lowest under alternative **F** (15 per cent).

Area of plantations results directly from the plantation area option for each alternative and ranges from a high of 37 per cent of the forest area under alternatives **E** and **D** to a low of five per cent under alternative **A** (Figure 23-2).

Area of spacings ranges from eight per cent to 30 per cent (Figure 23-3). The low values result under alternatives with high planting levels (alternatives **E** and **D**), as most of the silviculture budget is allocated to planting. Where planting is low or zero, more silviculture dollars are invested in spacing and the spaced area is high (alternatives **A** and **B**).

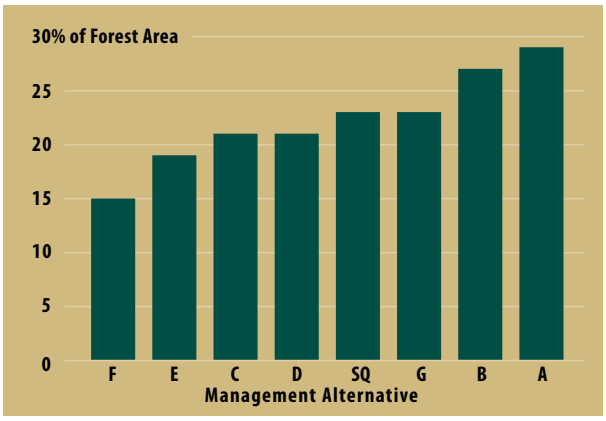

Figure 23-1 - *Unmanipulated stands*

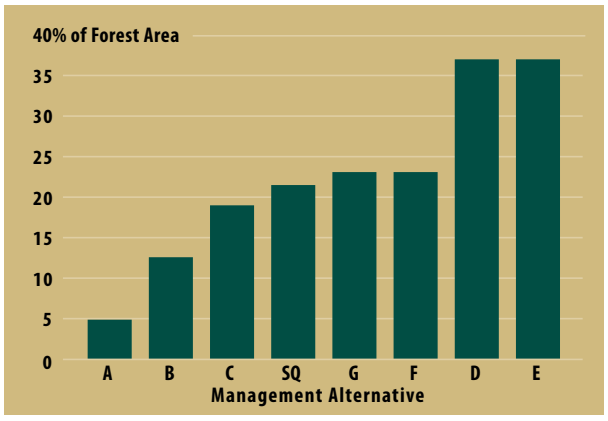

Figure 23-2 - *Plantations*

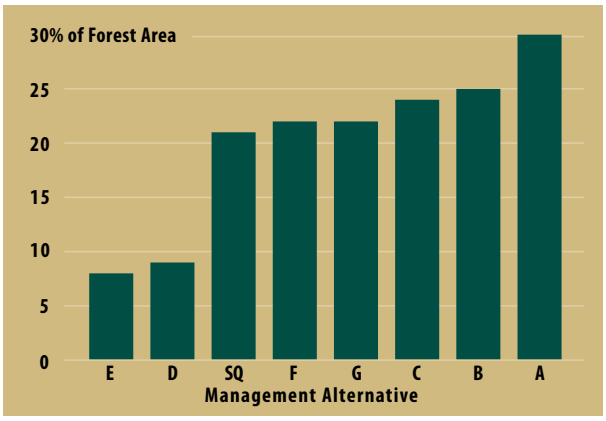

Figure 23-3 - *Spaced stands*

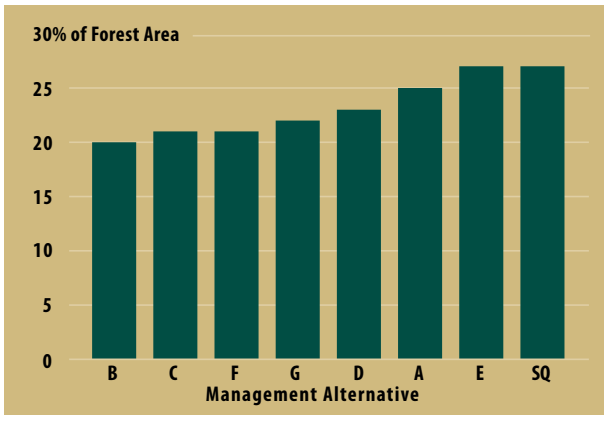

Figure 23-4 - *Unmanaged, even-aged stands*

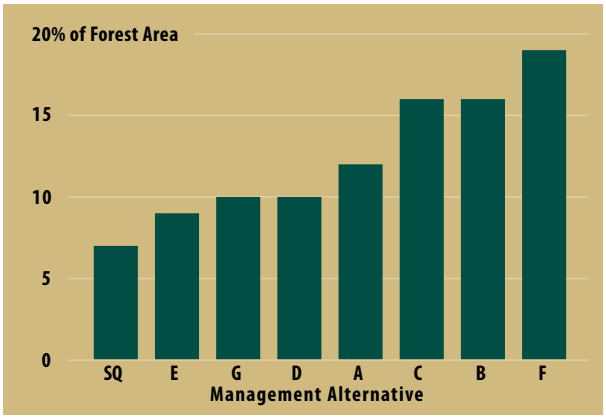

Figure 23-5 - *Uneven-aged managed stands*

Figure 23 - *Per cent forest area by five management history categories at forecast year 50 under eight management alternatives. See text for description of categories.*

Unmanaged even-aged stands are those resulting from clearcut or other even-aged harvesting prescriptions which are left to develop without further silviculture intervention, such as planting or spacing. The area in this condition is highest (27 per cent of the forest) under the status quo and alternative **E** because much of the silviculture budget is used for planting, which leaves much naturally regenerating area unspaced (Figure 23-4). This untreated naturally regenerating area could be spaced to the extent the silviculture budget is increased above the $24.5 million/year employed in the alternatives examined here.

Uneven-aged stands have multiple age classes, complex structures, and support growth of species such as cedar, hemlock, and tolerant hardwoods. The area under uneven-aged management is governed by the degree to which non-clearcut harvesting is employed. Under the status quo and alternative **E**, where such harvesting is least used, this area makes up less than 10 per cent of the forest (Figure 23-5). Where use of non-clearcut harvesting is greater (alternatives **B**, **C**, and **F**), the area doubles to over 15 per cent of the total forest.

Overall, alternatives **D** and **E** most strongly reflect the imprint of management emphasis on timber supply (Figures 25-5 and 25-6), and alternatives **A** and **B** most strongly reflect the imprint of management emphasis on forest diversity (Figures 25-2 and 25-3). Alternative **C** reflects intermediate emphasis on these dual objectives, resulting in the most even area distribution across the five categories of management history, with roughly 20 per cent in each (Figure 25-4).

Alternative **F** (Figure 25-7), which employs extensive application of low intensity management, results in a much different condition in that the unmanipulated area is least (15 per cent of the forest) and uneven-aged management area is greatest (almost 20 per cent), relative to other alternatives. Alternative **G** reveals its zoning structure, in that its two dominant forest conditions represent the two extremes of management intensity; plantations and unmanipulated forest each make up almost one-quarter of the forest (Figure 25-8).

Old Forest

Old forest is defined in terms of stand structural attributes which develop as stands reach advanced age and which provide unique and necessary conditions for the growth, survival, and reproduction of various plant and animal species.

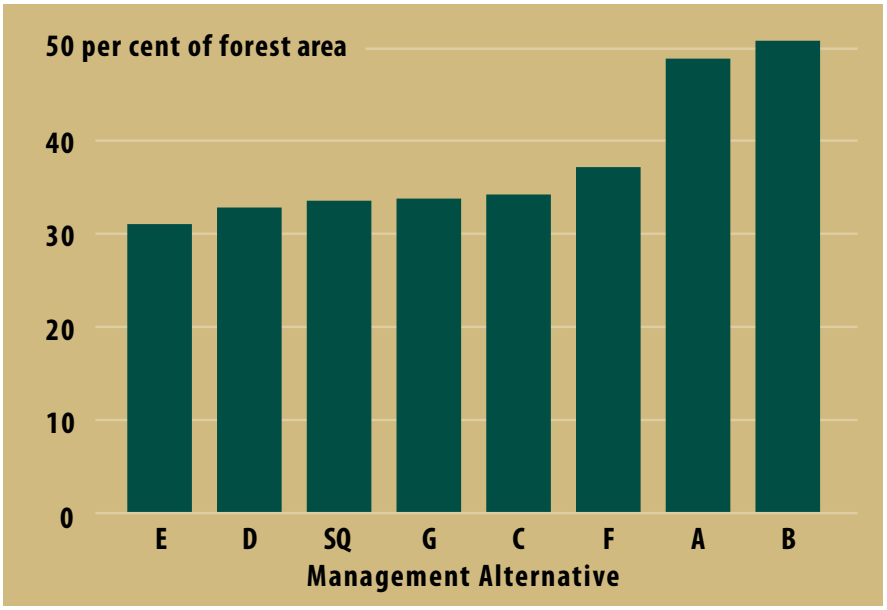

Figure 24 - *Old forest.*

The area of old forest is directly controlled by the old forest option of each alternative. Thus, it is highest (50 per cent of the total forest at forecast year 50) under alternatives **A** and **B**, and drops progressively in response to the objective level set in each alternative (Figure 24). It is lowest under alternative **E** (31per cent) because of the comparatively low area in conservation forest.

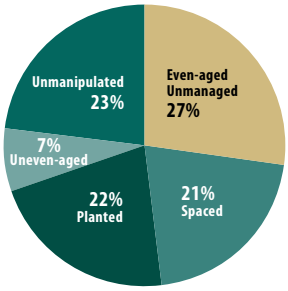

Figure 25-1 - *Status quo*

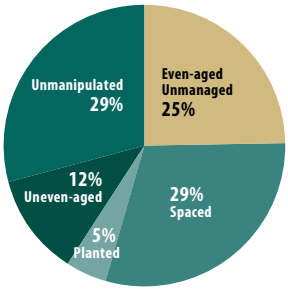

Figure 25-2 - *Alternative **A***

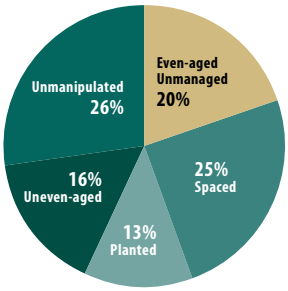

Figure 25-3 - *Alternative **B***

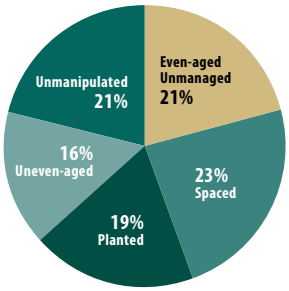

Figure 25-4 - *Alternative **C***

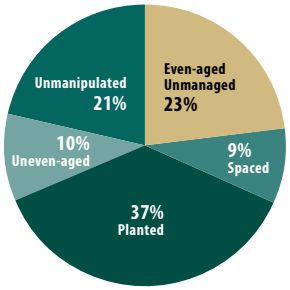

Figure 25-5 - *Alternative **D***

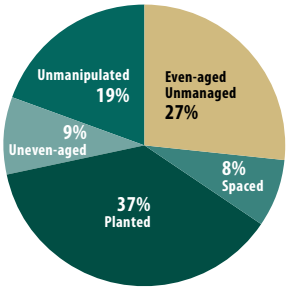

Figure 25-6 - *Alternative **E***

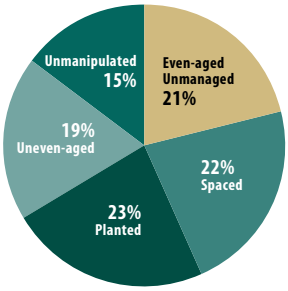

Figure 25-7 - *Alternative **F***

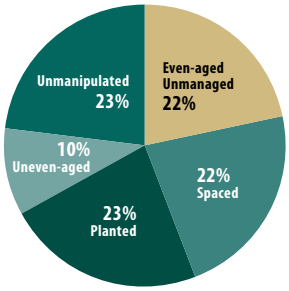

Figure 25-8 - *Alternative **G***

Figure 25 - *Per cent forest area by stand management history at forecast year 50 for eight management alternatives. See text for description of categories.*

By Species Composition

Species composition defines what tree species and mixes of tree species exist in the forest and in what abundance. This has important implications relating both to biological diversity in the forest and to economic diversity in use of the forest.

Area by species composition is affected largely by the choice of harvest prescription (which governs what species will regenerate and thrive following harvest) and the use of planting (which selectively establishes species) and spacing (which selectively retains naturally regenerated species). The effect of management on species composition of the forest emerges only gradually through time, as more and more area is affected by management actions. To clearly differentiate consequences of alternatives, species composition is reported here for forecast year 80.

Generally, the greater the use of non-clearcut harvesting, the greater the abundance of species which regenerate and thrive in the conditions of partial shade created by such harvesting. Thus, stands dominated by shade tolerant species are generally most abundant (over 30 per cent of the forest) under alternatives **B** and **C**, in which non-clearcut harvesting is most used (Figure 26-1). The abundance is lowest under the status quo and alternative **E** (21 per cent and 23 per cent, respectively), in which non-clearcut harvesting is least used.

Since spruces are the most common species planted, the area of spruce-dominated types increases with the extent of planting. Consequently, alternatives **D** and **E** result in the highest content of spruce (at 40 per cent of the forest) while the content falls to roughly 25 per cent under alternatives **A** and **B** which have the lowest levels of planting (Figure 26-2).

The area of the balsam fir stand type varies considerably across alternatives, partly because there are no specific objectives for it in any alternatives, and partly because it can be controlled significantly by silvicultural choices (Figure 26-3). Its area is reduced as plantation area increases, which results in low balsam fir abundance (10 per cent) under alternatives **D** and **E** and high abundance under **A** (26 per cent).

Pines (white pine and jack pine) combine to account for relatively little area under all alternatives. However, the overall pine content generally varies in proportion to area of plantations, increasing by half from a low of four per cent to a high of six per cent of the forest area under alternatives **D** and **E** (Figure 26-4). Pines make up a component, albeit small, of the seedling stock used in plantations, so as the area of plantations increases, so does the pine content in the forest. The area of white pine is highest under alternative **B**, which includes a specific objective to increase white pine abundance.

The intolerant mixedwood type commonly regenerates following clearcutting. Thus, it is lowest (16 per cent) under alternatives **A** and **B** which have the least area of clearcutting, and highest under the status quo, which has the most area of unplanted even-aged stands where intolerant hardwoods fare well (Figure 26-5).

Overall, forest composition is most even across these types under alternatives **A**, **C** and **F**. Alternative **B** produces the highest abundance of tolerant stand types, with an associated reduction in spruce types. Alternative **E** produces the reverse; namely, the highest abundance of spruce types with an associated reduction in tolerant types.

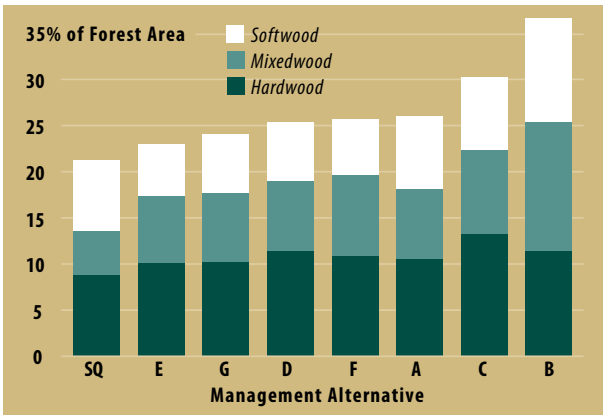

Figure 26-1 - *Tolerant species*

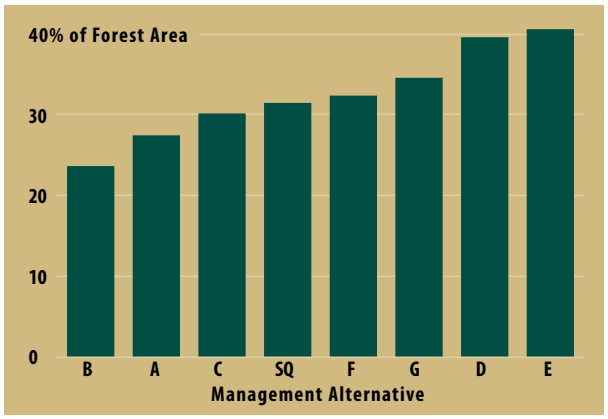

Figure 26-2 - *Spruce species*

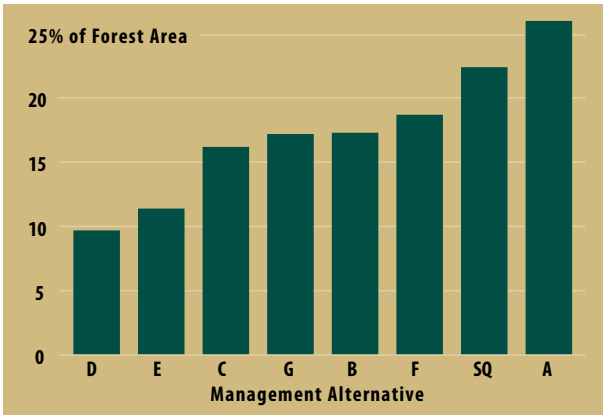

Figure 26-3 - *Balsam Fir*

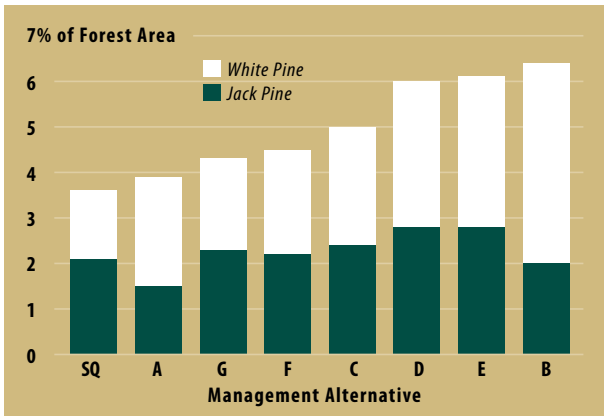

Figure 26-4 - *Pine species*

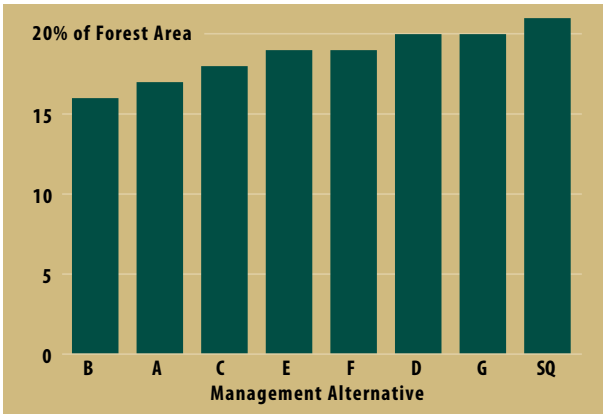

Figure 26-5 - *Intolerant species*

Figure 26 - *Per cent forest area by stand species composition at forecast year 80 under eight management alternatives.*

HARVEST PRESCRIPTIONS

Harvest prescriptions are the subject of much concern from ecological, social, and economic perspectives. At issue ecologically is the effect of harvest prescriptions on the structural and compositional diversity of harvested stands. Clearcutting is particularly controversial; some reject it on aesthetic grounds and deem broad use of it in the forest as environmentally damaging. Others promote clearcutting as being economically efficient, as a prerequisite to plantation establishment, and as ecologically appropriate in a variety of stand conditions.

Area Harvested By Clearcutting

The amount of area harvested by clearcutting as a per cent of all area harvested reveals the relative degree to which clearcutting is employed in the forest. The per cent varies two-fold across alternatives, from a high of 81 per cent under the status quo, to a low of 45 per cent under alternative **F** (Figure 27).

Alternatives that more heavily favour late-successional species employ less clearcutting (alternatives **A**, **B**, **C**, and **F**), while those alternatives with less emphasis on such species employ clearcut harvesting the most (alternative **E** and the status quo).

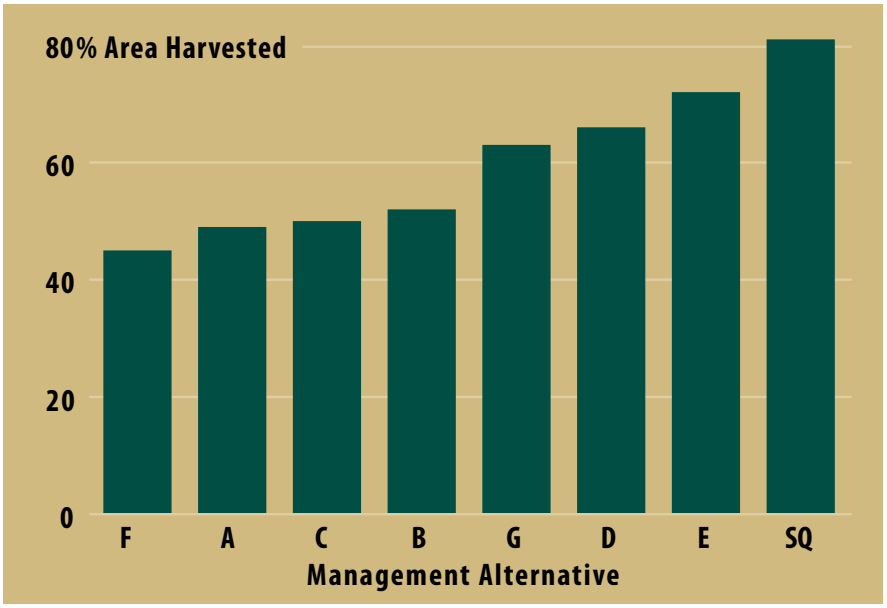

Figure 27 - *Area harvested by clearcutting (per cent of total area harvested over the next 25 years).*

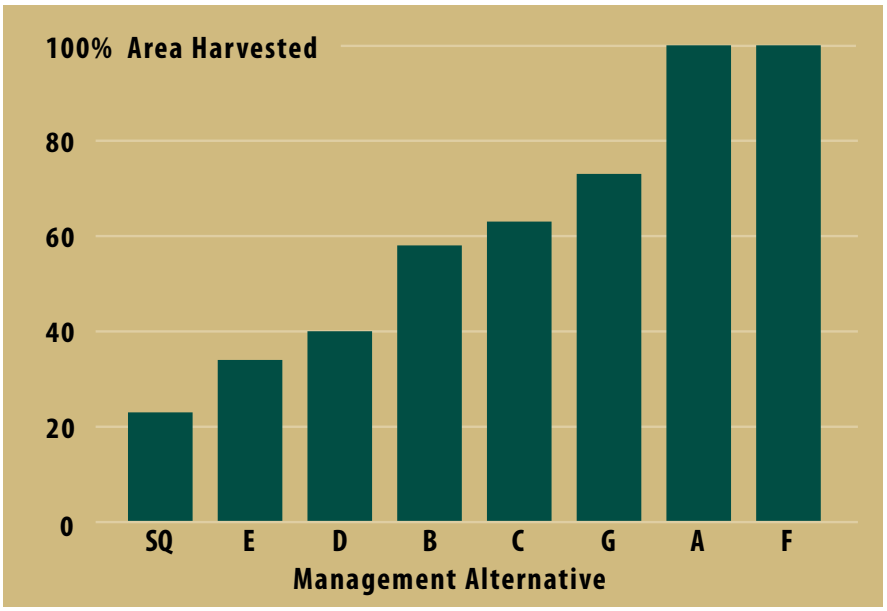

Figure 28 - *Area harvested in accordance with natural disturbance (per cent of total area harvested over the next 25 years).*

Area Harvested in Accordance with Natural Disturbance Tendency

An increasingly common view amongst forest ecologists is that diversity can be maintained in the forest if harvesting is conducted in accordance with the natural disturbances stands are prone to experience. The result is that post-harvest stand conditions retain some of the key elements stands possess following natural disturbances. Such stands thus maintain some of the habitat conditions used by flora and fauna that inhabit the natural forest.

Harvest prescriptions can be defined with reference to the natural disturbance tendency for various stand types. Under this view, the greater the per cent area harvested according to those prescriptions, the higher the likelihood natural forest diversity will be maintained.

Under alternatives **A** and **F**, 100 per cent of the harvest area is by these natural disturbance-based prescriptions (Figure 28). The percentage is lowest under the status quo (23 per cent) and alternative **E** (34 per cent) and at intermediate levels under alternatives **B** (58 per cent), **C** (63 per cent), and **G** (73 per cent).

SOCIO-ECONOMICS RELATING TO WOOD SUPPLY

Socio-economic impacts are highly important but especially problematic. They are based partly on the physical output from the forest, and actions taken in the forest, and partly on wood processing technologies and market-based wood product values. As such, socio-economic measures have an added element of uncertainty, relating to technology and markets, above and beyond that associated with the biological and physical measures presented thus far.

In recognition of that added layer of uncertainty, and the rapidly changing forest industry environment, socio-economic measures were derived only for the first 10 years of the forecast period. Beyond that period, one can use the forecast wood supply characteristics, together with one's expectations about the future economic environment, to make inferences about some socio-economic outcomes of the various alternatives.

Two socio-economic measures are reported here, value of shipments and employment. Contributions to gross domestic product and royalties paid to government for timber harvested are presented in the full report, and they fall in more-or-less direct proportion to the value of shipment outcomes shown here. To provide a common base, all measures were calculated based on assuming full utilization of the forecast wood supply; they thus represent potential rather than actual levels.

The reported measures do not include economic or employment activity associated with production of secondary forest products, such as paper or other value-added products. Further, they are based only on volume harvested from Crown land and do not represent overall provincial levels which incorporate wood sourced from private lands and imported volume.

Value Of Shipments

Value of shipments is a function of wood volume harvested and processed and of unit prices for products.

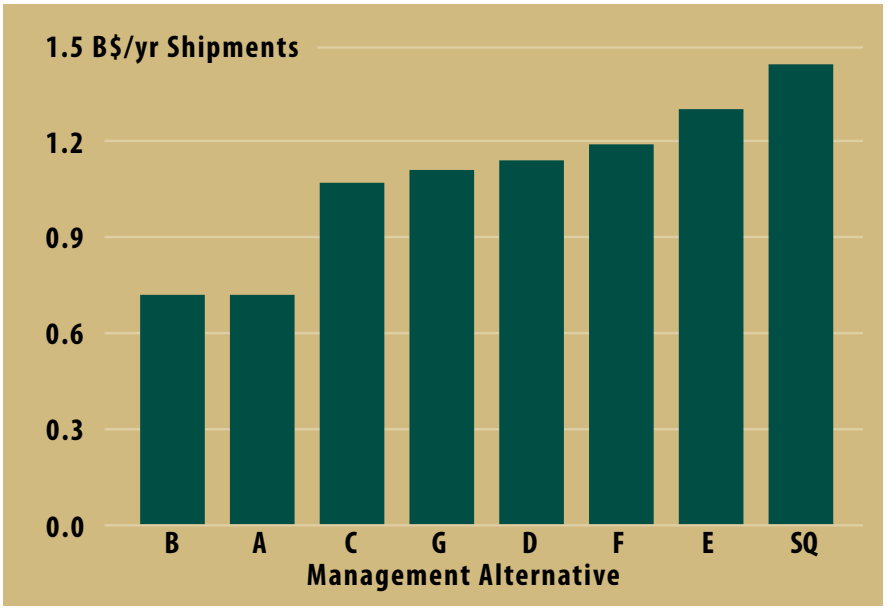

Figure 29 - *Value of shipments (year one-10 average).*

Based on current and short-term forecast prices for lumber and pulp, the status quo produces the highest value of shipments at just over $1.4 billion/yr (Figure 29). This result is because of the relatively high spruce/fir wood supply, and because of a short-term, but unsustainable, harvest of other species made possible by the absence of a long-term sustainability objective for supply of log-potential volume of those species (Figure 21).

Alternative **E** produces the next highest value of shipments, largely because of the reduced area of conservation forest and resulting higher harvest. Value of shipments drops as increasing emphasis is placed on forest diversity and conservation objectives. For this reason it falls to $0.7 billion/yr under alternatives **A** and **B**, and to intermediate levels between $1.0 and $1.2 billion/yr under alternatives **C**, **D**, **F**, and **G**.

Employment

Employment is a function of volume harvested, area treated silviculturally, and volume processed in pulp mills and sawmills.

Direct employment includes jobs involved in silviculture (planting and spacing), logging, and primary manufacturing of wood products. Average direct employment levels roughly double between alternative **A** (3,900 jobs) and the status quo (7,600 jobs) and generally increase in proportion to volume of available wood supply (Figure 30).

Seasonal silviculture work makes up between 13 per cent and 19 per cent of total employment, and varies by the absolute amount of area planted and spaced, with spacing creating more employment per hectare treated. Downstream processing of wood products has not been factored into employment estimates because the nature of that processing is unknown given recent changes in the industry.

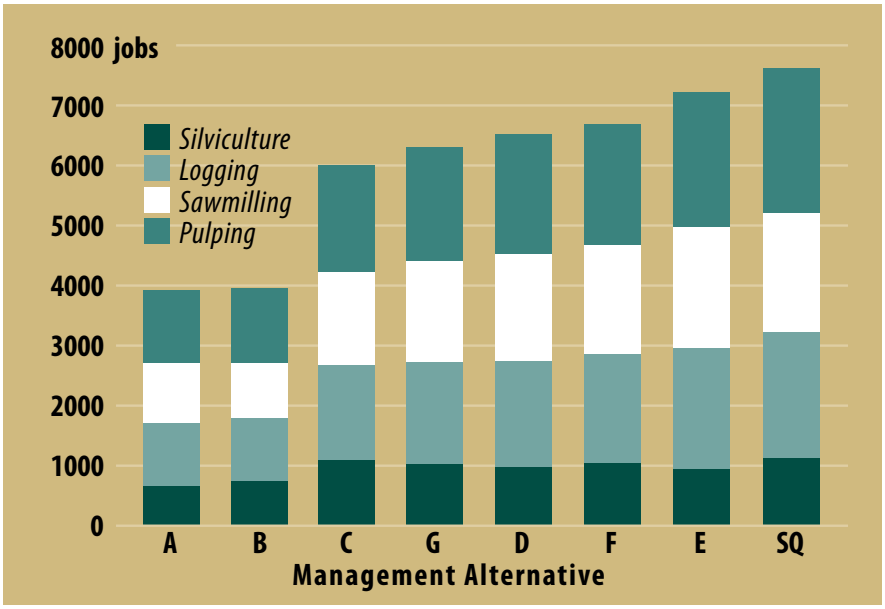

Figure 30 - *Annual employment (year one-10 average).*

Table 4 - Summary of selected outcomes under eight forest management alternatives for New Brunswick Crown forest

Indicator and Units		Alternative [1]							
		SQ	A	B	C	D	E	F	G
WOOD SUPPLY	**Spruce/fir Log-Potential** [2] (million m^3/yr)	2.7 4.2	*1.7* *2.2*	*1.7* 2.3	2.3 3.5	2.5 5.1	**2.8** **5.3**	2.6 4.4	2.5 4.8
	Spruce/fir Total [2] (million m^3/yr)	4.0 6.1	*2.5* *3.1*	2.7 3.4	3.6 5.1	3.8 7.0	**4.2** **7.3**	3.9 6.1	3.7 6.8
	Other Softwood Log-Potential [2] (thousand m^3/yr)								
	Cedar	**89** *39*	43 49	*35* *39*	62 69	60 66	72 76	75 **83**	62 68
	White Pine	**133** 128	67 136	*51* *112*	95 141	118 189	130 200	131 **212**	113 173
	Other Softwood Total [2] (thousand m^3/yr)								
	Cedar	**146** 58	70 70	*55* *55*	99 99	96 96	113 113	119 **119**	98 98
	White Pine	**229** 349	125 300	*101* *266*	174 372	196 469	212 478	207 **546**	187 455
	Hardwood Log-Potential [2] (thousand m^3/yr)								
	Sugar Maple and Yellow Birch	210 239	*129* *217*	171 **320**	183 261	202 270	**246** 278	212 270	202 233
	White Birch and Red Maple	**234** *110*	*113* 127	128 170	158 158	158 158	179 **179**	171 171	159 159
	Poplar	**194** *75*	90 90	*86* 107	111 111	113 113	132 **132**	117 117	105 105
	Hardwood Total [2] (thousand m^3/yr)								
	Sugar Maple and Yellow Birch	417 **662**	*259* *490*	326 661	348 526	373 535	**451** 542	392 570	377 496
	White Birch and Red Maple	**848** 603	*453* *499*	503 585	615 627	608 608	677 **677**	650 669	608 616
	Poplar	**386** 384	198 *218*	*193* 237	240 303	242 270	279 306	245 317	229 282
Wood Cost ($/$m^3$ years 1-25 in constant dollars)		*43.3*	44.5	44.9	44.6	45.1	43.7	**45.7**	44.8
Land Allocation (% of total forest) [4]									
General forest		68	*62*	68	75	75	79	**82**	72
Protected natural area (PNA)		*4*	**22**	10	13	13	10	10	16
Conservation forest outside PNA		**28**	16	22	12	12	11	*8*	12
Forest Condition (% of total forest area in 2062)									
Even-aged Planted [5]		22	*5*	13	19	**37**	**37**	23	23
Spaced		21	**29**	25	23	9	*8*	22	22
No silviculture treatment		**27**	25	*20*	21	23	**27**	21	22
Uneven-aged (created by harvest)		*7*	12	16	16	10	9	**19**	10
Unmanipulated		23	**29**	26	21	21	19	*15*	23
Old Forest (% of total forest area in 2062)		34	49	**51**	34	33	*31*	37	34
Forest Composition (% of total forest area in 2092)									
Fir and Spruce/fir		**54**	53	*41*	47	49	52	51	52
Tolerant (pure and mixed)		*21*	26	**37**	30	25	23	26	24
Pine (combined)		*4*	*4*	**6**	5	**6**	**6**	*4*	*4*
Intolerant Mixedwood		**21**	17	*16*	18	20	19	19	20
Area clearcut (% of total area harvested over years 1-25)		**81**	49	52	50	66	72	*45*	63
Natural Disturbance-based Harvest (% of total area harvested over years 1-25)		*23*	**100**	58	63	40	34	**100**	73
Employment [6] (jobs/yr)		**7600**	*3900*	4000	6000	6500	7200	6700	6300
Net Value of Shipments [6] (billion $/yr)		**1.44**	*0.72*	*0.72*	1.07	1.14	1.30	1.19	1.11
Contribution to GDP [6] (billion $/yr)		**0.80**	*0.40*	*0.40*	0.59	0.64	0.72	0.66	0.62
Royalties [6] (million $/yr)		**61**	31	*30*	48	54	60	55	51

1 **Highest values for each indicator are in bold**; *lowest values are underlined and italicized.*

2 Leftmost value in cell is average for years one-25; right value is average for years 26-100. Higher precision in values is used for calculating percentages stated in text.

3 Stand types are described in more detail in main text.

4 Land allocation to conservation forest varies slightly from the options defined for some alternatives because of inoperable forest and non-spatial inventory compilation.

5 Plantation area changes through time in accordance with limits for each alternative; limits are not met until after year 50 for some alternatives.

6 Average for years one-10 (constant $).

OTHER IMPORTANT CONSIDERATIONS

In addition to the information presented thus far, there are several matters that warrant careful thought and consideration in the decision about how best to manage the New Brunswick forest. These are highlighted below.

OTHER ALTERNATIVES

Although eight management alternatives were examined in detail by the task force, numerous others can be defined by combining the options for the seven cornerstone issues in various ways. The consequences of other alternatives, defined by different combinations of options, can be explored using the modeling framework built by the task force and provided to the Department of Natural Resources.

Further, additional analyses can be conducted to determine the impacts of alternate management decisions and assumptions about forest development. Sensitivity analysis of this sort are presented in the full task force report and include varying silvicultural investment (increasing it to $30 million/year), product specifications, forest growth rates, and stand response following harvest.

CATASTROPHIC LOSS

None of the alternatives accounted for catastrophic loss, as might be caused by wildfire, insect outbreaks, or windstorm; such losses are not predictable. The task force assumed that New Brunswick will continue its relatively effective forest protection programs, and in the event major losses do occur, they will be addressed adaptively by salvage harvesting and revision of management plans as is current practice.

CLIMATE CHANGE

Climate change has the potential to significantly impact the forest. However, given the complexity and uncertainty surrounding climate change and its impacts, it was only indirectly addressed in the management alternatives – largely by controlling the abundance of tree species deemed by the scientific community as best adapted to the expected changes in climate. Changes in tree growth rates, fire and pest incidence, and regeneration patterns are expected to occur, although gradually over time. Under any management alternative, the forestry community must be alert to such changes and be ready to revise management strategies as understanding of climate change impacts improves.

UNQUANTIFIED IMPACTS

Given the task force mandate, socio-economic impacts addressed here relate only to wood products manufacturing. However, the forest provides other economic benefits which should be considered when evaluating alternatives, such as those relating to eco-tourism, consumptive and non-consumptive recreation, and non-timber forest products.

Further, there are important social implications of management that cannot readily be addressed by objective measures. Such matters include aesthetics, spirituality, and perception of risk. To a limited extent, impacts on these socio-economic dimensions can be inferred from the forest conditions forecast under each alternative. However, more complete and explicit consideration of these issues should be made when evaluating the desirability of various alternatives.

The effect on ecological services provided by the forest is another important consideration in evaluating alternatives. Inferences about some such services, for example, maintenance of diversity, provision of habitat, and protection of water, can be readily made from the provided descriptions of management outcomes. Others, such as water and air purification, water regime regulation, and nutrient cycling, are not directly addressed, but the variation in impacts between alternatives is tempered by the fact that all alternatives retain the same forested land area and all involve ongoing maintenance and regeneration of forest cover. None involve the types of land use change (for example, urbanization or deforestation for agriculture) that most dramatically affects provision of ecological services by the environment.

MANAGEMENT FLEXIBILITY

Consideration of the future necessitates use of forecasts, despite the presence of many unavoidable uncertainties and unknowns relating to economic conditions, environmental conditions, forest products markets, and social values and preferences. Adaptation to changes in these factors is partly accommodated in forest management by regular and frequent replanning in which strategy adjustments are made in response to unfolding reality.

The ability to adapt to change is partly governed by the degree of flexibility afforded by the forest condition. There is no one forest condition that all parties would agree provides maximum flexibility. Regardless, the inevitability of unpredictable change makes thoughtful consideration of management flexibility a necessary part of responsible decision-making about forest management.

TRADE-OFFS

New Brunswickers treasure their public forest for multiple reasons, including economic, environmental, and social ones. But, as revealed in this report, not all values can be simultaneously maximized; measures to enhance some benefits will negatively affect others. The resulting trade-offs cannot be avoided but they can and should be explicitly recognized and consciously factored into management decisions.

The decision-making challenge is to evaluate thoroughly possibilities and implement a management strategy deemed to best provide the balance of values sought through time. The task force hopes that its efforts assist the province in that important and formidable task.

APPENDIX 1 - TASK FORCE MEMBERSHIP

Members

Blake Brunsdon	J.D. Irving, Ltd.
Roberta Clowater	Canadian Parks and Wilderness Society
David Coon	Conservation Council of New Brunswick
Robert Dick	New Brunswick Department of Natural Resources
Derek MacFarlane	Canadian Forest Service
Claude Pelletier	Madawaska Forest Products Marketing Board
Doug Prosser	Wood Products Group (representing)
Roger Roy	Université de Moncton
Thom Erdle (Chair)	University of New Brunswick

Analysts

Chris Ward	University of New Brunswick
Chris Norfolk	New Brunswick Department of Natural Resources

APPENDIX 2 - REFERENCES

1 New Brunswick Self-Sufficiency Task Force. 2007. *The road to self-sufficiency: A common cause*. Fredericton, N.B. 69p.

2 New Brunswick Department of Natural Resources. 2005. *Our shared future*. Fredericton, N.B. 10p.

3 New Brunswick Department of Natural Resources. 2005. *Objectives and standards for the New Brunswick Crown forest for the 2007-2012 Period*. Fredericton, N.B. 40p.