RURAL ECONOMY

A Delphi Study of Growth and Yield in Canada's Forests

Report of a Scientific Survey

W. Phillips, J. Beck, D. Boulter, D. Booth and K. Clark

Project Report 95-03

PROJECT REPORT

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Faculty of Agriculture, Forestry,
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University of Alberta
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A DELPHI STUDY OF GROWTH AND YIELD

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by

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EXECUTIVE SUMMARY

Information on growth and yield of Canada's forests tends to be anecdotal, site specific, difficult to compile, and unsuitable for general aggregation across species and to provincial and ecological region-wide levels. Yet aggregated information on growth and yield is necessary for estimating future timber supplies for large regions in order to plan for the future of both the industry and the other various non-timber forest users. Thus, a study was undertaken using the Delphi technique to summarize the opinions of growth and yield experts and practicing foresters across the country. Survey participants were asked to fill in a series of three sequential and carefully-designed questionnaires. Feedback from each previous questionnaire was used as a basis to refine initial responses and establish a final set of growth and yield estimates for various regions across the country.

The regional breakdown followed a combination of Rowe's forest regions and provincial boundaries: Atlantic-Acadian; Atlantic-Boreal; Quebec-Great Lakes/St. Lawrence; Quebec-Boreal; Ontario-Great Lakes/St. Lawrence; Ontario-Boreal; Prairie/Northwest Territories-Boreal; Interior British Columbia/Yukon-Boreal; Interior British Columbia-Subalpine; Interior British Columbia-Montane; Interior British Columbia-Columbia; Coastal British Columbia-Coast; and Coastal British Columbia-Subalpine. Within each of these 13 regions, responses were broken down further by species groupings: softwood, mixed-wood, and hardwood. Also, the questionnaires were divided into two parts, existing stands and regenerated stands.

Results of the Delphi survey show that existing stands are currently being harvested beyond the age of maximum mean annual increment (MAI) across the country with the exception of the Quebec-Great Lakes/St. Lawrence where harvest is at the age of maximum MAI. Estimated future harvest ages of regenerated stands were at the age of maximum MAI for all regions except the Atlantic-Acadian and Ontario-Great Lakes/St. Lawrence where estimated ages were beyond the age of maximum MAI.

Estimated growth responses connected with unevenaged management, fertilization, cleaning/brushing, juvenile spacing/pre-commercial thinning, and commercial thinning were provided by survey respondents for both existing and regenerated stands. Growth responses from genetic improvement were also provided for regenerated stands. Respondents' estimates of growth from unevenaged management tended to be considerably less than maximum MAI growth rates. Estimates of growth increases as a result of fertilization ranged from 0.1 m^3/ha/year for regenerated stands in the Atlantic-Acadian region to 2.6 m^3/ha/year for both existing and regenerated stands in the Coastal British Columbia-Coast region. Duration of increased growth was generally between 5 and 15 years.

Estimated growth increases from cleaning/brushing varied regionally from a low of 0.3 m^3/ha/year for regenerated stands in Coast British Columbia-Subalpine and Ontario-Boreal regions to a high of 1.8 m^3/ha/year for regenerated stands in the Atlantic-Boreal region. Duration of the increased growth response generally fell within the 7 to 15 year range. The expected growth response from juvenile spacing/pre-commercial thinning varied between -1.0 m^3/ha/year for the Interior British Columbia-Subalpine region and +2.6 m^3/ha/year for the Atlantic-Acadian region. Predicted change in the number of years to reach a rotation based on harvestable tree size was between 0 and -20 years but the effect on rotation age using maximum MAI was generally between -5 and +5 years. Predicted growth increases from commercial thinning varied from a low of -1.8 m^3/ha/year for existing stands in the Coast British Columbia-Coast region to a high of +1.5 m^3/ha/year for regenerated stands in the

Atlantic-Boreal region. Duration of growth changes are expected to be between 8 and 20 years except in the Coastal British Columbia regions where the range is from 27 to 43 years. Predicted shortening of rotation time based on harvestable tree size is from 1 to 10 years while changed rotation age at maximum MAI varied from -2 years to +17 years.

Estimated increases in MAI growth from genetic improvement of regenerated stands varied from 0.3 to 1.2 m^3/ha/year. In general, for most regions, predicted rotations from genetic improvement were shortened by 5 to 10 years.

The results were based on 42 responses over the 13 regions in the third and final round of the survey. Great care should be taken regarding the use of data for the four Interior British Columbia regions due to minimal responses. Otherwise, the data seem to represent the view of experts in the field. Delphi studies such as this one are useful as a first estimate when there is insufficient hard empirical data.

ACKNOWLEDGMENTS

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The efforts of the study Advisory Committee were invaluable in providing guidance, from the panel selection process, through the design of the questionnaire to the final report preparation. In particular, the authors thank Joe Lowe who not only served as an Advisory Committee member but provided essential baseline growth and yield data used in round one of the survey.

Last, but certainly not least, the input of the Expert Panel respondents is gratefully acknowledged. Without their interest, cooperation, patience, diligence and commitment of valuable time, this study would not have been possible.

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1. INTRODUCTION

Information on growth and yield of Canada's second growth forests is necessary for estimating future timber supply in order to plan for the future of both the industry and the various other forest users. While second growth is already an important component of harvest in some regions, particularly the Atlantic region, this is not the case for most of Canada. Millions of dollars have been spent over the years on regenerating and tending recently harvested areas. What are and what will be the yields on these new "tended" forests? While the national forest inventory can provide estimates of standing volumes per hectare and mean annual increments for existing stands (CFS 1994), how representative are these of future growth rates? And how does growth change under different management options and as a result of different disturbances?

There are 416 million hectares (ha) of forested lands in Canada that range from the tundra to the prairies, from the northern boreal forests to the rainforests of B.C.'s coast. Despite over one hundred years of harvesting, Canada's forests are still predominantly mature or over-mature; nearly 50% of the area of nonreserved, stocked forest area is old, representing over 68% of the volume, or 17 billion m^3 are in those marturity classes. This large stock of standing mature forest continues to be the main source of fibre for Canada's forest sector, and as a result, the focus of timber supply analysis to date has not been on growth and yield for second growth forests.

However, a number of factors are changing the face of timber supply analysis in Canada. Allowable annual cuts (AACs), which are the amounts of wood that can be harvested for a given area over time, are determined in each jurisdiction, with the bulk of the forest resource owned and controlled by the provinces. Because of the large expanse of existing mature forests however, these AACs reflect to a large extent the rate at which existing stocks of old timber can be harvested. Growth rates of existing as well as regenerating forests in many regions have historically not factored significantly into the calculation of short term harvest rates.

Over the past twenty years, there has been a recognition that there is a significant margin of the AAC that is not economically recoverable, given expectations of current and future costs, prices, products, technology, etc. The physical supply of timber was recognized to be clearly greater than the economic supply by some unknown margin. In addition, concerns for the environment and non-consumptive land uses (predominantly recreational), have begun to have an increasing impact in the form of withdrawals from the forest land base. The area of accessible, virgin mature timber is decreasing, and there is increasing pressures on the forest land base from other users of the forest. At the same time, previously harvested areas are maturing and the forest products industry is preparing for a transition to second growth. Intensive management of second growth stands is seen by some to be the solution to reductions in industrial forest area as a result of increasing regulations and land withdrawals.

There is a large amount of information on growth and yield across Canada but it tends to be very site specific. It is spread across the country, variable in quality, is not easily compiled, and is difficult to generalize. Anecdotal evidence of high yields has led some researchers and policy-makers to conjecture that there is a huge potential for growth increases from management of second growth stands, or even from unmanaged stands. Is it reasonable to extrapolate site-specific growth and yield information to all of Canada's forests? What in fact is the "average" growth response? This lack of good growth and yield and other forest resource information is indicated by Brand (1991) when he states that "...good data are not available on the nature and extent of the Canadian forest, its rates of growth, and the rates of harvesting, wildfire, or pest management" (p. 3). There is a "... need for enhancement in the current information base" (p. 3). Brand and Penner (1991) attempted to update information on Canada's growth and yield from second growth forests by carrying out an informal survey of growth rates in managed and natural stands across the country.

This Delphi study is a first attempt to quantify, on an aggregate basis, the expert judgements of growth and yield experts on the growth of Canada's forests both today and in the future. Because the information needed to make inferences about future second growth for large regional aggregates is lacking, a Delphi survey technique involving an expert panel of growth and yield specialists and practising foresters across Canada was used to generate the information. The panel was selected by a peer review and used to solicit member views as to current and future supply responses, i.e., growth and yield, following stand or forest depletion. Participants were asked to fill in a series of three carefully-designed questionnaires. Feedback from each previous questionnaire was used to try and refine and narrow the responses to the next , in order to reach a consensus of expert opinion. This project reports on the Delphi process and analyzes resultant growth and yield information on Canada's forests. Questions were asked on current growth and yield of existing forests and their responses to various management options. In addition, questions were asked on the growth and yield of second growth stands on forest land after logging, again for various intensive management options.

The final product contained in this report is a set of tables of yield data that are based on responses by regional experts across the country. National assessments of the supply of timber from Canada's forests have been carried out periodically over a number of years. This growth and yield information will be a vital component of analytical and economic studies of the forest sector, both within the Canadian Forest Service and outside.

2. METHODOLOGY

2.1 SURVEY TECHNIQUE

Participants in the survey were considered to be experts on the present and potential future growth and yield of forests. Their collective judgements are important, given the absence of a less than complete state of knowledge. Because the knowledge base is lacking, pooled expert opinion can provide an important foundation for improved forest resource modelling, routine problem solving and decision making. The Delphi technique was developed as a structured means of improving the information base using experts.

First developed by Delbecq *et al.* (1975) at the Rand Corporation during the late 1950s, the Delphi technique consists of a set of well-designed sequential questionnaires. Responses from the earlier questionnaire rounds are summarized and fed back to respondents in later questionnaires. The first questionnaire usually solicits responses to broad, general questions that focus on issues and relationships -- in this case estimates of growth and yield of Canada's forests. The questionnaires that follow allow for a review of earlier responses and reflect any clarification and refinement of expert opinion provided in the previous round. A minimum of three rounds of questionnaires are usually required (as in this case). The process is halted once a consensus is reached or sufficient information interchange is attained such that further significant opinion shifts are not likely.

The Delphi technique has been widely used in addressing a considerable variety of problems. First applications in the area of forecasting were followed by business and social planning applications. Prediction of future trends with great uncertainty and diverse opinion, advisability of alternative corporate strategies, establishment of social planning priorities, identification of underlying assumptions or information leading to diverse judgements, and correlation of expert judgements on various topics have all been successfully addressed using the technique. Two other applications of the Delphi technique to Canadian forestry preceded the growth and yield study reported herein. Phillips *et al.* (1986) used the technique to establish forest economics research priorities in western Canada. Fraser *et al.* (1985) applied the technique to forecast the potential impact of the long range transport of air pollutants on Canadian forests.

Application of the Delphi technique is particularly appropriate for a survey on growth and yield forest productivity in Canada. Experts are spread across the country, and the fact that the technique does not require face-to-face meetings of respondents is a distinct cost saving advantage. Resulting anonymity is also useful given the limited information available and the need for speculation. Self-consciousness in a face-to-face setting could otherwise interfere with some or all of the creative thought processes. Furthermore, balanced participation by the entire respondent group, and balanced attention to each idea, is facilitated by the technique. In a face-to-face setting, individual reputations, position seniority and personality styles may result in an imbalance of participation and attention to ideas. Individual judgements can be swayed by group social pressure. The application of the technique avoids these potential problems. Finally, survey responses can be quantified thus allowing for aggregation of individual judgements.

There are also a number of potential limiting factors that can arise in using this technique, but were not deemed to be problematic in this case. For example, the time required to design, distribute, revise and process each round of questionnaires can be considerable. In this case, the full growth and yield survey (three rounds) extended over a ten-month period and required a considerable commitment of staff resources to develop and test questionnaires and to analyze the results. The fact that the technique required participant skills in written communication was not an issue given that the respondent group consisted of professional foresters. A high degree of motivation to commit essential time and effort to the process in the part of respondents was, however, essential.

2.2 REGIONS AND SPECIES AGGREGATIONS

The growth of Canada's diverse forests is a function of many variables including climate, patterns of disturbance, tree species, silvicultural programs, site productivity, aspect, and geographic location, among other things. While there is a large amount of site and species specific data as well as anecdotal information on growth, there is very little information available at a broad scale for regional and national planning and decision-making purposes. While we recognize that there are significant biological and geographical differences across Canada that will have impacts on expected future yields, from a statistical and logistical point of view the number of experts limited the possible number of categories and regions. Therefore, responses are solicited based on Rowe's forest regions (Rowe, 1972) as a broad proxy for ecological regions. These were subdivided into provincial regions, to reflect the reality that most experts would tend to be more comfortable responding to their immediate region, but not, for example, for all of the boreal forest region of Canada. Species groups (i.e., softwood, hardwood, mixed-wood) further stratify the results. Aggregate species groups were required in order to obtain a manageable number of categories and hence questions. Respondents included information on the relevant species in their responses, i.e., the designation of hardwoods includes different species in the boreal region than in the Great Lakes/St. Lawrence region.

The high degree of aggregation of regions, treatments and species was a significant problem for many experts. Some experts dropped out as a result. More detailed information is of course preferable from a regional or provincial point of view, and is required for timber supply analyses. This study, however, allows a national perspective on growth and yield, with comparability among regions, and a manageable number of options and categories, and is a useful benchmark or baseline for future studies.

2.3 PROCESS

The selection of the panel was carried out using a peer-nominating technique to identify individual participants. The process began with the selection of well-known and respected individuals in the area of growth and yield. These individuals were contacted and provided with an explanation of the survey project, including criteria for selecting panel members. These same individuals were then asked for nominations of individuals who were felt to be desirable participants in the survey. A list of nominees was then prepared with particular attention paid to multiple nominations (i.e., if a person was nominated by a number of different people, then their status as an expert was probably justified). Consideration was made of appropriate representation of both biological forest regions and geographic regional jurisdictions in Canada. Individuals from this list were then asked to participate and a final list of panel members was developed.

The research team was guided by an advisory panel consisting of seven leading growth and yield experts from across Canada (Appendix A). The advisory panel was instrumental in establishing the panel of experts by identifying the initial list of potential panel members. The advisory panel also pre-tested and critically reviewed initial questionnaire drafts. One of the advisory panel members, Mr. Joe Lowe, arranged to provide base line growth and yield data that served as an initial benchmark in questionnaire #1 (see Appendix C).

Seventy-seven experts (listed in Appendix B) were nominated through the selection process outlined above. From this list over 50 actively participated in the survey process by responding to one or more of the three rounds of questionnaires. Every effort was made to have at least six panel members for each of the 13 forest regions, identified geographically as follows (see Rowe, 1972):

1. Atlantic Acadian
2. Atlantic Boreal
3. Quebec Great Lakes - St. Lawrence
4. Quebec Boreal
5. Ontario Great Lakes - St. Lawrence
6. Ontario Boreal
7. Prairie/Northwest Territories (NWT) Boreal
8. Yukon/Interior British Columbia Boreal
9. Interior British Columbia Subalpine
10. Interior British Columbia Montane
11. Interior British Columbia

12. Coast British Columbia Coast, and
13. Coast British Columbia Subalpine.

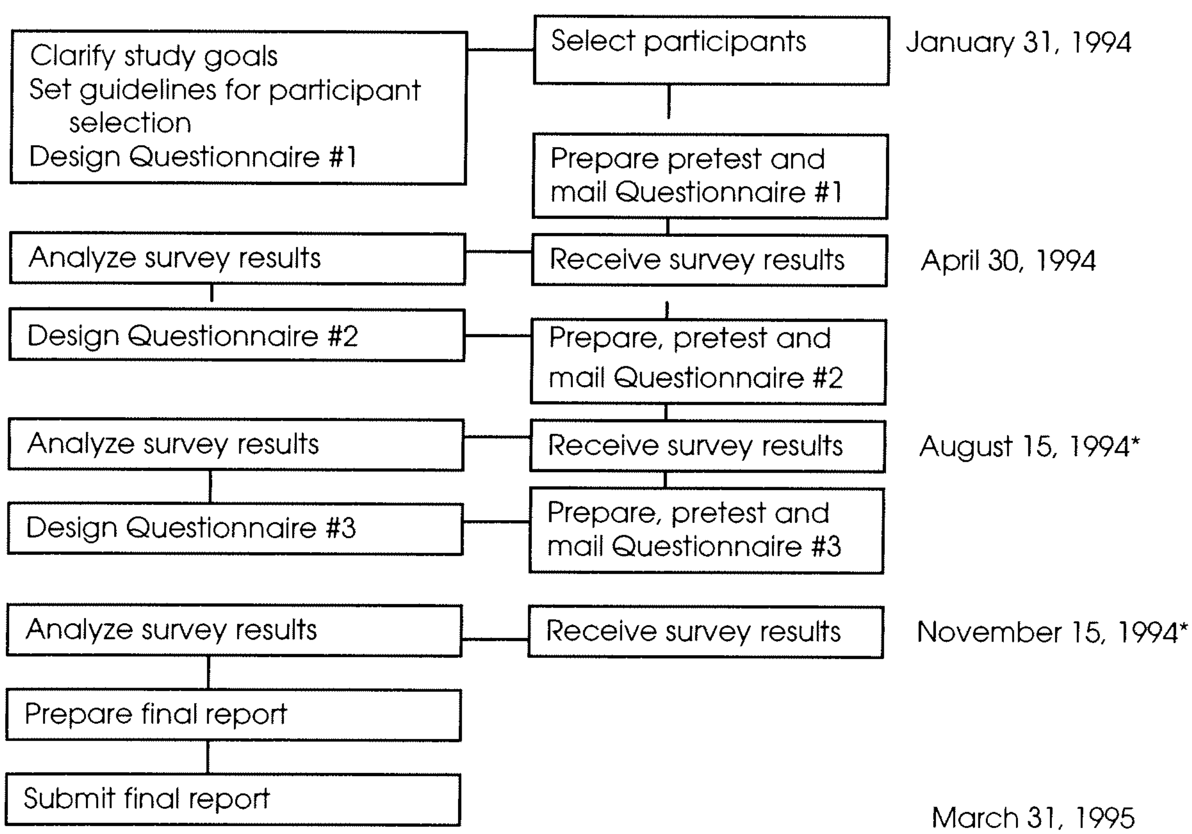
The survey process consisted of several stages beginning with clarification of goals and ending with a final report. The flow chart in Figure 1 describes the intervening stages as well as dates of completion of each stage.

2.4 QUESTIONNAIRE DESIGN

Questionnaire #1

Questionnaire #1, used in the first of the three rounds of questionnaires, consisted of two parts, one for existing stands and one for regenerated stands (see Appendix C for sample questionnaires. A separate technical appendix contains the questionnaires for all regions). Existing stands are those stands currently standing (stands alive "today"). Regenerated stands are those stands that would regenerate after harvesting (stands originating after "today").

Figure 1



*These delayed dates reflect the fact there was a poor response rate for four of the B.C. Regions and efforts on the part of the authors to get further responses for these regions.

The specific questions in each section were accompanied by baseline data from Canada's Forest Inventory (CanFI91) (Lowe et al. 1994) made available by Mr. Joe Lowe of the Petawawa National Forest Institute. For each of the 13 survey regions, baseline estimates were given for the areas (ha) within the region by species grouping as well as mean annual increments (MAI) (m^3/ha/year). Species groupings of softwood, mixed-wood and hardwood were used. This same breakdown was used in a series of bar graphs showing volumes per hectare (m^3/ha) by age class (20 year classes). The data were based on Canada's forest inventory and represented average values for each of the regions in the survey. These data represented a basis for comparison, and questionnaire respondents were referred to the data in order to answer the various questions for both existing and regenerated stands. The same questions were used for each of the 13 regions; only the baseline data varied by region.

Respondents first considered growth and yield of existing stands. They were asked to assess the baseline inventory estimates of MAI by species group, to determine whether they seemed too high, too low, or about right. They were then asked to provide their estimates for an area-weighted mean age of mature stands for each species grouping. Based on their revised estimates of MAI for mature stands, the respondents were then asked how their estimates of MAIs would change (in percentage terms) if the area weighted mean ages were 20 years older, 20 years younger and 40 years younger.

Respondents were then asked to consider yield responses over time from fertilizer applications. The percent change in yield, as well as the number of years this change would be in effect, were considered. Finally, impacts of thinning on both usable fibre (from harvest as well as thinnings) (increase or decrease in percent) and rotation age (increase or decrease in number of years) were considered.

Basically the same type of questions were then asked for regenerated stands. Respondents were asked what the average age at harvest would likely be, as well as the MAI at harvest in comparison to the baseline data. Questions were again asked regarding fertilizer and thinning impacts. Estimates of changes in useable fibre and rotation ages from juvenile spacing, genetically improved stands, and cleaned/brush controlled stands were also considered. At the conclusion of questionnaire #1, respondents were invited to provide any comments regarding the questionnaire or concerns that could be dealt with in subsequent rounds.

Questionnaire #2

Questionnaire #2 also consisted of two parts, one for existing stands and one for regenerated stands (see Appendix C). Some of the original baseline data as well as the mean responses from questionnaire #1 were brought forward into questionnaire #2 for further refinement and elaboration. There were also some changes in the framing of questions, in direct response to comments provided in round one. The result was improved clarity in questionnaire design. The data provided varied by region but, again, the questions themselves were identical across regions. Once again the softwood, mixed-wood and hardwood breakdown was applied throughout.

For existing stands, respondents were provided with the baseline estimates of MAI from the inventory, as well as the round one mean responses. Mean ages of mature stands from round one responses were also provided. The round one information was reformulated into a table (see question 1a) showing age and mean MAI responses from questionnaire #1 in 20 year classes. Respondents were asked to provide revised MAI estimates based on the round one feedback.

Based on feedback from round one, respondents were also asked a series of questions on uneven-aged stands. They were asked to indicate the percent of area in the region managed by uneven-aged management, the growth/ha/year on areas managed by uneven-aged management, the after-cut growing stock level (m^3/ha) left in areas managed by uneven-aged management, and the average cutting cycle (in years) used on areas managed by uneven-aged management.

The second question under existing stands in Questionnaire #2 dealt with fertilization applications and responses. Round one mean responses on yield increases and periods of effectiveness were presented as a point of departure for revised and expanded responses. In particular, respondents were asked to indicate the range of stand ages within which they would fertilize, the rates of fertilizer they would apply (kg/ha), the percentages of good, medium and poor sites they would fertilize, the expected growth increase (m^3/ha/y), and the length of time (years) that the increased growth would last.

The third question under existing stands in Questionnaire #2 dealt with thinning. The responses to thinning from round one were presented and further responses requested. In particular respondents were asked to provide changes in growth (m^3/ha/y), length of time growth changes would last (years), changes in rotation (years) based on harvestable tree size, and changes in rotation based on maximum MAI from cleaning/brushing, juvenile spacing/pre-commercial thinning, and commercial thinning.

For regenerated stands, the same three question sets as for existing stands were repeated, except with the corresponding different responses from questionnaire #1. In addition, a question on genetic improvement was unique to regenerated stands. Round one responses to genetic improvement were presented and respondents were asked to give revised and expanded responses. In particular they were asked to provide expected changes in MAI (m^3/ha/y) from genetic improvement, expected changes in rotation (years) based on harvestable tree size, and expected changes in rotation (years) based on maximum MAI.

Questionnaire #3

The responses called for in round two met the objectives of the study in terms of the nature and extent of growth and yield data solicited. The purpose of the third round was to provide feedback from the previous rounds and to provide an opportunity for respondents to revise their individual responses, if desired, after reviewing the earlier collective responses. As a consequence, the questions in Questionnaire #3 were identical to those in Questionnaire #2. The only difference was the provision of mean responses from both rounds one and two. Once again the questions were identical across the 13 regions, but the mean responses varied over the regions.

3. SURVEY RESULTS

3.1 RESPONDENT CHARACTERISTICS AND RESPONSE RATES

The 77 selected panel members (see Appendix B) were drawn from government (federal and provincial), private and university sectors (Table 1). The majority were employed by governments, reflecting the heavy government involvement in growth and yield research programs. There were also significant numbers employed in the private sector.

Table 1: Nominee Group by Employer Category

Category	Number of Nominees
Government	44
Private Sector	24
University	9
Total	77

Nominees were geographically distributed and represented all regions of Canada. Table 2 shows the distribution of individuals by region. The largest number came from British Columbia followed by Ontario. This distribution reflects the need to have expertise in all of the various forest regions within these geographic areas.

Table 2: Nominee Group by Geographical Location

Geographic Area	Number of Nominees
Newfoundland	6
Maritimes	6
Quebec	6
Ontario	18
Prairie/Northwest Territories	15
British Columbia/Yukon	26
Total	77

The response rates were somewhat lower than the 77 individuals initially identified. Reasons for non-response varied but were largely related to pressures from other commitments or the inability to respond given the high level of aggregation asked for in the questionnaires. The number of respondents varied over the three rounds of questionnaires (Table 3). Not all respondents completed all three rounds. Many respondents provided expert response to more than one of the 13 forest regions for each round.

Table 3: Number of respondents by forest region for each round of Questionnaires

Forest Region	Round One	Round Two	Round Three
Atlantic-Acadian	6	3	2
Atlantic-Boreal	5	3	3
Quebec-Great Lakes-St. Lawrence	4	7	3
Quebec-Boreal	5	5	3
Ontario-Great Lakes-St. Lawrence	8	4	6
Ontario-Boreal	7	5	5
Prairie/NWT-Boreal	12	7	8
Yukon/Interior B.C.-Boreal	2	2	1
Interior B.C.-Subalpine	2	0	1
Interior B.C.-Montane	3	0	1
Interior B.C.-Columbia	5	1	1
Coastal B.C.-Coast	7	2	4
Coastal B.C.-Subalpine	4	2	4
Total No. of Responses	70	41	42
Total No. of Respondents	51	29	29

3.2 REGIONAL GROWTH ESTIMATES

Table 4 summarizes the responses of participants for existing and regenerated stands for each region for softwood, mixed-wood, and hardwood species groups. These estimates represent an average for the whole region, over all sites and species, for a pulpwood utilization standard. For existing stands, the fourth age (shown as bold) in each species group represents the participants' estimate of the area-weighted mean age of harvest of that species group and the mean annual increment, MAI, of that age. Participants provided MAI values which were then multiplied by age to produce the per hectare volumes in Table 4. For regenerated stands, this fourth age (also bold) represents the expected age of harvest of regenerated stands. This fourth age was considered the base age, and growth estimates for age classes in the two 20 year age classes above and below this age were considered.

For existing stands, participants' responses confirm that, in most of the country, stands are currently being harvested above the age of maximum MAI. The major regional exception to this is the Quebec-Great Lakes/St. Lawrence region where current harvest is estimated to be right at the age of maximum MAI.

For regenerated stands, participants estimated future harvest ages at or slightly older than the age of maximum MAI for all regions except the Atlantic-Acadian and Ontario-Great Lakes/St. Lawrence regions, where estimated harvest ages were beyond the age of maximum MAI.

Table 4: Regional Growth & Yield Estimates

Atlantic - Acadian

Existing Stands

Softwood			Mixed-wood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
16	2.0	32	18	2.2	40	23	2.3	53
36	2.2	79	38	2.3	87	43	2.4	103
56	2.2	123	58	2.3	133	63	2.3	145
76	1.7	129	**78**	1.8	140	**83**	1.9	158
96	1.1	106	98	1.4	137	103	1.5	155
116	0.3	35	118	1.0	118	123	1.2	148

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
0	1.0	0	0	1.0	0	0	1.0	0
8	2.3	18	15	2.8	42	18	2.8	50
28	3.7	104	35	2.8	98	38	2.8	106
48	3.0	144	**55**	2.2	121	**58**	2.3	133
68	2.9	197	75	2.0	150	78	2.0	156
88	2.3	202	95	1.8	171	98	1.9	186

Atlantic - Boreal

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
31	1.1	34	34	1.8	61	15	1.3	20
51	2.0	102	54	2.3	124	35	1.9	67
71	1.9	135	74	2.0	148	55	1.8	99
91	1.6	146	**94**	1.7	160	**75**	1.6	120
111	1.1	122	114	1.1	125	95	1.3	124
131	1.0	131	134	0.6	80	115	1.2	138

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
0	0.0	0	0	0.0	0	0	0.0	0
19	0.3	6	18	1.0	18	12	1.3	16
39	1.9	74	38	2.0	76	32	2.3	74
59	2.3	136	**58**	2.5	145	**52**	2.8	146
79	2.0	158	78	2.3	179	72	2.5	180
99	1.7	168	98	1.5	147	92	1.8	166

Table 4: Regional Growth & Yield Estimates (Continued)

Coastal B.C. - Coast

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
198	3.3	653	125	4.7	588	22	4.0	88
218	2.9	632	145	4.3	624	42	5.7	239
238	2.8	666	165	3.9	644	62	5.2	322
258	2.7	697	**185**	3.6	666	**82**	4.7	385
278	2.5	695	205	3.2	656	102	3.4	347
298	2.0	596	225	2.9	653	122	2.0	244

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
27	4.7	127	29	3.6	104	1	0.0	0
47	6.2	291	49	4.8	235	21	5.2	109
67	7.5	503	69	5.5	380	41	7.1	291
87	7.5	653	**89**	5.8	516	**61**	6.7	409
107	7.0	749	109	5.7	621	81	5.6	454
127	6.4	813	129	5.2	671	101	4.3	434

Coastal B.C. - Subalpine

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
209	2.8	585	193	2.7	521	17	0.4	7
229	2.7	618	213	2.6	554	37	0.6	22
249	2.6	647	233	2.4	559	57	0.9	51
269	2.5	673	**253**	2.3	582	**77**	1.1	85
289	2.4	694	273	2.1	573	97	1.2	116
309	2.0	618	293	1.9	557	117	1.2	140

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
55	3.1	171	37	2.4	89	5	0.8	4
75	4.0	300	57	3.0	171	25	2.0	50
95	5.0	475	77	3.6	277	45	2.9	131
115	4.8	552	**97**	3.8	369	**65**	3.6	234
135	4.4	594	117	3.7	433	85	3.3	281
155	4.0	620	137	3.5	480	105	2.7	284

Table 4: Regional Growth & Yield Estimates (Continued)

Interior B.C. - Columbia

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
103	3.0	309	83	2.3	191	47	1.5	71
123	2.9	357	103	2.5	258	67	1.8	121
143	2.8	400	123	2.4	295	87	2.0	174
163	2.6	424	**143**	2.3	329	**107**	1.8	193
183	2.4	439	163	2.1	342	127	1.5	191
203	2.2	447	183	1.9	348	147	1.0	147

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
34	1.2	41	33	1.0	33	17	1.0	17
54	2.2	119	53	1.8	95	37	1.6	59
74	2.8	207	73	2.3	168	57	2.0	114
94	3.2	301	**93**	2.6	242	**77**	2.3	177
114	3.1	353	113	2.5	283	97	2.2	213
134	3.0	402	133	2.4	319	117	2.0	234

Interior B.C. - Montane

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
100	2.0	200	105	2.0	210	95	2.0	190
120	2.3	276	125	2.3	288	115	2.2	253
140	2.2	308	145	2.2	319	135	2.1	284
160	2.1	336	**165**	2.1	347	**155**	1.9	295
180	2.0	360	185	2.0	370	175	1.7	298
200	1.8	360	205	1.8	369	195	1.4	273

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
40	2.0	80	30	1.5	45	10	0.8	8
60	2.5	150	50	2.4	120	30	2.0	60
80	2.8	224	70	2.9	203	50	2.5	125
100	3.0	300	**90**	3.2	288	**70**	2.8	196
120	2.9	348	110	3.1	341	90	2.6	234
140	2.8	392	130	3.0	390	110	2.4	264

Table 4: Regional Growth & Yield Estimates (Continued)

Interior B.C. - Subalpine

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
130	3.0	390	140	2.5	350	90	2.0	180
150	2.9	435	160	2.4	384	110	1.9	209
170	2.8	476	180	2.2	396	130	1.7	221
190	2.6	494	**200**	2.0	400	**150**	1.5	225
210	2.4	504	220	1.8	396	170	1.3	221
230	2.0	460	240	1.6	384	190	1.0	190

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
60	2.5	150	40	1.8	72	20	1.0	20
80	2.9	232	60	2.4	144	40	1.8	72
100	3.1	310	80	2.8	224	60	2.2	132
120	3.0	360	**100**	3.0	300	**80**	2.5	200
140	2.9	406	120	2.9	348	100	2.3	230
160	2.7	432	140	2.7	378	120	2.0	240

NWT and Prairies - Boreal

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
49	1.4	69	40	1.7	68	26	1.9	49
69	1.6	110	60	1.9	114	46	2.3	106
89	1.7	151	80	1.9	152	66	2.4	158
109	1.6	174	**100**	1.9	190	**86**	2.3	198
129	1.4	181	120	1.7	204	106	2.1	223
149	1.3	194	140	1.5	210	126	1.6	202

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha	Age Years	MAI $m^3/ha/y$	Vol/ha m^3/ha
30	1.3	39	33	1.7	56	8	1.8	14
50	1.7	85	53	2.0	106	28	2.2	62
70	1.9	133	73	2.8	204	48	2.4	115
90	1.8	162	**93**	2.7	251	**68**	2.4	163
110	1.7	187	113	2.6	294	88	2.2	194
130	1.5	195	133	1.8	239	108	2.0	216

Table 4: Regional Growth & Yield Estimates (Continued)

Ontario - Boreal

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
40	1.7	68	33	2.0	66	23	2.1	48
60	2.0	120	53	2.3	122	43	2.8	120
80	2.1	168	73	2.4	175	63	2.8	176
100	2.0	200	**93**	2.1	195	**83**	2.5	208
120	1.7	204	113	1.8	203	103	2.0	206
140	1.4	196	133	1.5	200	123	1.6	197

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
19	1.1	21	15	1.0	15	1	0.6	1
39	1.7	66	35	1.8	63	21	2.0	42
59	2.0	118	55	2.4	132	41	2.5	103
79	2.1	166	**75**	2.5	188	**61**	2.9	177
99	1.8	178	95	2.1	200	81	2.6	211
119	1.6	190	115	1.7	196	101	2.1	212

Ontario - Great Lakes/St. Lawrence

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
53	2.1	111	42	2.1	88	50	2.0	100
73	2.3	168	62	2.4	149	70	2.3	161
93	2.3	214	82	2.5	205	90	2.3	207
113	2.2	249	**102**	2.1	214	**110**	2.0	220
133	1.9	253	122	2.0	244	130	1.8	234
153	1.6	245	142	1.7	241	150	1.6	240

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
27	2.7	73	21	2.2	46	21	1.9	40
47	3.1	146	41	2.7	111	41	2.4	98
67	2.9	194	61	2.9	177	61	2.8	171
87	2.8	244	**81**	2.8	227	**81**	2.8	227
107	2.3	246	101	2.5	253	101	2.2	222
127	1.9	241	121	2.2	266	121	1.9	230

Table 4: Regional Growth & Yield Estimates (Continued)

Quebec - Boreal

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
44	0.7	31	32	0.9	29	18	0.9	16
64	1.2	77	52	1.5	78	38	1.6	61
84	1.2	101	72	1.6	115	58	2.0	116
104	1.0	104	**92**	1.4	129	**78**	1.8	140
124	0.7	87	112	1.0	112	98	1.5	147
144	0.5	72	132	0.6	79	118	0.9	106

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
16	0.4	6	6	0.3	2	0	0.5	0
36	0.9	32	26	1.0	26	16	1.0	16
56	1.3	73	46	1.8	83	36	1.9	68
76	1.4	106	**66**	1.8	119	**56**	2.1	118
96	1.1	106	86	1.4	120	76	1.9	144
116	0.9	104	106	0.7	74	96	1.7	163

Quebec - Great Lakes/St. Lawrence

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
0	0.0	0	10	0.6	6	25	1.2	30
20	1.3	26	30	1.5	45	45	1.7	77
40	1.5	60	50	1.9	95	65	2.0	130
60	1.6	96	**70**	2.0	140	**85**	2.2	187
80	1.4	112	90	1.9	171	105	2.0	210
100	1.0	100	110	1.7	187	125	1.9	238

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
0	0.7	0	10	0.7	7	50	1.6	80
18	0.7	13	30	1.4	42	70	2.0	139
38	1.5	57	50	1.9	95	90	2.0	180
58	1.8	104	**70**	2.0	140	**110**	2.1	231
78	1.7	133	90	1.8	162	130	1.9	247
98	1.3	127	110	1.6	176	150	0.9	135

Table 4: Regional Growth & Yield Estimates (Continued)

Yukon and Interior B.C. - Boreal

Existing Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
85	1.9	162	80	2.2	176	55	1.9	105
105	2.0	210	100	2.3	230	75	2.0	150
125	1.9	238	120	2.1	252	95	1.9	181
145	1.8	261	**140**	2.0	280	**115**	1.8	207
165	1.7	281	160	1.9	304	135	1.6	216
185	1.6	296	180	1.8	324	155	1.2	186

Regenerated Stands

Softwood			Mixedwood			Hardwood		
Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha	Age Years	MAI m^3/ha/y	Vol/ha m^3/ha
55	1.8	99	45	2.0	90	15	1.9	29
75	1.9	143	65	2.1	137	35	2.2	77
95	2.0	190	85	2.2	187	55	2.3	127
115	2.0	230	**105**	2.2	231	**75**	2.4	180
135	1.9	257	125	2.1	263	95	2.3	219
155	1.8	279	145	1.9	276	115	2.1	242

3.3 RESPONSES TO SILVICULTURAL TREATMENTS

As well as developing estimates for existing and regenerated stand growth rates, the survey attempted to obtain estimates of the growth responses to various silvicultural management options. Estimates were obtained for each species group (softwood, hardwood and mixed-wood) for growth-related data for unevenaged management, and responses to fertilization, cleaning/brushing, juvenile spacing/pre-commercial thinning, and commercial thinning for existing stands. For regenerated stands, response information was gathered for all of the above silvicultural techniques as well as genetic improvement. These estimates are summarized by region in Tables 5-17 and are shown in detail in the technical appendix to this report.

Unevenaged Management

Participants were asked to estimate what proportion of the region was currently managed by unevenaged management as well as what portion of the area would be managed by unevenaged management in the future. Results tend overall to indicate that more area will be managed by unevenaged management in the future compared to the present levels, although there are many exceptions.

The Great Lakes/St. Lawrence region (both Quebec and Ontario) had the largest proportion of area managed by unevenaged management. Growth estimates for unevenaged management, in general and for most regions, tended to be lower, usually significantly lower, than the maximum MAI growth rates estimated for each species group. The reserve growing stock levels, with the exception of British Columbia, tended to be in the 80 to 120 m^3/ha range, while the estimated cutting cycle was close to 20 years in almost all cases.

The survey results for this section tended to have less closure between survey rounds across all regions, and tended to have large standard deviations in comparison to mean values.

Fertilization

Estimates of fertilization rates were in the 150 to 275 kg/ha range, with a tendency to concentrate fertilization on Good and Medium site classes for both existing and regenerated stands. Age of application appears to vary considerably across regions as well as for existing and regenerated stands. For existing stands, results indicate that fertilization would occur near harvest age for the Quebec - Great Lakes/St. Lawrence, the Atlantic - Boreal and the Ontario - Boreal regions. On the other hand, fertilization in all Coastal and Interior British Columbia regions would occur only on young existing stands. In the remaining regions, fertilization tended to occur at mid-rotation age.

For regenerated stands, fertilization was expected to occur near harvest age for both Atlantic regions and the Quebec - Boreal region. Fertilization of regenerated stands was expected at an early stage for all British Columbia regions except the Coast British Columbia - Coast region which would be fertilized at an early to mid-rotation age time. Fertilization of the remaining regions was estimated to occur at mid-rotation age.

Estimates of growth increases from fertilization, and the duration of the increased growth, did not differ significantly between existing stands and regenerated stands in any specific region. Increased growth ranged from 0.1 m^3/ha/year for regenerated stands in the Atlantic - Acadian region to 2.6 m^3/ha/year for Coast British Columbia - Coastal region, for

Table 5: Estimated Results of Silvicultural Options
Atlantic - Acadian

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	4.0	%	9.0	%	23.0	%
Growth per Hectare per Year	1.8	m^3/ha/y	1.8	m^3/ha/y	1.8	m^3/ha/y
After Cut Growing Stock	79	m^3/ha	77	m^3/ha	77	m^3/ha
Cutting Cycle Length	18	years	18	years	18	years
Fertilization						
Minimum Stand	32	years	34	years	34	years
Maximum Stand	45	years	50	years	53	years
Rate of Application	200	kg/ha	200	kg/ha	200	kg/ha
Increase in Growth	0.2	m^3/ha/y	0.2	m^3/ha/y	0.2	m^3/ha/y
Duration of Increased Growth	5	years	5	years	5	years
Cleaning/Brushing						
Change in Growth	0.4	m^3/ha/y	0.4	m^3/ha/y	0.4	m^3/ha/y
Duration of Growth Response	13	years	13	years	13	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-2	years	-2	years	-2	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	2.6	m^3/ha/y	2.6	m^3/ha/y	2.6	m^3/ha/y
Duration of Growth Response	23	years	23	years	23	years
Change in Tree Size Rotation	0	years	2	years	2	years
Change in MAI Rotation	10	years	10	years	10	years
Commercial Thinning						
Change in Growth	0.8	m^3/ha/y	0.8	m^3/ha/y	0.8	m^3/ha/y
Duration of Growth Response	20	years	20	years	20	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	10	years

Table 5: Estimated Results of Silvicultural Options (Continued)
Atlantic - Acadian

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	4.0	%	6.0	%	20.0	%
Growth per Hectare per Year	4.9	m^3/ha/y	1.9	m^3/ha/y	1.9	m^3/ha/y
After Cut Growing Stock	78	m^3/ha	78	m^3/ha	78	m^3/ha
Cutting Cycle Length	18	years	18	years	18	years
Fertilization						
Minimum Stand	25	years	25	years	25	years
Maximum Stand	40	years	40	years	50	years
Rate of Application	200	kg/ha	200	kg/ha	200	kg/ha
Increase in Growth	0.1	m^3/ha/y	0.1	m^3/ha/y	0.1	m^3/ha/y
Duration of Increased Growth	5	years	5	years	5	years
Cleaning/Brushing						
Change in Growth	0.4	m^3/ha/y	0.4	m^3/ha/y	0.4	m^3/ha/y
Duration of Growth Response	13	years	13	years	13	years
Change in Tree Size Rotation	0	years	0	years	0	years
Change in MAI Rotation	0	years	0	years	0	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	2.1	m^3/ha/y	2.4	m^3/ha/y	2.6	m^3/ha/y
Duration of Growth Response	23	years	23	years	23	years
Change in Tree Size Rotation	-13	years	-13	years	-11	years
Change in MAI Rotation	10	years	12	years	15	years
Commercial Thinning						
Change in Growth	0.0	m^3/ha/y	0.0	m^3/ha/y	0.0	m^3/ha/y
Duration of Growth Response	10	years	10	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	10	years
Genetic Improvement						
Change in MAI	0.7	m^3/ha/y	0.3	m^3/ha/y	0.3	m^3/ha/y
Change in Tree Size Rotation	0	years	-2	years	-2	years
Change in MAI Rotation	0	years	NA	years	NA	years

Table 6: Estimated Results of Silvicultural Options
Atlantic - Boreal

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	2.0	%	2.5	%	2.5	%
Growth per Hectare per Year	1.7	m^3/ha/y	1.8	m^3/ha/y	1.9	m^3/ha/y
After Cut Growing Stock	75	m^3/ha	100	m^3/ha	125	m^3/ha
Cutting Cycle Length	20	years	15	years	10	years
Fertilization						
Minimum Stand	50	years	45	years	NA	years
Maximum Stand	70	years	55	years	NA	years
Rate of Application	200	kg/ha	150	kg/ha	NA	kg/ha
Increase in Growth	1.5	m^3/ha/y	1.0	m^3/ha/y	NA	m^3/ha/y
Duration of Increased Growth	10	years	5	years	NA	years
Cleaning/Brushing						
Change in Growth	1.0	m^3/ha/y	1.3	m^3/ha/y	1.5	m^3/ha/y
Duration of Growth Response	15	years	15	years	5	years
Change in Tree Size Rotation	-10	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-3	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	1.8	m^3/ha/y	2.3	m^3/ha/y	2.5	m^3/ha/y
Duration of Growth Response	23	years	15	years	10	years
Change in Tree Size Rotation	-18	years	-15	years	-10	years
Change in MAI Rotation	-10	years	-5	years	5	years
Commercial Thinning						
Change in Growth	0.8	m^3/ha/y	1.0	m^3/ha/y	1.3	m^3/ha/y
Duration of Growth Response	20	years	10	years	10	years
Change in Tree Size Rotation	-3	years	-2	years	NA	years
Change in MAI Rotation	3	years	2	years	NA	years

Table 6: Estimated Results of Silvicultural Options (Continued)

Atlantic - Boreal

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	3.0	%	5.0	%	5.0	%
Growth per Hectare per Year	1.8	m^3/ha/y	NA	m^3/ha/y	NA	m^3/ha/y
After Cut Growing Stock	85	m^3/ha	110	m^3/ha	135	m^3/ha
Cutting Cycle Length	20	years	15	years	10	years
Fertilization						
Minimum Stand	30	years	35	years	NA	years
Maximum Stand	50	years	45	years	NA	years
Rate of Application	150	kg/ha	100	kg/ha	NA	kg/ha
Increase in Growth	1.8	m^3/ha/y	1.5	m^3/ha/y	NA	m^3/ha/y
Duration of Increased Growth	10	years	5	years	NA	years
Cleaning/Brushing						
Change in Growth	1.3	m^3/ha/y	1.5	m^3/ha/y	1.8	m^3/ha/y
Duration of Growth Response	20	years	10	years	10	years
Change in Tree Size Rotation	-15	years	-10	years	-10	years
Change in MAI Rotation	-10	years	-5	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	1.4	m^3/ha/y	1.3	m^3/ha/y	1.5	m^3/ha/y
Duration of Growth Response	30	years	20	years	15	years
Change in Tree Size Rotation	-20	years	-20	years	-15	years
Change in MAI Rotation	-13	years	-10	years	-10	years
Commercial Thinning						
Change in Growth	1.0	m^3/ha/y	1.3	m^3/ha/y	1.5	m^3/ha/y
Duration of Growth Response	20	years	10	years	10	years
Change in Tree Size Rotation	-3	years	-2	years	NA	years
Change in MAI Rotation	3	years	2	years	NA	years
Genetic Improvement						
Change in MAI	0.3	m^3/ha/y	0.8	m^3/ha/y	1.0	m^3/ha/y
Change in Tree Size Rotation	-10	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-3	years	-3	years

Table 7: Estimated Results of Silvicultural Options
Coastal B.C. - Coast

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	4.0	%	2.0	%	0.0	%
Growth per Hectare per Year	4.6	m^3/ha/y	3.8	m^3/ha/y	1.3	m^3/ha/y
After Cut Growing Stock	338	m^3/ha	267	m^3/ha	175	m^3/ha
Cutting Cycle Length	20	years	18	years	10	years
Fertilization						
Minimum Stand	28	years	33	years	0	years
Maximum Stand	45	years	52	years	12	years
Rate of Application	233	kg/ha	225	kg/ha	75	kg/ha
Increase in Growth	2.6	m^3/ha/y	1.8	m^3/ha/y	1.0	m^3/ha/y
Duration of Increased Growth	29	years	10	years	7	years
Cleaning/Brushing						
Change in Growth	1.3	m^3/ha/y	1.3	m^3/ha/y	0.5	m^3/ha/y
Duration of Growth Response	40	years	40	years	22	years
Change in Tree Size Rotation	-12	years	-13	years	-3	years
Change in MAI Rotation	4	years	7	years	0	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.2	m^3/ha/y	-0.3	m^3/ha/y	-0.3	m^3/ha/y
Duration of Growth Response	30	years	7	years	6	years
Change in Tree Size Rotation	-12	years	-13	years	-5	years
Change in MAI Rotation	-9	years	7	years	0	years
Commercial Thinning						
Change in Growth	-1.1	m^3/ha/y	-1.3	m^3/ha/y	-1.8	m^3/ha/y
Duration of Growth Response	40	years	37	years	35	years
Change in Tree Size Rotation	-2	years	-2	years	-2	years
Change in MAI Rotation	11	years	13	years	2	years

Table 7: Estimated Results of Silvicultural Options (Continued)
Coastal B.C. - Coast

	Regenerated Stands					
	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	5.0	%	5.0	%	0.0	%
Growth per Hectare per Year	5.4	m^3/ha/yr	4.3	m^3/ha/yr	1.3	m^3/ha/yr
After Cut Growing Stock	300	m^3/ha	267	m^3/ha	175	m^3/ha
Cutting Cycle Length	20	years	20	years	10	years
Fertilization						
Minimum Stand	24	years	28	years	0	years
Maximum Stand	45	years	48	years	16	years
Rate of Application	233	kg/ha	125	kg/ha	75	kg/ha
Increase in Growth	2.6	m^3/ha/yr	1.5	m^3/ha/yr	1.8	m^3/ha/yr
Duration of Increased Growth	28	years	12	years	7	years
Cleaning/Brushing						
Change in Growth	1.4	m^3/ha/yr	1.5	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	39	years	39	years	23	years
Change in Tree Size Rotation	-12	years	-13	years	-3	years
Change in MAI Rotation	4	years	8	years	-2	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.4	m^3/ha/yr	-0.3	m^3/ha/yr	-0.3	m^3/ha/yr
Duration of Growth Response	30	years	7	years	6	years
Change in Tree Size Rotation	-13	years	-13	years	-5	years
Change in MAI Rotation	9	years	8	years	1	years
Commercial Thinning						
Change in Growth	-1.1	m^3/ha/yr	-1.3	m^3/ha/yr	-1.3	m^3/ha/yr
Duration of Growth Response	43	years	38	years	35	years
Change in Tree Size Rotation	-3	years	-4	years	-3	years
Change in MAI Rotation	10	years	11	years	0	years
Genetic Improvement						
Change in MAI	0.5	m^3/ha/yr	1.1	m^3/ha/yr	1.2	m^3/ha/yr
Change in Tree Size Rotation	-6	years	-5	years	-7	years
Change in MAI Rotation	-4	years	-4	years	-7	years

Table 8: Estimated Results of Silvicultural Options
Coastal B.C. - Subalpine

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	3.0	%	3.0	%	0.0	%
Growth per Hectare per Year	2.5	m^3/ha/yr	2.8	m^3/ha/yr	0.0	m^3/ha/yr
After Cut Growing Stock	118	m^3/ha	107	m^3/ha	0	m^3/ha
Cutting Cycle Length	26	years	27	years	0	years
Fertilization						
Minimum Stand	25	years	35	years	0	years
Maximum Stand	40	years	53	years	25	years
Rate of Application	135	kg/ha	250	kg/ha	0	kg/ha
Increase in Growth	1.7	m^3/ha/yr	1.0	m^3/ha/yr	1.3	m^3/ha/yr
Duration of Increased Growth	35	years	13	years	13	years
Cleaning/Brushing						
Change in Growth	0.4	m^3/ha/yr	0.4	m^3/ha/yr	0.4	m^3/ha/yr
Duration of Growth Response	35	years	48	years	30	years
Change in Tree Size Rotation	-10	years	-12	years	-5	years
Change in MAI Rotation	7	years	12	years	-3	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.3	m^3/ha/yr	-0.3	m^3/ha/yr	-0.3	m^3/ha/yr
Duration of Growth Response	32	years	10	years	7	years
Change in Tree Size Rotation	-12	years	-15	years	-7	years
Change in MAI Rotation	5	years	3	years	0	years
Commercial Thinning						
Change in Growth	-1.5	m^3/ha/yr	-1.3	m^3/ha/yr	-1.3	m^3/ha/yr
Duration of Growth Response	33	years	40	years	27	years
Change in Tree Size Rotation	-4	years	-3	years	-3	years
Change in MAI Rotation	15	years	17	years	7	years

Table 8: Estimated Results of Silvicultural Options (Continued)
Coastal B.C. - Subalpine

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	6.0	%	7.0	%	0.0	%
Growth per Hectare per Year	2.5	m^3/ha/yr	2.5	m^3/ha/yr	0.0	m^3/ha/yr
After Cut Growing Stock	163	m^3/ha	167	m^3/ha	0	m^3/ha
Cutting Cycle Length	24	years	23	years	0	years
Fertilization						
Minimum Stand	25	years	35	years	0	years
Maximum Stand	40	years	53	years	25	years
Rate of Application	135	kg/ha	250	kg/ha	0	kg/ha
Increase in Growth	1.7	m^3/ha/yr	1.0	m^3/ha/yr	1.3	m^3/ha/yr
Duration of Increased Growth	20	years	13	years	13	years
Cleaning/Brushing						
Change in Growth	0.6	m^3/ha/yr	0.6	m^3/ha/yr	0.3	m^3/ha/yr
Duration of Growth Response	30	years	37	years	23	years
Change in Tree Size Rotation	-9	years	-10	years	-2	years
Change in MAI Rotation	5	years	7	years	-2	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.3	m^3/ha/yr	-0.3	m^3/ha/yr	-0.3	m^3/ha/yr
Duration of Growth Response	31	years	8	years	7	years
Change in Tree Size Rotation	-9	years	-13	years	-5	years
Change in MAI Rotation	5	years	7	years	0	years
Commercial Thinning						
Change in Growth	-1.4	m^3/ha/yr	-1.2	m^3/ha/yr	-1.2	m^3/ha/yr
Duration of Growth Response	33	years	38	years	27	years
Change in Tree Size Rotation	-4	years	-3	years	-3	years
Change in MAI Rotation	16	years	17	years	7	years
Genetic Improvement						
Change in MAI	0.3	m^3/ha/yr	0.3	m^3/ha/yr	0.5	m^3/ha/yr
Change in Tree Size Rotation	-7	years	-6	years	-6	years
Change in MAI Rotation	-5	years	-6	years	-6	years

Table 9: Estimated Results of Silvicultural Options
Interior B.C. - Columbia

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	20.0	%	20.0	%	NA	%
Growth per Hectare per Year	2.0	m^3/ha/yr	2.0	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	150	m^3/ha	150	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	30	years	NA	years
Fertilization						
Minimum Stand	0	years	0	years	0	years
Maximum Stand	30	years	30	years	20	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Increased Growth	15	years	15	years	10	years
Cleaning/Brushing						
Change in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	1.0	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-5	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-5	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.5	m^3/ha/yr	-1.5	m^3/ha/yr	-1.5	m^3/ha/yr
Duration of Growth Response	20	years	20	years	15	years
Change in Tree Size Rotation	-3	years	-3	years	-5	years
Change in MAI Rotation	10	years	10	years	10	years

Table 9: Estimated Results of Silvicultural Options (Continued)
Interior B.C. - Columbia

	Regenerated Stands					
	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	30.0	%	30.0	%	0.0	%
Growth per Hectare per Year	2.0	m^3/ha/yr	2.0	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	150	m^3/ha	150	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	30	years	NA	years
Fertilization						
Minimum Stand	0	years	0	years	0	years
Maximum Stand	20	years	20	years	15	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	1.0	m^3/ha/yr
Duration of Increased Growth	15	years	15	years	10	years
Cleaning/Brushing						
Change in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	1.0	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-5	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-0.5	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-5	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.5	m^3/ha/yr	-1.5	m^3/ha/yr	-1.5	m^3/ha/yr
Duration of Growth Response	20	years	20	years	15	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	10	years
Genetic Improvement						
Change in MAI	0.5	m^3/ha/yr	0.5	m^3/ha/yr	1.0	m^3/ha/yr
Change in Tree Size Rotation	-5	years	-5	years	-10	years
Change in MAI Rotation	-5	years	-5	years	-10	years

Table 10: Estimated Results of Silvicultural Options
Interior B.C. - Montane

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	10.0	%	0.0	%	0.0	%
Growth per Hectare per Year	1.8	m^3/ha/yr	NA	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	105	m^3/ha	NA	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	NA	years	NA	years
Fertilization						
Minimum Stand	0	years	0	years	0	years
Maximum Stand	30	years	30	years	20	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	NA	m^3/ha/yr
Duration of Increased Growth	15	years	15	years	NA	years
Cleaning/Brushing						
Change in Growth	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-10	years	-10	years	-10	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr
Duration of Growth Response	20	years	20	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-5	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr
Duration of Growth Response	20	years	20	years	20	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	5	years

Table 10: Estimated Results of Silvicultural Options (Continued)
Interior B.C. - Montane

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	20.0	%	20.0	%	NA	%
Growth per Hectare per Year	2.3	m^3/ha/yr	2.3	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	150	m^3/ha	150	m^3/ha	NA	m^3/ha
Cutting Cycle Length	25	years	25	years	NA	years
Fertilization						
Minimum Stand	0	years	0	years	0	years
Maximum Stand	30	years	30	years	20	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	NA	m^3/ha/yr
Duration of Increased Growth	15	years	15	years	NA	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-10	years	-10	years	-10	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr
Duration of Growth Response	20	years	20	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-5	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr
Duration of Growth Response	20	years	20	years	20	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	5	years
Genetic Improvement						
Change in MAI	0.5	m^3/ha/yr	0.5	m^3/ha/yr	1.0	m^3/ha/yr
Change in Tree Size Rotation	-10	years	-10	years	-15	years
Change in MAI Rotation	-10	years	-10	years	-20	years

Table 11: Estimated Results of Silvicultural Options

Interior B.C. - Subalpine

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	10.0	%	10.0	%	0.0	%
Growth per Hectare per Year	2.5	m^3/ha/yr	2.2	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	150	m^3/ha	150	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	30	years	NA	years
Fertilization						
Minimum Stand	0	years	0	years	0	years
Maximum Stand	30	years	30	years	29	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	1.0	m^3/ha/yr	0.8	m^3/ha/yr	NA	m^3/ha/yr
Duration of Increased Growth	10	years	10	years	NA	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-5	years
Change in MAI Rotation	-10	years	-10	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-0.8	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-10	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.5	m^3/ha/yr	-1.5	m^3/ha/yr	-1.0	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	5	years

Table 11: Estimated Results of Silvicultural Options (Continued)
Interior B.C. - Subalpine

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	20.0	%	10.0	%	NA	%
Growth per Hectare per Year	2.5	m^3/ha/yr	2.5	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	150	m^3/ha	150	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	30	years	NA	years
Fertilization						
Minimum Stand	0	years	0	years	0	years
Maximum Stand	30	years	30	years	10	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	NA	m^3/ha/yr
Duration of Increased Growth	15	years	15	years	NA	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-5	years
Change in MAI Rotation	-10	years	-10	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-0.8	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-10	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.5	m^3/ha/yr	-1.5	m^3/ha/yr	-1.0	m^3/ha/yr
Duration of Growth Response	15	years	15	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	10	years	10	years	5	years
Genetic Improvement						
Change in MAI	0.3	m^3/ha/yr	0.3	m^3/ha/yr	0.5	m^3/ha/yr
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-5	years	-10	years

Table 12: Estimated Results of Silvicultural Options NWT and Prairies - Boreal

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	1.0	%	4.0	%	0.0	%
Growth per Hectare per Year	1.5	m^3/ha/yr	1.7	m^3/ha/yr	1.7	m^3/ha/yr
After Cut Growing Stock	68	m^3/ha	90	m^3/ha	27	m^3/ha
Cutting Cycle Length	35	years	43	years	17	years
Fertilization						
Minimum Stand	37	years	41	years	25	years
Maximum Stand	72	years	75	years	57	years
Rate of Application	74	kg/ha	56	kg/ha	36	kg/ha
Increase in Growth	1.3	m^3/ha/yr	1.9	m^3/ha/yr	2.0	m^3/ha/yr
Duration of Increased Growth	8	years	8	years	8	years
Cleaning/Brushing						
Change in Growth	0.4	m^3/ha/yr	1.0	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	9	years	9	years	8	years
Change in Tree Size Rotation	-9	years	-8	years	-8	years
Change in MAI Rotation	-6	years	-3	years	-3	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.2	m^3/ha/yr	0.2	m^3/ha/yr	0.2	m^3/ha/yr
Duration of Growth Response	9	years	9	years	8	years
Change in Tree Size Rotation	-8	years	-5	years	-4	years
Change in MAI Rotation	-1	years	0	years	0	years
Commercial Thinning						
Change in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	1.0	m^3/ha/yr
Duration of Growth Response	12	years	11	years	10	years
Change in Tree Size Rotation	-10	years	-8	years	-5	years
Change in MAI Rotation	1	years	0	years	-1	years

Table 12: Estimated Results of Silvicultural Options(Continued)
NWT and Prairies - Boreal

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	2.0	%	12.0	%	2.0	%
Growth per Hectare per Year	1.6	m^3/ha/yr	1.8	m^3/ha/yr	1.7	m^3/ha/yr
After Cut Growing Stock	40	m^3/ha	86	m^3/ha	36	m^3/ha
Cutting Cycle Length	34	years	29	years	20	years
Fertilization						
Minimum Stand	41	years	42	years	28	years
Maximum Stand	76	years	78	years	59	years
Rate of Application	74	kg/ha	81	kg/ha	36	kg/ha
Increase in Growth	1.0	m^3/ha/yr	1.2	m^3/ha/yr	1.0	m^3/ha/yr
Duration of Increased Growth	9	years	10	years	8	years
Cleaning/Brushing						
Change in Growth	0.4	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	8	years	8	years	7	years
Change in Tree Size Rotation	-7	years	-7	years	-6	years
Change in MAI Rotation	-5	years	-5	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.2	m^3/ha/yr	0.3	m^3/ha/yr	0.3	m^3/ha/yr
Duration of Growth Response	10	years	9	years	8	years
Change in Tree Size Rotation	-8	years	-8	years	-7	years
Change in MAI Rotation	-1	years	-1	years	-1	years
Commercial Thinning						
Change in Growth	1.0	m^3/ha/yr	1.0	m^3/ha/yr	1.0	m^3/ha/yr
Duration of Growth Response	12	years	11	years	11	years
Change in Tree Size Rotation	-8	years	-7	years	-5	years
Change in MAI Rotation	0	years	-1	years	-1	years
Genetic Improvement						
Change in MAI	0.8	m^3/ha/yr	0.9	m^3/ha/yr	1.2	m^3/ha/yr
Change in Tree Size Rotation	-11	years	-11	years	-13	years
Change in MAI Rotation	-2	years	-2	years	-3	years

Table 13: Estimated Results of Silvicultural Options
Ontario - Boreal

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	NA	%	9.0	%	10.0	%
Growth per Hectare per Year	1.6	m^3/ha/yr	2.0	m^3/ha/yr	2.4	m^3/ha/yr
After Cut Growing Stock	43	m^3/ha	52	m^3/ha	57	m^3/ha
Cutting Cycle Length	32	years	29	years	22	years
Fertilization						
Minimum Stand	14	years	8	years	7	years
Maximum Stand	35	years	33	years	30	years
Rate of Application	183	kg/ha	175	kg/ha	175	kg/ha
Increase in Growth	0.6	m^3/ha/yr	0.5	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Increased Growth	9	years	9	years	8	years
Cleaning/Brushing						
Change in Growth	0.6	m^3/ha/yr	0.5	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	11	years	6	years	7	years
Change in Tree Size Rotation	-2	years	1	years	1	years
Change in MAI Rotation	-1	years	-2	years	2	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.7	m^3/ha/yr	0.7	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	12	years	9	years	12	years
Change in Tree Size Rotation	-7	years	-1	years	-1	years
Change in MAI Rotation	-2	years	-3	years	-3	years
Commercial Thinning						
Change in Growth	0.6	m^3/ha/yr	0.6	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	10	years	8	years	9	years
Change in Tree Size Rotation	-1	years	-3	years	-3	years
Change in MAI Rotation	-2	years	-2	years	-2	years

Table 13: Estimated Results of Silvicultural Options (Continued)
Ontario - Boreal

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	5.0	%	9.0	%	10.0	%
Growth per Hectare per Year	1.8	m^3/ha/yr	2.3	m^3/ha/yr	2.5	m^3/ha/yr
After Cut Growing Stock	55	m^3/ha	55	m^3/ha	55	m^3/ha
Cutting Cycle Length	22	years	20	years	20	years
Fertilization						
Minimum Stand	5	years	8	years	5	years
Maximum Stand	30	years	30	years	30	years
Rate of Application	200	kg/ha	150	kg/ha	150	kg/ha
Increase in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Increased Growth	10	years	8	years	15	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.3	m^3/ha/yr	0.3	m^3/ha/yr
Duration of Growth Response	8	years	7	years	10	years
Change in Tree Size Rotation	-4	years	-1	years	-4	years
Change in MAI Rotation	-2	years	-1	years	-4	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.2	m^3/ha/yr	0.2	m^3/ha/yr	0.2	m^3/ha/yr
Duration of Growth Response	10	years	7	years	9	years
Change in Tree Size Rotation	-4	years	-2	years	-3	years
Change in MAI Rotation	-3	years	-1	years	-3	years
Commercial Thinning						
Change in Growth	0.7	m^3/ha/yr	0.7	m^3/ha/yr	NA	m^3/ha/yr
Duration of Growth Response	10	years	11	years	11	years
Change in Tree Size Rotation	-2	years	-2	years	-2	years
Change in MAI Rotation	-2	years	-2	years	-2	years
Genetic Improvement						
Change in MAI	0.4	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Change in Tree Size Rotation	1	years	-1	years	-1	years
Change in MAI Rotation	1	years	-1	years	-1	years

Table 14: Estimated Results of Silvicultural Options
Ontario - Great Lakes/St. Lawrence

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	15.0	%	25.0	%	50.0	%
Growth per Hectare per Year	2.0	m^3/ha/yr	2.2	m^3/ha/yr	2.5	m^3/ha/yr
After Cut Growing Stock	50	m^3/ha	50	m^3/ha	63	m^3/ha
Cutting Cycle Length	17	years	19	years	22	years
Fertilization						
Minimum Stand	11	years	11	years	6	years
Maximum Stand	33	years	31	years	33	years
Rate of Application	200	kg/ha	208	kg/ha	235	kg/ha
Increase in Growth	0.7	m^3/ha/yr	0.9	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Increased Growth	5	years	5	years	5	years
Cleaning/Brushing						
Change in Growth	0.8	m^3/ha/yr	0.8	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	11	years	6	years	5	years
Change in Tree Size Rotation	-3	years	-1	years	-1	years
Change in MAI Rotation	-1	years	0	years	0	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.9	m^3/ha/yr	0.9	m^3/ha/yr	0.9	m^3/ha/yr
Duration of Growth Response	10	years	8	years	7	years
Change in Tree Size Rotation	-5	years	-4	years	-4	years
Change in MAI Rotation	0	years	-1	years	0	years
Commercial Thinning						
Change in Growth	0.8	m^3/ha/yr	0.8	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	9	years	10	years	11	years
Change in Tree Size Rotation	-2	years	-2	years	-3	years
Change in MAI Rotation	1	years	1	years	1	years

Table 14: Estimated Results of Silvicultural Options (Continued)
Ontario - Great Lakes/St. Lawrence

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	23.0	%	33.0	%	51.0	%
Growth per Hectare per Year	2.5	m^3/ha/yr	2.6	m^3/ha/yr	2.5	m^3/ha/yr
After Cut Growing Stock	66	m^3/ha	84	m^3/ha	82	m^3/ha
Cutting Cycle Length	22	years	22	years	19	years
Fertilization						
Minimum Stand	15	years	13	years	15	years
Maximum Stand	24	years	24	years	32	years
Rate of Application	200	kg/ha	239	kg/ha	175	kg/ha
Increase in Growth	0.9	m^3/ha/yr	0.6	m^3/ha/yr	1.4	m^3/ha/yr
Duration of Increased Growth	6	years	7	years	6	years
Cleaning/Brushing						
Change in Growth	0.7	m^3/ha/yr	0.8	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	8	years	7	years	8	years
Change in Tree Size Rotation	-3	years	-2	years	-3	years
Change in MAI Rotation	-3	years	-1	years	-2	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	12	years	9	years	10	years
Change in Tree Size Rotation	-3	years	-3	years	-3	years
Change in MAI Rotation	0	years	1	years	0	years
Commercial Thinning						
Change in Growth	0.4	m^3/ha/yr	0.4	m^3/ha/yr	0.4	m^3/ha/yr
Duration of Growth Response	9	years	8	years	8	years
Change in Tree Size Rotation	-3	years	-1	years	-2	years
Change in MAI Rotation	1	years	1	years	1	years
Genetic Improvement						
Change in MAI	0.7	m^3/ha/yr	0.6	m^3/ha/yr	0.7	m^3/ha/yr
Change in Tree Size Rotation	-3	years	-3	years	-3	years
Change in MAI Rotation	-3	years	-3	years	-3	years

Table 15: Estimated Results of Silvicultural Options
Quebec - Boreal

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	5.0	%	7.0	%	0.0	%
Growth per Hectare per Year	1.0	m^3/ha/yr	1.3	m^3/ha/yr	1.5	m^3/ha/yr
After Cut Growing Stock	40	m^3/ha	95	m^3/ha	120	m^3/ha
Cutting Cycle Length	30	years	28	years	30	years
Fertilization						
Minimum Stand	58	years	50	years	38	years
Maximum Stand	70	years	63	years	52	years
Rate of Application	254	kg/ha	177	kg/ha	25	kg/ha
Increase in Growth	0.5	m^3/ha/yr	0.6	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Increased Growth	10	years	10	years	10	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.6	m^3/ha/yr	0.6	m^3/ha/yr
Duration of Growth Response	18	years	18	years	14	years
Change in Tree Size Rotation	-8	years	-8	years	-7	years
Change in MAI Rotation	0	years	0	years	0	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.5	m^3/ha/yr	0.6	m^3/ha/yr	0.6	m^3/ha/yr
Duration of Growth Response	23	years	23	years	18	years
Change in Tree Size Rotation	-10	years	-10	years	-8	years
Change in MAI Rotation	-3	years	-3	years	-3	years
Commercial Thinning						
Change in Growth	0.7	m^3/ha/yr	0.7	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	14	years	13	years	13	years
Change in Tree Size Rotation	-7	years	-7	years	-6	years
Change in MAI Rotation	2	years	2	years	2	years

Table 15: Estimated Results of Silvicultural Options (Continued)
Quebec - Boreal

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	10.0	%	17.0	%	0.0	%
Growth per Hectare per Year	1.1	m^3/ha/yr	1.4	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	40	m^3/ha	60	m^3/ha	NA	m^3/ha
Cutting Cycle Length	15	years	10	years	NA	years
Fertilization						
Minimum Stand	50	years	40	years	35	years
Maximum Stand	62	years	52	years	47	years
Rate of Application	254	kg/ha	267	kg/ha	242	kg/ha
Increase in Growth	0.5	m^3/ha/yr	0.4	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Increased Growth	10	years	10	years	10	years
Cleaning/Brushing						
Change in Growth	0.6	m^3/ha/yr	0.6	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	18	years	18	years	14	years
Change in Tree Size Rotation	-6	years	-6	years	-4	years
Change in MAI Rotation	0	years	0	years	0	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.5	m^3/ha/yr	0.6	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	23	years	22	years	18	years
Change in Tree Size Rotation	-9	years	-9	years	-8	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	0.7	m^3/ha/yr	0.8	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	16	years	15	years	14	years
Change in Tree Size Rotation	-7	years	-7	years	-6	years
Change in MAI Rotation	2	years	2	years	2	years
Genetic Improvement						
Change in MAI	0.6	m^3/ha/yr	0.7	m^3/ha/yr	0.8	m^3/ha/yr
Change in Tree Size Rotation	-8	years	-8	years	-8	years
Change in MAI Rotation	-8	years	-8	years	-8	years

Table 16: Estimated Results of Silvicultural Options
Quebec - Great Lakes/St. Lawrence

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	17.0	%	48.0	%	60.0	%
Growth per Hectare per Year	1.6	m^3/ha/yr	2.0	m^3/ha/yr	2.1	m^3/ha/yr
After Cut Growing Stock	88	m^3/ha	98	m^3/ha	105	m^3/ha
Cutting Cycle Length	23	years	20	years	20	years
Fertilization						
Minimum Stand	43	years	40	years	50	years
Maximum Stand	55	years	53	years	67	years
Rate of Application	229	kg/ha	254	kg/ha	294	kg/ha
Increase in Growth	0.6	m^3/ha/yr	0.7	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Increased Growth	10	years	10	years	10	years
Cleaning/Brushing						
Change in Growth	0.6	m^3/ha/yr	0.7	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	13	years	14	years	13	years
Change in Tree Size Rotation	-7	years	-7	years	-7	years
Change in MAI Rotation	-1	years	-1	years	-1	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.7	m^3/ha/yr	0.7	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	13	years	15	years	15	years
Change in Tree Size Rotation	-8	years	-7	years	-7	years
Change in MAI Rotation	-2	years	-2	years	-2	years
Commercial Thinning						
Change in Growth	0.8	m^3/ha/yr	0.8	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	15	years	14	years	14	years
Change in Tree Size Rotation	-6	years	-6	years	-5	years
Change in MAI Rotation	3	years	2	years	2	years

Table 16: Estimated Results of Silvicultural Options (Continued)

Quebec - Great Lakes/St. Lawrence

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	17.0	%	45.0	%	57.0	%
Growth per Hectare per Year	1.1	m^3/ha/yr	2.0	m^3/ha/yr	1.2	m^3/ha/yr
After Cut Growing Stock	88	m^3/ha	98	m^3/ha	105	m^3/ha
Cutting Cycle Length	23	years	20	years	20	years
Fertilization						
Minimum Stand	37	years	42	years	58	years
Maximum Stand	48	years	53	years	65	years
Rate of Application	229	kg/ha	254	kg/ha	2079	kg/ha
Increase in Growth	0.6	m^3/ha/yr	0.7	m^3/ha/yr	0.6	m^3/ha/yr
Duration of Increased Growth	10	years	10	years	10	years
Cleaning/Brushing						
Change in Growth	0.6	m^3/ha/yr	0.8	m^3/ha/yr	0.7	m^3/ha/yr
Duration of Growth Response	13	years	14	years	13	years
Change in Tree Size Rotation	-7	years	-7	years	-7	years
Change in MAI Rotation	-1	years	-1	years	-1	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	0.8	m^3/ha/yr	0.8	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	13	years	15	years	15	years
Change in Tree Size Rotation	-8	years	-7	years	-7	years
Change in MAI Rotation	-2	years	-2	years	-2	years
Commercial Thinning						
Change in Growth	0.8	m^3/ha/yr	0.8	m^3/ha/yr	0.8	m^3/ha/yr
Duration of Growth Response	15	years	14	years	14	years
Change in Tree Size Rotation	-8	years	-8	years	-7	years
Change in MAI Rotation	2	years	2	years	2	years
Genetic Improvement						
Change in MAI	0.8	m^3/ha/yr	0.7	m^3/ha/yr	0.7	m^3/ha/yr
Change in Tree Size Rotation	-8	years	-8	years	-8	years
Change in MAI Rotation	-9	years	-8	years	-8	years

Table 17: Estimated Results of Silvicultural Options

Yukon and Interior B.C. - Boreal

Existing Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	5.0	%	NA	%	NA	%
Growth per Hectare per Year	1.5	m^3/ha/yr	NA	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	100	m^3/ha	NA	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	NA	years	NA	years
Fertilization						
Minimum Stand	5	years	0	years	0	years
Maximum Stand	30	years	30	years	30	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	0.7	m^3/ha/yr	0.3	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Increased Growth	15	years	13	years	10	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	15	years	13	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-5	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr
Duration of Growth Response	15	years	13	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-10	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr
Duration of Growth Response	20	years	17	years	15	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	0	years	0	years	0	years

Table 17: Estimated Results of Silvicultural Options (Continued)
Yukon and Interior B.C. - Boreal

Regenerated Stands

	Softwood		Mixedwood		Hardwood	
Unevenaged Management						
Current Area Management	5.0	%	0.0	%	0.0	%
Growth per Hectare per Year	1.5	m^3/ha/yr	NA	m^3/ha/yr	NA	m^3/ha/yr
After Cut Growing Stock	150	m^3/ha	NA	m^3/ha	NA	m^3/ha
Cutting Cycle Length	30	years	NA	years	NA	years
Fertilization						
Minimum Stand	5	years	0	years	0	years
Maximum Stand	30	years	30	years	30	years
Rate of Application	NA	kg/ha	NA	kg/ha	NA	kg/ha
Increase in Growth	0.7	m^3/ha/yr	0.6	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Increased Growth	15	years	13	years	10	years
Cleaning/Brushing						
Change in Growth	0.5	m^3/ha/yr	0.5	m^3/ha/yr	0.5	m^3/ha/yr
Duration of Growth Response	15	years	13	years	10	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-5	years	-5	years
Juv.Spacing/Pre-com. Thinning						
Change in Growth	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr	-0.5	m^3/ha/yr
Duration of Growth Response	15	years	13	years	10	years
Change in Tree Size Rotation	-10	years	-10	years	-10	years
Change in MAI Rotation	0	years	0	years	0	years
Commercial Thinning						
Change in Growth	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr	-1.0	m^3/ha/yr
Duration of Growth Response	20	years	17	years	15	years
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	0	years	0	years	0	years
Genetic Improvement						
Change in MAI	0.3	m^3/ha/yr	0.3	m^3/ha/yr	0.3	m^3/ha/yr
Change in Tree Size Rotation	-5	years	-5	years	-5	years
Change in MAI Rotation	-5	years	-5	years	-10	years

both regenerated and existing stands. The duration of increased growth was generally in the 5 to 15 year period with some longer periods estimated for the coastal British Columbia regions.

Thinning

Estimated results regarding thinning vary by type of thinning. Respondents commented on the difficulty in answering the extremely simplified questions on thinning for existing stands and on juvenile spacing and thinning for regenerated stands in the round one survey. Thus, the survey for Questionnaires # 2 and #3 extended this section to include more species groups and more classes of thinning (cleaning/brushing, juvenile spacing/pre-commercial thinning, and commercial thinning).

For cleaning/brushing, participants predicted little difference in response between existing stands and regenerated stands within a given region. However, responses between regions vary considerably. The change in growth varies from a low of 0.3 m^3/ha/year for regenerated stands in both the Coast British Columbia - Subalpine and the Ontario - Boreal regions to a high of 1.8 m^3/ha/year for regenerated stands in the Atlantic - Boreal region. Most estimates of expected growth increase fell within the range of 0.5 to 1.0 m^3/ha/year. The estimated duration of the increased growth response due to cleaning/brushing ranges from 5 years for existing stands in the Atlantic - Acadian and the Ontario - Great Lakes/St. Lawrence regions to a high of 40 years in existing stands in the Coast British Columbia - Coast region. Most estimates for duration of the growth response fell within the range of 7 to 15 years. These changes in growth were estimated to modify rotation ages in general by shortening them, although there were some exceptions where extended rotations were predicted.

For juvenile spacing/pre-commercial thinning, participant responses again did not differ significantly between existing stands and regenerated stands within a given region. Differences between regions did exist. Expected growth responses varied from -1.0 m^3/ha/year for the Interior British Columbia - Subalpine region to +2.6 m^3/ha/year for the Atlantic - Acadian region. Predicted growth response was negative for about half of the regions and positive for the other half. Predicted changes in time to reach a rotation based on harvestable tree size range from 0 to -20 years indicating, in general, the expectation of bigger trees sooner. However, the effect on rotation age determined by maximum MAI is mixed, with a range from -13 to +15 years. Most predictions are in the -5 to +5 range.

For commercial thinning, results show more differences between existing stands and regenerated stands than either of the two classes of thinning discussed above, but in general, they are not significantly different within a region. Predicted growth increases range from a low of -1.8 m^3/ha/year for existing stands in the Coast British Columbia - Coast region to a high of +1.5 m^3/ha/year for regenerated stands in the Atlantic - Boreal region. These growth changes are predicted to last from 8 to 20 years in all regions except the Coastal British Columbia regions, where the responses are predicted to last from 27 to 43 years. Length of time to reach a harvestable tree size estimate is reduced by 1 to 10 years. Estimates of the change in rotation age at maximum MAI range from -2 years to +17 years.

Genetic Improvement of Regenerated Stands

Participants estimated increases in MAI from genetic improvement of regenerated stands from 0.3 to 1.2 m^3/ha/year, with the largest being predicted for hardwoods in both the Coast British Columbia - Coast and NWT/Prairies - Boreal regions. The effects of genetic improvement on harvestable tree size rotation age and age of maximum MAI rotation age varied from reducing rotation ages as much as 20 years in the Interior British Columbia - Montane region to lengthening the rotation by one year in the Ontario - Boreal region. However, most regions predicted shortened rotations in the 5 to 10 year range.

3.4 DEGREE OF CLOSURE OF RESULTS

The mean estimates over the three rounds were expected to vary as respondents reconsidered their answers in light of previous aggregated results. The technical appendix, as a companion document, reports the results of all three rounds. The major issue is not shifts in means as answers are refined, but rather whether the variations around the means have declined by the third round.

Any Delphi survey technique application attempts to achieve a degree of consensus on values over the sequential questionnaire rounds. This attempt to reach closure on specific values is often measured by the change in variances or standard deviations of replies to each question between survey rounds. A decline in standard deviations represents some closure or agreement or consensus as to the values involved.

In this study the standard deviation of the responses to each question for each region for surveys two and three were calculated and analyzed. Due to the low level of responses for B.C. Coast-Coast, B.C. Coast-Subalpine, Interior B.C.-Columbia, Interior B.C.-Montane, Interior B.C., Subalpine, and Yukon/Interior B.C.-Boreal, it is impossible to measure any closure by comparing the two survey rounds. Standard deviations either were not calculable or not reliable due to the low number of responses to questions in either the second survey or third survey or both. In general, round three results showed less variation than round two. However, the degree of closure varied somewhat and, as indicated above, could not be assessed in the British Columbia regions. Each of the remaining regions other than those in British Columbia are discussed below.

<u>Atlantic-Acadian</u>

While the number of respondents declined from survey two to survey three, the standard deviations for the vast majority of answers in round three were smaller than the standard deviations of answers in round two. In cases where this decline was not true, the increases in standard deviations were small in comparison to round two standard deviations and to the mean values involved. The estimates of the changes in rotation ages based on harvestable tree size resulting from juvenile spacing of existing stands were an exception to this general statement. In this case, the standard deviations of the round three means were significantly larger than the round two standard deviations and were up to several times the size of the means. With this exception, overall closure or consensus on mean values seems reasonable.

Atlantic Boreal

Most of the questions in both round two and round three were answered by only one respondent. In cases where more than one respondent replied in both rounds, the round three standard deviations were smaller, indicating some degree of closure.

NWT/Prairies-Boreal

The number of answers per question in round three was nearly double that of round two despite the fact that the number of respondents was only marginally larger (seven versus eight - see Table 3). The standard deviations for estimated mean responses in round three for a vast majority of cases were substantially lower than those of round two. In cases where this was not true, the increases in standard deviations were very small and the round three standard deviations remained small in relation to mean estimates. Overall closure was attained.

Ontario-Boreal

The number of respondents for round two and round three were identical. However, there was a reduction in replies to questions in round three compared to round two. In spite of a reduced number of answers in round three, the standard deviations followed the pattern of that discussed above for the NWT/Prairies Boreal. As in the previous case, closure was evident.

Ontario-Great Lakes/St. Lawrence

The response rate was higher in round three than in round two and the standard deviations for estimated means for round three followed the same pattern as for those of the NWT/Prairie-Boreal region, which demonstrated reasonable consensus on final results.

Quebec-Boreal

There was a drop in response rate in round three compared to round two, but, as above, the round three standard deviations indicated a reasonable degree of closure when compared to round two standard deviations.

Quebec-Great Lakes/St. Lawrence

Respondents to round three dropped by over half (from seven to three - see Table 3). However, in spite of fewer round three respondents, standard deviations to estimated values were smaller for round three compared to round two for the majority of cases. Similar to most of the other non-B.C. regions, these estimates for this region show reasonable closure.

3.5 OVERALL PARTICIPATION

During the design and planning of this study, the authors were concerned about two major issues. First, would a panel of participants agree to participate in the study given the degree of aggregation required for each region? And second, if a panel was formed, would they follow through with the survey and reach closure on estimates? We were pleased to find a representative panel of 77 persons who represented a good cross section of survey regions. However, as the survey progressed, some of the panel members who had agreed to participate wrote to us indicating they could not participate because of concerns over the degree of aggregated responses required. As well, some, after viewing the results of round one or round two, discontinued participation because they saw what they felt were inconsistencies in the average results and thus did not feel the study was going to close on a theoretically valid result. Of particular note is the low response rate to the second and third round surveys from the British Columbia regions (Table 3).

Since the study was designed based on a small number of participants (justified due to the availability of knowledgeable people, timing and budget limitations), any loss of participation has a serious impact on the significance of resulting estimates. Therefore, great care should be taken in using data in this report, particularly from the six B.C. regions. For the other seven regions with higher response rates, the responses did come to varying degrees of closure and therefore better represented "the view of the experts in the field".

However, users of the results must remember that Delphi studies are used when there is no source of "hard data". This study shows the summary results of experts' estimates of growth and yield, provided by those of the 77 participants listed in Appendix B who chose to participate.

3.6 AREAS FOR FURTHER RESEARCH

The information collated here provides useful input into studies of the forest resource. However, the economic dimension was not addressed to any extent. This type of Delphi study could be useful in identifying the extent of the economically accessible forest land base. One member of the advisory panel recommended that the current study be oriented in that direction. The idea would be to solicit responses to volume (m^3/ha) and value (\$/m^3) curves over time for existing levels of silviculture expenditures, no silviculture, and twice the current level of silviculture expenditures. In addition, harvesting cost curves (\$/m^3) for the lowest cost, average cost, and high costs proportions of the physical land base could be solicited. Other information on the land base could also be requested. For example, the proportions of the land base (in terms of area, by age class) that are physically accessible versus currently economically accessible, the probability of catastrophic destruction, and the proportion of the land base likely to be set aside for other uses in the near future, would be useful information. This type of information is not available for Canada as a whole on any comparable basis, and makes assessment of supply options and opportunities difficult. Questions related to investments in silviculture and assessing tradeoffs in silviculture expenditures, versus protection of current standing stocks, or extending the operability margin, are all important to the picture of Canada's future timber supply. Providing a national perspective on growth and yield, however, is one step in this direction.

4. CONCLUSIONS

This study provides a view of the growth and yield of Canada's forests by region and aggregate species groups. The results are based on the convergence of expert opinion, and provide a reasonable indication, for most regions, of average yields and responses to treatments.

There are many caveats and problems with this sort of analysis that are, in part, a function of the degree of aggregation. There are many factors that influence growth that are not captured in the aggregate questions of the survey. In addition, to what extent do today's forests reflect their future potential? For example, there have been significant changes in forest policies in the provinces over the years, some of which directly impact the growth of forests. These include policies on planting, site preparation, and species selection after harvest. Do current second growth forests reflect the actual potential of the forest? For example, if species were planted on the wrong site, or if harvesting practices were to change significantly, then what is on the ground now would not be a good indication of future potential. Questions such as the impact on growth from ecosystem management practices and partial cuttings are also difficult to assess.

Nonetheless, there are some useful results and conclusions that can be gained from this study. One of them is that the experts do not see, with a few exceptions, huge volume increases or major changes in rotation ages with second growth stands, on aggregate large regions.

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APPENDIX A: Advisory Panel

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Dave Maclean	Canadian Forest Service, Fredericton
Steve Northway	MacMillan Bloedel Ltd., Nanaimo
Stephen Sterns-Smith	British Columbia Ministry of Forests
Chhun Huon Ung	Service canadien des forêts, Ste-Foy

APPENDIX B: List of Panel Members

Name	Affiliation
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Denes Bajzak	Memorial University
Jim Ball	Canadian Forest Service
John Barker	Western Forest Products
Jim Beck	University of Alberta
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List of Panel Members

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APPENDIX C: Questionnaires and results for Ontario boreal region

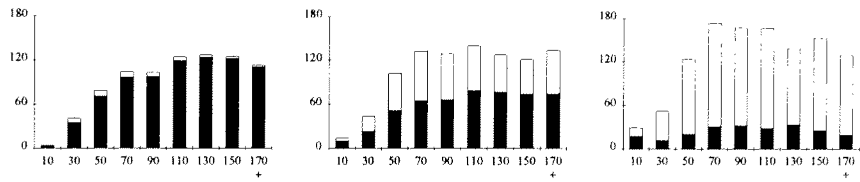
QUESTIONNAIRE #1

ADMINISTRATIVE / BIOLOGICAL REGION: **Ontario - Boreal**

BASELINE ESTIMATES	Softwood	Mixedwood	Hardwood
AREA (ha) Excluding Protected Areas	7,251,261	6,650,682	1,880,704
MAI of Mature Stands (m^3/ha/yr)	1.44 (1.2c, 0.24b)*	2.17 (0.99c, 1.19b)*	2.9 (0.69c, 2.20b)*

* c = conifer and b = broadleaf component of MAI

VOLUME / HECTARE (m^3/ha)



■ CONIFER 20 YEAR AGE CLASSES □ BROADLEAF

EXISTING STANDS

1. Are you sufficiently knowledgeable about this region to provide growth and yield estimates? YES ____ NO ____

If "**NO**" please go on to the information/question set for the next region - Thank you.

If "**YES**" please proceed in answering the questions below.

2. Please comment on the MAI estimates outlined above in terms of whether they are too high, too low or about right. In the scales below please circle the appropriate **percentage** value indicating your MAI estimates in relation to the baseline estimates.

Circle your estimate of MAI of mature stands compared to baseline estimates.

Softwood MAI (%)	<50 50 60 70 80 90 MAI 110 120 130 140 150 160 170 180 190 200 >200
Mixedwoods MAI (%)	<50 50 60 70 80 90 MAI 110 120 130 140 150 160 170 180 190 200 >200
Hardwood MAI (%)	<50 50 60 70 80 90 MAI 110 120 130 140 150 160 170 180 190 200 >200

2b. Considering the current age distribution of the species making up each of the three species categories, please indicate your estimates for the area-weighted mean age of mature stands (including over-mature) for each category.

	Softwood	Mixedwoods	Hardwood
Mean age	________ years	________ years	________ years

3. Given your revised estimate for the MAI of mature stands made in Question 2(a), how would the MAI change if the area weighted mean age was:

	Softwood	Mixedwoods	Hardwood
20 years older	________ %	________ %	________ %
20 years younger	________ %	________ %	________ %
40 years younger	________ %	________ %	________ %

Use (+) or positive percentages for increases in MAI and (-) or negative percentages for decreases in MAI.

4. If existing stands were **fertilized** what increase (+) or decrease (-) in yield would you expect and for what period would the change apply?

	Softwood	Mixedwoods	Hardwood
% Change	________ %	________ %	________ %
Period of Effect	________ years	________ years	________ years

5a. If existing stands were **thinned** would you expect a net change in useable fibre (thinning plus final harvest) from the stands? YES ____ NO ____

5b. If yes, what percentage change do you expect? +/- ______ %

5c. Would **thinning** reduce the rotation age or time till final harvest? YES ____ NO ____

5d. If yes, how many years would the reduction be? _______ years

REGENERATED STANDS

6. With current silviculture practice for this region what would you expect the mean age of regenerated stands at harvest to be?

	Softwood	Mixedwoods	Hardwood
Mean Age at Harvest	_______ years	_______ years	_______ years

7. Again, with current silviculture practice for this region, what would you expect the MAI of regenerated stands to be at the ages you listed above compared to the MAI of existing mature stands?

Circle your estimate of MAI for regenerated stands compared to baseline estimates

Softwood MAI (%)	<50 50 60 70 80 90 MAI 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 >250
Mixedwoods MAI (%)	<50 50 60 70 80 90 MAI 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 >250
Hardwood MAI (%)	<50 50 60 70 80 90 MAI 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 >250

8. Given your revised estimate for MAI of the area weighted mean age of regenerated stands, how would the MAI change if the area weighted mean age was:

	Softwood	Mixedwoods	Hardwood
20 years older	_______ %	_______ %	_______ %
20 years younger	_______ %	_______ %	_______ %
40 years younger	_______ %	_______ %	_______ %

Use (+) or positive percentages for increases in MAI and (-) or negative percentages for decreases in MAI.

9. If regenerated stands were **fertilized** what increase (+) or decrease (-) in yield would you expect and for what period would the change apply?

	Softwood	Mixedwoods	Hardwood
% Change	_______ %	_______ %	_______ %
Period of Effect	_______ years	_______ years	_______ years

10a. If regenerated stands were **thinned** would you expect a net change in useable fibre (thinning plus final harvest) from the stands? YES ____ NO ____

10b. If yes, what percentage change do you expect? +/- _____ %

10c. Would **thinning** reduce the rotation age or time till final harvest? YES ____ NO ____

10d. If yes, how many years would the reduction be? _______ years

11a. If regenerated stands were **juvenile spaced** would you expect a net change in useable fibre from the stands? YES ____ NO ____

11b. If yes, what percentage change do you expect? +/- _____ %

11c. Would **juvenile spacing** reduce the rotation age or time till final harvest? YES ____ NO ____

11d. If yes, how many years would the reduction be? _______ years

12a. If regenerated stands were **genetically improved** would you expect a net change in useable fibre from the stands? YES ____ NO ____

12b. If yes, what percentage change do you expect? +/- _____ %

12c. Would **genetic improvement** reduce the rotation age or time till final harvest? YES ____ NO ____

12d. If yes, how many years would the reduction be? _______ years

13a. If regenerated stands were **cleaned/brush controlled** would you expect a net change in useable fibre from the stands? YES ____ NO ____

13b. If yes, what percentage change do you expect? +/- _____ %

13c. Would **cleaning/brush control** reduce the rotation age or time till final harvest? YES ____ NO ____

13d. If yes, how many years would the reduction be? _______ years

This space is provided for any comments regarding any part of this survey. If you have concerns you would like to have examined in future rounds of this project, please note these here as well.

QUESTIONNAIRE #2

ADMINISTRATIVE / BIOLOGICAL REGION **Ontario - Boreal**

EXISTING STANDS

1. From Questionnaire #1, collective (mean) responses from survey participants indicated the following about growth (MAI) of existing stands. Included are average estimates of MAI from the baseline we provided in Questionnaire #1 and average estimates of area-weighted mean age of mature stands.

	MAI: Provided	MAI: Your Est.	AGE: Your Est.
Softwood	1.44	1.67	100.0
Mixedwood	2.17	2.02	93.3
Hardwood	2.90	2.56	82.5

Additionally you expressed concern over "uneven age management" and that existing stands may be 2nd, 3rd or 4th generation "regenerated stands". For the survey, the growth and yield data for "existing stands" is meant to apply to stands growing today. "Regenerated stands" are those we create after "today".

1a. Please complete the table below with your revised estimates of MAI (Age in years and MAI in m3/ha/yr). Note: NA means not available from round one.

Softwood			Mixedwood			Hardwood		
Age	MAI	New MAI	Age	MAI	New MAI	Age	MAI	New MAI
40	NA	________	33	NA	________	23	NA	________
60	1.93	________	53	2.20	________	43	2.83	________
80	1.84	________	73	2.20	________	63	2.81	________
*100	1.67	________	*93	2.02	________	*83	2.56	________
120	1.50	________	113	1.91	________	103	2.26	________
140	NA	________	133	NA	________	123	NA	________

* Based on aggregated estimates (rounded) from your estimates reported above.

1b. What proportion of the area in the region is managed by uneven-aged management?
Softwood _______ % Mixedwood _______ % Hardwood _________ %

1c. What growth per ha/year do you expect on areas managed by uneven-aged management?
Softwood ______ m3/ha/yr Mixedwood ______ m3/ha/yr Hardwood ______ m3/ha/yr

1d. What after-cut growing stock level do you expect to be left on areas managed by uneven-aged management?
Softwood _______ m3/ha Mixedwood _______ m3/ha Hardwood _________ m3/ha

1e. What would be the average cutting cycle used on areas managed by uneven-aged management?
Softwood _______ years Mixedwood _______ years Hardwood _________ years

2. From Questionnaire #1 your collective (mean) responses to **fertilization** of existing stands indicated fertilization would result in yield increases and may have a period of effect as follows:

Softwood	7.4%	Mixedwood	4.5%	Hardwood	3.5%
Softwood	8.1 years	Mixedwood	5.2 years	Hardwood	5.2 years

However your comments indicated concern over fertilizing "all stands', "all sites", "age of stands fertilized" and "amount of fertilizer". Please answer the following questions to account for these concerns:

2a. At what stand age range would you fertilize? Answer should be range between a low figure and a high figure expressed in years of age.
Softwood ____ & ____ years old Mixedwood ____ & ____ years old Hardwood ____ & ____ years old

2b. At what rate of fertilizer (kg/ha) would you apply?

Softwood _______ kg/ha   Mixedwood _______ kg/ha   Hardwood _________ kg/ha

2c. If sites are distinguished as Good, Medium and Poor what proportion of sites would you fertilize?

Good ____________ %   Medium ___________%   Poor ____________%

2d. What increase in growth (m3/ha/yr) would you expect?

Softwood _______   Mixedwood _______   Hardwood _________

2e. How long would the increased growth indicated above last (years)?

Softwood _______   Mixedwood _______   Hardwood _________

3. From Questionnaire #1 your collective (mean) responses to thinning of existing stands were as follows: 100% of respondents felt there would be a net change in yield due to thinning, and the mean of the change was a (+) 15.0 % . 86 % of respondents felt the rotation age would be reduced by a mean of 13.3 years.

Significant comments were made regarding "what to thin", "would never thin in mature stands", "I assume thinning of immature stands only", and "is rotation set by achieving a certain tree size or maximum mean annual increment". To help clarify **Thinning responses** please answer the following:

3a. For existing immature stands what do you expect from **cleaning /brushing** (assume no utilization) regarding:

3aa. Change in growth?

Softwood +/-_______ m3/ha/yr   Mixedwood +/-_______ m3/ha/yr   Hardwood +/-_______ m3/ha/yr

3ab. How long would this change in growth last?

Softwood _______ years   Mixedwood _______ years   Hardwood _________ years

3ac. Change in rotation based on harvestable tree size?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

3ad. Change in rotation based on maximum MAI?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

3b. For existing immature stands what do you expect from **juvenile spacing/ pre-commercial thinning** (assume no utilization) regarding:

3ba. Change in growth?

Softwood +/-_______ m3/ha/yr   Mixedwood +/-_______ m3/ha/yr   Hardwood +/-_______ m3/ha/yr

3bb. How long would this change in growth last?

Softwood _______ years   Mixedwood _______ years   Hardwood _________ years

3bc. Change in rotation based on harvestable tree size?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

3bd. Change in rotation based on maximum MAI?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

3c. For existing immature stands what do you expect from **commercial thinning** (include thinning plus final harvest) regarding:

3ca. Change in growth?

Softwood +/-_______ m3/ha/yr   Mixedwood +/-_______ m3/ha/yr   Hardwood +/-_______ m3/ha/yr

3cb. How long would this change in growth last?

Softwood _______ years   Mixedwood _______ years   Hardwood _________ years

3cc. Change in rotation based on harvestable tree size?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

3cd. Change in rotation based on maximum MAI?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

REGENERATED STANDS

4. From Questionnaire #1, collective (mean) responses from survey participants indicated the following about growth (MAI) of regenerated stands. Included are average estimates of MAI from the baseline we provided in Questionnaire #1 and average estimates of area-weighted mean age of mature stands. "Regenerated stands" are those we create after "today".

	MAI: Provided	MAI: Your Est.	AGE: Your Est.
Softwood	1.44	1.82	78.6
Mixedwood	2.17	2.34	75.0
Hardwood	2.90	2.84	60.8

4a. Please complete the table below with your revised estimates of MAI (Age in years and MAI in m3/ha/yr).

Softwood			Mixedwood			Hardwood		
Age	MAI	New MAI	Age	MAI	New MAI	Age	MAI	New MAI
19	NA	________	15	NA	________	1	NA	________
39	1.51	________	35	1.67	________	21	2.13	________
59	1.99	________	55	2.11	________	41	2.59	________
*79	1.82	________	*75	2.34	________	*61	2.84	________
99	1.71	________	95	2.17	________	81	2.50	________
119	NA	________	115	NA	________	101	NA	________

* Based on aggregated estimates (rounded) from your estimates reported above.

4b. What proportion of the area in the region is managed by uneven-aged management?
Softwood _______% Mixedwood _______% Hardwood _________%

4c. What growth per ha/year do you expect on areas managed by uneven-aged management?
Softwood _______ m3/ha/yr Mixedwood _______ m3/ha/yr Hardwood _________ m3/ha/yr

4d. What after-cut growing stock level do you expect to be left on areas managed by uneven-aged management?
Softwood _______ m3/ha Mixedwood _______ m3/ha Hardwood _________ m3/ha

4e. What would be the average cutting cycle used on areas managed by uneven-aged management?
Softwood _______ years Mixedwood _______ years Hardwood _________ years

5. From Questionnaire #1 your collective (mean) responses to **fertilization** of regenerated stands indicated fertilization would result in yield increases and may have a period of effect as follows:

Softwood 8.7 % Mixedwood 6.5 % Hardwood 5.5 %
Softwood 6.8 years Mixedwood 5.2 years Hardwood 5.2 years

However your comments indicated concern over fertilizing "all stands', "all sites", "age of stands fertilized" and "amount of fertilizer". To help clarify these concerns please answer the following questions:

5a. At what stand age range would you fertilize? Answer should be range between a low figure and a high figure expressed in years of age.
Softwood ____ & ____ years old Mixedwood ____ & ____ years old Hardwood ____ & ____ years old

5b. At what rate of fertilizer (kg/ha) would you apply?
Softwood _______ kg/ha Mixedwood _______ kg/ha Hardwood _________ kg/ha

5c. If sites are distinguished as Good, Medium and Poor what proportion of sites would you fertilize?
Good ___________% Medium __________% Poor ___________%

5d. What increase in growth (m3/ha/yr) would you expect?
Softwood _______ Mixedwood _________ Hardwood _________

5e. How long would the increased growth indicated above last (years)?

Softwood _______ Mixedwood _______ Hardwood _________

6. Significant comments were made regarding "what to thin", "would never thin in mature stands", "I assume thinning of immature stands only", and "is rotation set by achieving a certain tree size or maximum mean annual increment". To help clarify **Thinning responses** please answer the following:

6a. From Questionnaire #1 your collective (mean) responses to cleaning/ brush control of regenerated stands were as follows: 86% of respondents felt there would be a net change in yield, and the mean of the change was a (+) 20.8 %. 86 % of respondents felt the rotation age would be reduced by a mean of 16 years. For regenerated immature stands what do you expect from **cleaning /brushing** (assume no utilization) regarding:

6aa. Change in growth?
Softwood +/-_______ m3/ha/yr Mixedwood +/-_______ m3/ha/yr Hardwood +/-_______ m3/ha/yr
6ab. How long would this change in growth last?
Softwood _______ years Mixedwood _______ years Hardwood _________ years
6ac. Change in rotation based on harvestable tree size?
Softwood +/-_______ years Mixedwood +/-_______ years Hardwood +/-_______ years
6ad. Change in rotation based on maximum MAI?
Softwood +/-_______ years Mixedwood +/-_______ years Hardwood +/-_______ years

6b. From Questionnaire #1 your collective (mean) responses to juvenile spacing of regenerated stands were as follows: 71% of respondents felt there would be a net change in yield, and the mean of the change was a (+) 5.0 % . 71 % of respondents felt the rotation age would be reduced by a mean of 10 years. For regenerated immature stands what do you expect from **juvenile spacing/ pre-commercial thinning** (assume no utilization) regarding:

6ba. Change in growth?
Softwood +/-_______ m3/ha/yr Mixedwood +/-_______ m3/ha/yr Hardwood +/-_______ m3/ha/yr
6bb. How long would this change in growth last?
Softwood _______ years Mixedwood _______ years Hardwood _________ years
6bc. Change in rotation based on harvestable tree size?
Softwood +/-_______ years Mixedwood +/-_______ years Hardwood +/-_______ years
6bd. Change in rotation based on maximum MAI?
Softwood +/-_______ years Mixedwood +/-_______ years Hardwood +/-_______ years

6c. From Questionnaire #1 your collective (mean) responses to thinning of regenerated stands were as follows: 100% of respondents felt there would be a net change in yield, and the mean of the change was a (+) 16.7 %. 100 % of respondents felt the rotation age would be reduced by a mean of 13.3 years. For regenerated immature stands what do you expect from **commercial thinning** (include thinning plus final harvest) regarding:

6ca. Change in growth?
Softwood +/-_______ m3/ha/yr Mixedwood +/-_______ m3/ha/yr Hardwood +/-_______ m3/ha/yr
6cb. How long would this change in growth last?
Softwood _______ years Mixedwood _______ years Hardwood _________ years
6cc. Change in rotation based on harvestable tree size?
Softwood +/-_______ years Mixedwood +/-_______ years Hardwood +/-_______ years
6cd. Change in rotation based on maximum MAI?
Softwood +/-_______ years Mixedwood +/-_______ years Hardwood +/-_______ years

7. From Questionnaire #1 your collective (mean) responses to **genetic improvement** of regenerated stands were as follows: 100% of respondents felt there would be a net change in yield, and the mean of the change was a (+) 6.8 %. 100% of respondents felt the rotation age would be reduced by a mean of 7.5 years. Comments indicated uncertainty about unproved **genetic improvement** yields and concerns over rotation being time to certain size tree or Maximum MAI. Please answer the following:

7a. What change in MAI do you expect for genetic improvement?

Softwood _______ m3/ha/yr   Mixedwood _______ m3/ha/yr   Hardwood _______ m3/ha/yr

7b. What change in rotation based on harvestable tree size would you expect?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

7c. What change in rotation based on Maximum MAI would you expect?

Softwood +/-_______ years   Mixedwood +/-_______ years   Hardwood +/-_______ years

QUESTIONNAIRE #3

ADMINISTRATIVE / BIOLOGICAL REGION **Ontario - Boreal**

EXISTING STANDS

1. Growth (MAI) of existing stands for softwood, mixedwood and hardwood.

1a. From Questionnaires #1 and #2, aggregate (mean) responses from survey participants about growth of existing stands are provided below. In most cases, Questionnaire #2 results led to a mean MAI maximization which was inconsistent with Questionnaire #1 age estimate of maximum MAI. Please examine each case below and provide final revised estimates of MAI for each species/age class. The age classes were set in 20 year increments from Questionnaire #1 results that gave estimates of the ages of maximum MAI's which are denoted by an asterisk. Remember, the MAI should be maximum at the 20 year age class where you expect maximum biological growth for pulpwood utilization for the region.

	Softwood					Mixedwood					Hardwood		
Age	Que#1 MAI	Que#2 MAI	Final MAI		Age	Que#1 MAI	Que#2 MAI	Final MAI		Age	Que#1 MAI	Que#2 MAI	Final MAI
40	NA	1.6			33	NA	1.9			23	NA	1.8	
60	1.9	1.9			53	2.2	2.5			43	2.8	2.7	
80	1.8	2.0			73	2.2	2.5			63	2.8	2.9	
100*	1.7	1.8			93*	2.0	2.2			83*	2.6	2.4	
120	1.5	1.6			113	1.9	1.8			103	2.3	2.0	
140	NA	1.3			133	NA	1.5			123	NA	1.6	

The aggregated results below are taken from round 2 survey results. Please review the figures and provide any revised figures that you deem more representative of the region. If your revised figure agrees with the survey figure, please enter your estimate even if it is the same as the survey one.

1b. What proportion of the area is managed by uneven-aged management?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 6 %	Survey result: 13 %	Survey result: 19 %
Your est. ______ %	Your est. ______ %	Your est. ______ %

1c. What is the growth per ha/year on areas managed by uneven-aged management?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 1.8 m3/ha/yr	Survey result: 2.2 m3/ha/yr	Survey result: 2.3 m3/ha/yr
Your est. ______ m3/ha/yr	Your est. ______ m3/ha/yr	Your est. ______ m3/ha/yr

1d. What after-cut growing stock level is left on areas managed by uneven-aged management?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 54 m3/ha	Survey result: 50 m3/ha	Survey result: 57 m3/ha
Your est. ______ m3/ha	Your est. ______ m3/ha	Your est. ______ m3/ha

1e. What is the average cutting cycle used on areas managed by uneven-aged management?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 24 years	Survey result: 24 years	Survey result: 21 years
Your est. ______ years	Your est. ______ years	Your est. ______ years

2. From Questionnaire #2 the results regarding **fertilization** of existing stands have been aggregated and are given below. Please review these figures and provide any revised figures that you deem more representative of the region. Base your figures on one-time application (comments from the previous round suggested that number of applications be clarified). Please enter your estimates even if in one or more cases they are identical to those of the survey results.

2a. At what stand age range would you fertilize? Answer should range between X and Y years of age.

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 13 & 41 yrs old	Survey result: 14 & 41 yrs old	Survey result: 12 & 36 yrs old
Your est. ____ & ____ yrs old	Your est. ____ & ____ yrs old	Your est. ____ & ____ yrs old

2b. At what rate of fertilizer (kg/ha) would you apply?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 175 kg/ha	Survey result: 175 kg/ha	Survey result: 175 kg/ha
Your est. ______ kg/ha	Your est. ______ kg/ha	Your est. ______ kg/ha

2c. If sites are distinguished as Good, Medium and Poor what proportion of sites would you fertilize?

Good:	**Medium:**	**Poor:**
Survey result: 31 %	Survey result: 25 %	Survey result: 11 %
Your est. ______ %	Your est. ______ %	Your est. ______ %

2d. What increase in growth (m3/ha/yr) would you expect?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 0.9 m3/ha/yr	Survey result: 0.6 m3/ha/yr	Survey result: 0.8 m3/ha/yr
Your est. ______ m3/ha/yr	Your est. ______ m3/ha/yr	Your est. ______ m3/ha/yr

2e. How long would the increased growth indicated above last (years)?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 10 years	Survey result: 10 years	Survey result: 11 years
Your est. ______ years	Your est. ______ years	Your est. ______ years

3. Comments from Questionnaire #1 regarding thinning indicated this topic had to be split into several categories and that thinning would occur only on immature stands. Several comments on round 2 again emphasize immature stands only. Each question below applies only to immature stands. The mean of your responses to round 2 are given below. Please review these results and provide revised estimates. If your estimate agrees with the mean figure from round 2, please enter this as your estimate.

3a. For existing immature stands what do you expect from **cleaning/brushing** (assume no utilization) regarding:

3aa. Change in growth?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 0.7 m3/ha/yr	Survey result: 0.4 m3/ha/yr	Survey result: 0.8 m3/ha/yr
Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr

3ab. How long would this change in growth last?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 11 years	Survey result: 6 years	Survey result: 9 years
Your est. ______ years	Your est. ______ years	Your est. ______ years

3ac. Change in rotation based on harvestable tree size?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: -3 years	Survey result: +2 years	Survey result: +8 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

3ad. Change in rotation based on maximum MAI?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 00 years	Survey result: +3 years	Survey result: +10 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

3b. For existing immature stands what do you expect from **juvenile spacing/pre-commercial thinning** (assume no utilization) regarding:

3ba. Change in growth?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 0.9 m3/ha/yr	Survey result: 1.0 m3/ha/yr	Survey result: 1.1 m3/ha/yr
Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr

3bb. How long would this change in growth last?

Softwood:
Survey result: 11 years
Your est. ______ years

Mixedwood:
Survey result: 11 years
Your est. ______ years

Hardwood:
Survey result: 14 years
Your est. ______ years

3bc. Change in rotation based on harvestable tree size?

Softwood:
Survey result: -3 years
Your est. +/-______ years

Mixedwood:
Survey result: +1 years
Your est. +/-______ years

Hardwood:
Survey result: +1 years
Your est. +/-______ years

3bd. Change in rotation based on maximum MAI?

Softwood:
Survey result: -1 years
Your est. +/-______ years

Mixedwood:
Survey result: +1 years
Your est. +/-______ years

Hardwood:
Survey result: +1 years
Your est. +/-______ years

3c. For existing immature stands what do you expect from **commercial thinning** (include thinning plus final harvest) regarding:

3ca. Change in growth?

Softwood:
Survey result: 0.8 m3/ha/yr
Your est. +/-______ m3/ha/yr

Mixedwood:
Survey result: 1.2 m3/ha/yr
Your est. +/-______ m3/ha/yr

Hardwood:
Survey result: 1.2 m3/ha/yr
Your est. +/-______ m3/ha/yr

3cb. How long would this change in growth last?

Softwood:
Survey result: 11 years
Your est. ______ years

Mixedwood:
Survey result: 13 years
Your est. ______ years

Hardwood:
Survey result: 12 years
Your est. ______ years

3cc. Change in rotation based on harvestable tree size?

Softwood:
Survey result: +2 years
Your est. +/-______ years

Mixedwood:
Survey result: +3 years
Your est. +/-______ years

Hardwood:
Survey result: +3 years
Your est. +/-______ years

3cd. Change in rotation based on maximum MAI?

Softwood:
Survey result: +3 years
Your est. +/-______ years

Mixedwood:
Survey result: +2 years
Your est. +/-______ years

Hardwood:
Survey result: +2 years
Your est. +/-______ years

REGENERATED STANDS

4. Growth (MAI) of regenerated stands for softwood, mixedwood and hardwood.

4a. From Questionnaires #1 and #2, aggregate (mean) responses from survey participants about growth of regenerated stands are provided below. In most cases, Questionnaire #2 results led to a mean MAI maximization which was inconsistent with Questionnaire #1 age estimate of maximum MAI. Please examine each case below and provide final revised estimates of MAI for each species/age class. The age classes were set in 20 year increments from Questionnaire #1 results that gave estimates of the ages of maximum MAI's which are denoted by an asterisk. Remember, the MAI should be maximum at the 20 year age class where you expect maximum biological growth for pulpwood utilization for the region.

	Softwood					Miedwood					Hardwood		
Age	Que#1 MAI	Que#2 MAI	Final MAI		Age	Que#1 MAI	Que#2 MAI	Final MAI		Age	Que#1 MAI	Que#2 MAI	Final MAI
19	NA	1.2			15	NA	1.2			1	NA	1.1	
39	1.5	1.7			35	1.7	2.1			21	2.1	2.2	
59	2.0	1.9			55	2.1	2.4			41	2.6	2.5	
79*	1.8	2.0			75 *	2.3	2.5			61*	2.8	2.7	
99	1.7	1.8			95	2.1	2.1			81	2.5	2.3	

119	NA	1.6			11 5	NA	1.7			101	NA	1.6	

The aggregated results below are taken from round 2 survey results. Please review the figures and provide any revised figures that you deem more representative of the region. If your revised figure agrees with the survey figure, please enter your estimate even if it is the same as the survey one.

4b. What proportion of the area will be managed by uneven-aged management?

Softwood: Survey result: 9 % Your est. ______ %
Mixedwood: Survey result: 18 % Your est. ______ %
Hardwood: Survey result 21 % Your est. ______ %

4c. What growth per ha/year do you expect on areas that will be managed by uneven-aged management?

Softwood: Survey result: 1.9 m3/ha/yr Your est. _____ m3/ha/yr
Mixedwood: Survey result: 2.1 m3/ha/yr Your est. _____ m3/ha/yr
Hardwood: Survey result 2.2 m3/ha/yr Your est. ____ m3/ha/yr

4d. What after-cut growing stock level do you expect to be left on areas that will be managed by uneven-aged management?

Softwood:
Survey result: 47 m3/ha
Your est. ______ m3/ha

Mixedwood:
Survey result: 47 m3/ha
Your est. ______ m3/ha

Hardwood:
Survey result 46 m3/ha
Your est. ______ m3/ha

4e. What would be the average cutting cycle used on areas that will be managed by uneven-aged management?

Softwood:
Survey result: 24 years
Your est. ______ years

Mixedwood:
Survey result: 21 years
Your est. ______ years

Hardwood:
Survey result 21 years
Your est. ______ years

5. From Questionnaire #2 the results regarding **fertilization** of regenerated stands have been aggregated and are given below. Please review these figures and provide any revised figures that you deem more representative of the region. Base your figures on one-time application (comments from the previous round suggested that number of applications be clarified). Please enter your estimates even if in one or more cases they are identical to those of the survey results.

5a. At what stand age range would you fertilize? Answer should range between X and Y years of age.

Softwood:
Survey result: 13 & 44 yrs old
Your est. _____ & ____ yrs old

Mixedwood:
Survey result: 14 & 45 yrs old
Your est. ____ & ____ yrs old

Hardwood:
Survey result: 12 & 38 yrs old
Your est. ____ & ____ yrs old

5b. At what rate of fertilizer (kg/ha) would you apply?

Softwood:
Survey result: 150 kg/ha
Your est. ______ kg/ha

Mixedwood:
Survey result: 150 kg/ha
Your est. ______ kg/ha

Hardwood:
Survey result: 150 kg/ha
Your est. ______ kg/ha

5c. If sites are distinguished as Good, Medium and Poor what proportion of sites would you fertilize?

Good:
Survey result: 28 %
Your est. ______ %

Medium:
Survey result: 24 %
Your est. ______ %

Poor:
Survey result: 16 %
Your est. ______ %

5d. What increase in growth (m3/ha/yr) would you expect?

Softwood:
Survey result: 0.5 m3/ha/yr
Your est. ______ m3/ha/yr

Mixedwood:
Survey result: 0.6 m3/ha/yr
Your est. ______ m3/ha/yr

Hardwood:
Survey result: 0.5 m3/ha/yr
Your est. ______ m3/ha/yr

5e. How long would the increased growth indicated above last (years)?

Softwood:
Survey result: 10 years
Your est. ______ years

Mixedwood:
Survey result: 10 years
Your est. ______ years

Hardwood:
Survey result: 13 years
Your est. ______ years

6. Comments from Questionnaire #1 regarding thinning indicated this topic had to be split into several categories and that thinning would occur only on immature stands. Several comments on round 2 again emphasize immature stands only. Each question below applies only to immature stands. The mean of your responses to round 2 are given below. Please review these results and provide revised estimates. If your estimate agrees with the mean figure from round 2, please enter this as your estimate.

6a. For regenerated immature stands what do you expect from **cleaning/brushing** (assume no utilization) regarding:

6aa. Change in growth?

Softwood:	Mixedwood:	Hardwood:
Survey result: 0.6 m3/ha/yr	Survey result: 0.5 m3/ha/yr	Survey result: 0.8 m3/ha/yr
Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr

6ab. How long would this change in growth last?

Softwood:	Mixedwood:	Hardwood:
Survey result: 10 years	Survey result: 7 years	Survey result: 10 years
Your est. ______ years	Your est. ______ years	Your est. ______ years

6ac. Change in rotation based on harvestable tree size?

Softwood:	Mixedwood:	Hardwood:
Survey result: +1 years	Survey result: +2 years	Survey result: +8 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

6ad. Change in rotation based on maximum MAI?

Softwood:	Mixedwood:	Hardwood:
Survey result: +1 years	Survey result: +2 years	Survey result: +8 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

6b. For regenerated immature stands what do you expect from **juvenile spacing/pre-commercial thinning** (assume no utilization) regarding:

6ba. Change in growth?

Softwood:	Mixedwood:	Hardwood:
Survey result: 0.7 m3/ha/yr	Survey result: 0.8 m3/ha/yr	Survey result: 0.8 m3/ha/yr
Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr

6bb. How long would this change in growth last?

Softwood:	Mixedwood:	Hardwood:
Survey result: 14 years	Survey result: 13 years	Survey result: 14 years
Your est. ______ years	Your est. ______ years	Your est. ______ years

6bc. Change in rotation based on harvestable tree size?

Softwood:	Mixedwood:	Hardwood:
Survey result: -2 years	Survey result: 00 years	Survey result: 00 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

6bd. Change in rotation based on maximum MAI?

Softwood:	Mixedwood:	Hardwood:
Survey result: +1 years	Survey result: +1 years	Survey result: +1 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

6c. For regenerated immature stands what do you expect from **commercial thinning** (include thinning plus final harvest) regarding:

6ca. Change in growth?

Softwood:	Mixedwood:	Hardwood:
Survey result: 0.7 m3/ha/yr	Survey result: 0.8 m3/ha/yr	Survey result: 0.8 m3/ha/yr
Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr	Your est. +/-______ m3/ha/yr

6cb. How long would this change in growth last?

Softwood:	Mixedwood:	Hardwood:
Survey result: 13 years	Survey result: 14 years	Survey result: 13 years
Your est. ______ years	Your est. ______ years	Your est. ______ years

6cc. Change in rotation based on harvestable tree size?

Softwood:	Mixedwood:	Hardwood:
Survey result: 00 years	Survey result: +1 years	Survey result: +3 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

6cd. Change in rotation based on maximum MAI?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: +1 years	Survey result: -1 years	Survey result: +1 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

7. From Questionnaire #2, the results regarding **genetic improvement** of regenerated stands have been aggregated and are given below. Please review these figures and provide any revised figures that you deem more representative of the region. Please enter your estimates even if, in one or more cases, they are identical to those of the survey results.

7a. What change in MAI do you expect from greater improvement?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: 0.7 m3/ha/yr	Survey result: 0.7 m3/ha/yr	Survey result: 0.8 m3/ha/yr
Your est. ______ m3/ha/yr	Your est. ______ m3/ha/yr	Your est. ______ m3/ha/yr

7b. What change in rotation based on harvestable tree size would you expect?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: +6 years	Survey result: +5 years	Survey result: +4 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

7c. What change in rotation based on Maximum MAI would you expect?

Softwood:	**Mixedwood:**	**Hardwood:**
Survey result: +5 years	Survey result: +4 years	Survey result: +3 years
Your est. +/-______ years	Your est. +/-______ years	Your est. +/-______ years

6b. For regenerated immature stands expectations from **juvenile spacing/pre-commercial thinning** (assuming no utilization) regarding the following are:

6ba. Change in growth?
Softwood: Ques #2 result: 0.3 m^3/ha/yr; Ques #3 result: 0.2 m^3/ha/yr
Mixedwood: Ques #2 result: 0.4 m^3/ha/yr; Ques #3 result: 0.3 m^3/ha/yr
Hardwood: Ques #2 result: 0.4 m^3/ha/yr; Ques #3 result: 0.3 m^3/ha/yr

6bb. Length of time this change in growth lasted.
Softwood: Ques #2 result: 9 years; Ques #3 result: 10 years
Mixedwood: Ques #2 result: 9 years; Ques #3 result: 9 years
Hardwood: Ques #2 result: 11 years; Ques #3 result: 8 years

6bc. Change in rotation based on harvestable tree size.
Softwood: Ques #2 result: -8 years; Ques #3 result: -8 years
Mixedwood: Ques #2 result: -7 years; Ques #3 result: -8 years
Hardwood: Ques #2 result: -5 years; Ques #3 result: -7 years

6bd. Change in rotation based on maximum MAI.
Softwood: Ques #2 result: 2 years; Ques #3 result: -1 years
Mixedwood: Ques #2 result: 2 years; Ques #3 result: -1 years
Hardwood: Ques #2 result: 2 years; Ques #3 result: -1 years

6c. For regenerated immature stands, expectations from **commercial thinning** (including thinning plus final harvest) regarding the following are:

6ca. Change in growth.
Softwood: Ques #2 result: 1.1 m^3/ha/yr; Ques #3 result: 1.0 m^3/ha/yr
Mixedwood: Ques #2 result: 1.1 m^3/ha/yr; Ques #3 result: 1.0 m^3/ha/yr
Hardwood: Ques #2 result: 1.1 m^3/ha/yr; Ques #3 result: 1.0 m^3/ha/yr

6cb. Length of time this change in growth last.
Softwood: Ques #2 result: 12 years; Ques #3 result: 12 years
Mixedwood: Ques #2 result: 11 years; Ques #3 result: 11 years
Hardwood: Ques #2 result: 12 years; Ques #3 result: 11 years

6cc. Change in rotation based on harvestable tree size.
Softwood: Ques #2 result: -7 years; Ques #3 result: -8 years
Mixedwood: Ques #2 result: -4 years; Ques #3 result: -7 years
Hardwood: Ques #2 result: -2 years; Ques #3 result: -5 years

6cd. Change in rotation based on maximum MAI.
Softwood: Ques #2 result: 2 years; Ques #3 result: 0 years
Mixedwood: Ques #2 result: 2 years; Ques #3 result: -1 years
Hardwood: Ques #2 result: 0 years; Ques #3 result: -1 years

7. From Questionnaires #2, and #3 the results regarding **genetic improvement** of regenerated stands have been aggregated and are given below.

7a. Change in MAI expected from greater improvement.
Softwood: Ques #2 result: 0.9 m^3/ha/yr; Ques #3 result: 0.8 m^3/ha/yr
Mixedwood: Ques #2 result: 1.0 m^3/ha/yr; Ques #3 result: 0.9 m^3/ha/yr
Hardwood: Ques #2 result: 1.1 m^3/ha/yr; Ques #3 result: 1.2 m^3/ha/yr

7b. Change in rotation expected based on harvestable tree size.
Softwood: Ques #2 result: -12 years; Ques #3 result: -11 years
Mixedwood: Ques #2 result: -12 years; Ques #3 result: -11 years
Hardwood: Ques #2 result: -10 years; Ques #3 result: -13 years

7c. Change in rotation expected based on Maximum MAI.
Softwood: Ques #2 result: -2 years; Ques #3 result: -2 years
Mixedwood: Ques #2 result: -1 years; Ques #3 result: -2 years
Hardwood: Ques #2 result: -3 years; Ques #3 result: -3 years

RESULTS FOR ALL 3 QUESTIONNAIRES

EXISTING STANDS

1. Growth (MAI) of existing stands for softwood, mixedwood and hardwood.

1a. From Questionnaires #1, #2 and #3, aggregate (mean) responses from survey participants about growth of existing stands are provided below. In most cases, Questionnaire #2 and #3 results led to mean MAI maximization which was inconsistent with Questionnaire #1 age estimate of maximum MAI. The age classes were set in 20 year increments from Questionnaire #1 results that gave estimates of the ages of maximum MAI's which are denoted by an asterisk. The MAI estimates are maximum at the 20 year age class where maximum biological growth is expected for pulpwood utilization for the region.

Softwood					Mixedwood					Hardwood			
Age	Que#1 MAI	Que#2 MAI	Que#3 MAI		Age	Que#1 MAI	Que#2 MAI	Que#3 MAI		Age	Que#1 MAI	Que#2 MAI	Que#3 MAI
40	NA	1.6	1.7		33	NA	1.9	2.0		23	NA	1.8	2.1
60	1.9	1.9	2.0		53	2.2	2.5	2.3		43	2.8	2.7	2.8
80	1.8	2.0	2.1		73	2.2	2.5	2.4		63	2.8	2.9	2.8
100*	1.7	1.8	2.0		93*	2.0	2.2	2.1		83*	2.6	2.4	2.5
120	1.5	1.6	1.7		113	1.9	1.8	1.8		103	2.3	2.0	2.0
140	NA	1.3	1.4		133	NA	1.5	1.5		123	NA	1.6	1.6

The aggregated results below are from rounds 2 and 3 survey results.

1b. What proportion of the area is managed by uneven-aged management.

Softwood: Ques #2 result: 6%
Ques #3 result: NA%

Mixedwood: Ques #2 result: 13%
Ques #3 result: 9%

Hardwood: Ques #2 result: 19%
Ques #3 result: 10%

1c. Growth per ha/year on areas managed by uneven-aged management.

Softwood: Ques #2 result: 1.8 m^3/ha/yr
Ques #3 result: 1.6 m^3/ha/yr

Mixedwood: Ques #2 result: 2.2 m^3/ha/yr
Ques #3 result: 2.0 m^3/ha/yr

Hardwood: Ques #2 result: 2.3 m^3/ha/yr
Ques #3 result: 2.4 m^3/ha/yr

1d. After-cut growing stock level left on areas managed by uneven-aged management.

Softwood: Ques #2 result: 54 m^3/ha
Ques #3 result: 43 m^3/ha

Mixedwood: Ques #2 result: 50 m^3/ha
Ques #3 result: 52 m^3/ha

Hardwood: Ques #2 result: 57 m^3/ha
Ques #3 result: 57 m^3/ha

1e. Average cutting cycle used on areas managed by uneven-aged management?

Softwood: Ques #2 result: 24 years
Ques #3 result: 32 years

Mixedwood: Ques #2 result: 24 years
Ques #3 result: 29 years

Hardwood: Ques #2 result: 21 years
Ques #3 result: 22 years

2. From Questionnaires #2 and #3 the results regarding **fertilization** of existing stands have been aggregated and are given below. Figures are based on one-time applications

2a. Stand age range when fertilization could take place.

Softwood: Ques #2 result: 13 & 41 yrs old
Ques #3 result: 14 & 35 yrs old

Mixedwood: Ques #2 result: 14 & 41 yrs old
Ques #3 result: 8 & 33 yrs old

Hardwood: Ques #2 result: 12 & 36 yrs old
Ques #3 result: 7 & 30 yrs old

2b. Rate of fertilizer (kg/ha) application.

Softwood: Ques #2 result: 175 kg/ha
Ques #3 result: 183 kg/ha

Mixedwood: Ques #2 result: 175 kg/ha
Ques #3 result: 175 kg/ha

Hardwood: Ques #2 result: 175 kg/ha
Ques #3 result: 175 kg/ha

2c. For sites distinguished as Good, Medium and Poor, the proportion of sites that would be fertilized.

Good: Ques #2 result: 31%
Ques #3 result: 14%

Medium: Ques #2 result: 25%
Ques #3 result: 20%

Poor: Ques #2 result: 11%
Ques #3 result: 6%

2d. Expected increase in growth (m3/ha/yr).

Softwood: Ques #2 result: 0.9 m^3/ha/yr
Ques #3 result: 0.6 m^3/ha/yr

Mixedwood: Ques #2 result: 0.6 m^3/ha/yr
Ques #3 result: 0.5 m^3/ha/yr

Hardwood: Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr

2e. Length of time the increased growth would last (years).

Softwood: Ques #2 result: 10 years
Ques #3 result: 9 years

Mixedwood: Ques #2 result: 10 years
Ques #3 result: 9 years

Hardwood: Ques #2 result: 11 years
Ques #3 result: 8 years

3. Comments from Questionnaire #1 regarding thinning indicated this topic had to be split into several categories and that thinning would occur only on immature stands. Several comments on round 2 again emphasize immature stands only. The results below apply only to immature stands. The mean of responses to round 2 and 3 are given below.

3a. For existing immature stands, expectations from **cleaning/brushing** (assuming no utilization) regarding the following are:

3aa. Change in growth.

Softwood: Ques #2 result: 0.7 m^3/ha/yr
Ques #3 result: 0.6 m^3/ha/yr

Mixedwood: Ques #2 result: 0.4 m^3/ha/yr
Ques #3 result: 0.5 m^3/ha/yr

Hardwood: Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr

3ab. Length of time this change in growth would last.

Softwood: Ques #2 result: 11 years
Ques #3 result: 11 years

Mixedwood: Ques #2 result: 6 years
Ques #3 result: 6 years

Hardwood: Ques #2 result: 9 years
Ques #3 result: 7 years

3ac. Change in rotation based on harvestable tree size.

Softwood: Ques #2 result: -3 years
Ques #3 result: -2 years

Mixedwood: Ques #2 result: 2 years
Ques #3 result: 1 years

Hardwood: Ques #2 result: 8 years
Ques #3 result: 1 years

3ad. Change in rotation based on maximum MAI.

Softwood: Ques #2 result: 0 years
Ques #3 result: -1 years

Mixedwood: Ques #2 result: 3 years
Ques #3 result: -2 years

Hardwood: Ques #2 result: 10 years
Ques #3 result: 2 years

3b. For existing immature stands expectations from **juvenile spacing/pre-commercial thinning** (assuming no utilization) regarding the following are:

3ba. Change in growth.

Softwood: Ques #2 result: 0.9 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr

Mixedwood: Ques #2 result: 1.0 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr

Hardwood: Ques #2 result: 1.1 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr

3bb. Length of time this change in growth lasted.

Softwood: Ques #2 result: 11 years
Ques #3 result: 12 years

Mixedwood: Ques #2 result: 11 years
Ques #3 result: 9 years

Hardwood: Ques #2 result: 14 years
Ques #3 result: 12 years

3bc. Change in rotation based on harvestable tree size.

Softwood: Ques #2 result: -3 years
Ques #3 result: -7 years

Mixedwood: Ques #2 result: 1 years
Ques #3 result: -1 years

Hardwood: Ques #2 result: 1 years
Ques #3 result: -1 years

3bd. Change in rotation based on maximum MAI.

Softwood: Ques #2 result: -1 years
Ques #3 result: -2 years

Mixedwood: Ques #2 result: 1 years
Ques #3 result: -3 years

Hardwood: Ques #2 result: 1 years
Ques #3 result: -3 years

3c. For existing immature stands expectations from **commercial thinning** (including thinning plus final harvest) regarding the following are:

3ca. Change in growth.
Softwood: Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.6 m^3/ha/yr
Mixedwood: Ques #2 result: 1.2 m^3/ha/yr
Ques #3 result: 0.6 m^3/ha/yr
Hardwood: Ques #2 result: 1.2 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr

3cb. Length of time this change in growth lasted.
Softwood: Ques #2 result: 11 years
Ques #3 result: 10 years
Mixedwood: Ques #2 result: 13 years
Ques #3 result: 8 years
Hardwood: Ques #2 result: 12 years
Ques #3 result: 9 years

3cc. Change in rotation based on harvestable tree size.
Softwood: Ques #2 result: 2 years
Ques #3 result: -1 years
Mixedwood: Ques #2 result: 3 years
Ques #3 result: -3 years
Hardwood: Ques #2 result: 3 years
Ques #3 result: -3 years

3cd. Change in rotation based on maximum MAI.
Softwood: Ques #2 result: 3 years
Ques #3 result: -2 years
Mixedwood: Ques #2 result: 2 years
Ques #3 result: -2 years
Hardwood: Ques #2 result: 2 years
Ques #3 result: -2 years

REGENERATED STANDS

4. Growth (MAI) of regenerated stands for softwood, mixedwood and hardwood.

4a. From Questionnaires #1, #2 and #3, aggregate (mean) responses from survey participants about growth of regenerated stands are provided below. In most cases, Questionnaire #2 and #3 results led to a mean MAI maximizations which were inconsistent with Questionnaire #1 age estimate of maximum MAI. The age classes were set in 20 year increments from Questionnaire #1 results that gave estimates of the ages of maximum MAI's which are denoted by an asterisk. The MAI should estimates are maximum at the 20 year age class where maximum biological growth is expected for pulpwood utilization for the region.

Softwood					Mixedwood					Hardwood			
Age	Que#1 MAI	Que#2 MAI	Que#3 MAI		Age	Que#1 MAI	Que#2 MAI	Que#3 MAI		Age	Que#1 MAI	Que#2 MAI	Que#3 MAI
19	NA	1.2	1.1		15	NA	1.2	1.0		1	NA	1.1	0.6
39	1.5	1.7	1.7		35	1.7	2.1	1.8		21	2.1	2.2	2.0
59	2.0	1.9	2.0		55	2.1	2.4	2.4		41	2.6	2.5	2.5
79*	1.8	2.0	2.1		75*	2.3	2.5	2.5		61*	2.8	2.7	2.9
99	1.7	1.8	1.8		95	2.1	2.1	2.1		81	2.5	2.3	2.6
119	NA	1.6	1.6		115	NA	1.7	1.7		101	NA	1.6	2.1

The aggregated results below are taken from rounds 2 and 3 survey results.

4b. Proportion of the area that will be managed by uneven-aged management.
Softwood: Ques #2 result: 9%
Ques #3 result: 5%
Mixedwood: Ques #2 result: 18%
Ques #3 result: 9%
Hardwood: Ques #2 result: 21%
Ques #3 result: 10%

4c. Growth per ha/year expected on areas that will be managed by uneven-aged management.
Softwood: Ques #2 result: 1.9 m^3/ha/yr
Ques #3 result: 1.8 m^3/ha/yr
Mixedwood: Ques #2 result: 2.1 m^3/ha/yr
Ques #3 result: 2.3 m^3/ha/yr
Hardwood: Ques #2 result: 2.2 m^3/ha/yr
Ques #3 result: 2.5 m^3/ha/yr

4d. After-cut growing stock level expected to be left on areas that will be managed by uneven-aged management.

Softwood: Ques #2 result: 47 m^3/ha
Ques #3 result: 55 m^3/ha

Mixedwood: Ques #2 result: 47 m^3/ha
Ques #3 result: 55 m^3/ha

Hardwood: Ques #2 result: 46 m^3/ha
Ques #3 result: 55 m^3/ha

4e. Average cutting cycle used on areas that will be managed by uneven-aged management.

Softwood: Ques #2 result: 24 years
Ques #3 result: 22 years

Mixedwood: Ques #2 result: 21 years
Ques #3 result: 20 years

Hardwood: Ques #2 result: 21 years
Ques #3 result: 20 years

5. From Questionnaires #2 and #3 the results regarding **fertilization** of regenerated stands have been aggregated and are given below. Figures are based on one-time applications.

5a. Stand age range when fertilization would take place.

Softwood: Ques #2 result: 13 & 44 yrs old
Ques #3 result: 5 & 30 yrs old

Mixedwood: Ques #2 result: 14 & 45 yrs old
Ques #3 result: 8 & 30 yrs old

Hardwood: Ques #2 result: 12 & 38 yrs old
Ques #3 result: 5 & 30 yrs old

5b. Rate of fertilizer (kg/ha).

Softwood: Ques #2 result: 150 kg/ha
Ques #3 result: 200 kg/ha

Mixedwood: Ques #2 result: 150 kg/ha
Ques #3 result: 150 kg/ha

Hardwood: Ques #2 result: 150 kg/ha
Ques #3 result: 150 kg/ha

5c. For sites distinguished as Good, Medium and Poor, that proportion of sites that would be fertilized.

Good: Ques #2 result: 28%
Ques #3 result: 13%

Medium: Ques #2 result: 24%
Ques #3 result: 20%

Poor: Ques #2 result: 16%
Ques #3 result: 0%

5d. Expected increase in growth (m3/ha/yr).

Softwood: Ques #2 result: 0.5 m^3/ha/yr
Ques #3 result: 0.5 m^3/ha/yr

Mixedwood: Ques #2 result: 0.6 m^3/ha/yr
Ques #3 result: 0.5 m^3/ha/yr

Hardwood: Ques #2 result: 0.5 m^3/ha/yr
Ques #3 result: 0.5 m^3/ha/yr

5e. Length of time the increased growth indicated above last (years).

Softwood: Ques #2 result: 10 years
Ques #3 result: 10 years

Mixedwood: Ques #2 result: 10 years
Ques #3 result: 8 years

Hardwood: Ques #2 result: 13 years
Ques #3 result: 15 years

6. Comments from Questionnaire #1 regarding thinning indicated this topic had to be split into several categories and that thinning would occur only on immature stands. Several comments on round 2 again emphasize immature stands only. The results below apply only to immature stands. The mean of responses to round 2 and 3 are given below.

6a. For regenerated immature stands, expectations from **cleaning/brushing** (assuming no utilization) regarding the following are:

6aa. Change in growth.

Softwood: Ques #2 result: 0.6 m^3/ha/yr
Ques #3 result: 0.5 m^3/ha/yr

Mixedwood: Ques #2 result: 0.5 m^3/ha/yr
Ques #3 result: 0.3 m^3/ha/yr

Hardwood: Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.3 m^3/ha/yr

6ab. Length of time this change in growth lasted.

Softwood: Ques #2 result: 10 years
Ques #3 result: 8 years

Mixedwood: Ques #2 result: 7 years
Ques #3 result: 7 years

Hardwood: Ques #2 result: 10 years
Ques #3 result: 10 years

6ac. Change in rotation based on harvestable tree size.

Softwood: Ques #2 result: 1 years
Ques #3 result: -4 years

Mixedwood: Ques #2 result: 2 years
Ques #3 result: -1 years

Hardwood: Ques #2 result: 8 years
Ques #3 result: -4 years

6ad. Change in rotation based on maximum MAI.

Softwood: Ques #2 result: 1 years
Ques #3 result: -2 years

Mixedwood: Ques #2 result: 2 years
Ques #3 result: -1 years

Hardwood: Ques #2 result: 8 years
Ques #3 result: -4 years

6b. For regenerated immature stands expectations from **juvenile spacing/pre-commercial thinning** (assuming no utilization) regarding the following are:

6ba. Change in growth?

Softwood: Ques #2 result: 0.7 m^3/ha/yr	**Mixedwood:** Ques #2 result: 0.8 m^3/ha/yr	**Hardwood:** Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.2 m^3/ha/yr	Ques #3 result: 0.2 m^3/ha/yr	Ques #3 result: 0.2 m^3/ha/yr

6bb. Length of time this change in growth lasted.

Softwood: Ques #2 result: 14 years	**Mixedwood:** Ques #2 result: 13 years	**Hardwood:** Ques #2 result: 14 years
Ques #3 result: 10 years	Ques #3 result: 7 years	Ques #3 result: 9 years

6bc. Change in rotation based on harvestable tree size.

Softwood: Ques #2 result: -2 years	**Mixedwood:** Ques #2 result: 0 years	**Hardwood:** Ques #2 result: 0 years
Ques #3 result: -4 years	Ques #3 result: -2 years	Ques #3 result: -3 years

6bd. Change in rotation based on maximum MAI.

Softwood: Ques #2 result: 1 years	**Mixedwood:** Ques #2 result: 1 years	**Hardwood:** Ques #2 result: 1 years
Ques #3 result: -3 years	Ques #3 result: -1 years	Ques #3 result: -3 years

6c. For regenerated immature stands, expectations from **commercial thinning** (including thinning plus final harvest) regarding the following are:

6ca. Change in growth.

Softwood: Ques #2 result: 0.7 m^3/ha/yr	**Mixedwood:** Ques #2 result: 0.8 m^3/ha/yr	**Hardwood:** Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.7 m^3/ha/yr	Ques #3 result: 0.7 m^3/ha/yr	Ques #3 result: NA m^3/ha/yr

6cb. Length of time this change in growth last.

Softwood: Ques #2 result: 13 years	**Mixedwood:** Ques #2 result: 14 years	**Hardwood:** Ques #2 result: 13 years
Ques #3 result: 10 years	Ques #3 result: 11 years	Ques #3 result: 11 years

6cc. Change in rotation based on harvestable tree size.

Softwood: Ques #2 result: 0 years	**Mixedwood:** Ques #2 result: 1 years	**Hardwood:** Ques #2 result: 3 years
Ques #3 result: -2 years	Ques #3 result: -2 years	Ques #3 result: -2 years

6cd. Change in rotation based on maximum MAI.

Softwood: Ques #2 result: 1 years	**Mixedwood:** Ques #2 result: -1 years	**Hardwood:** Ques #2 result: 1 years
Ques #3 result: -2 years	Ques #3 result: -2 years	Ques #3 result: -2 years

7. From Questionnaires #2, and #3 the results regarding **genetic improvement** of regenerated stands have been aggregated and are given below.

7a. Change in MAI expected from greater improvement.

Softwood: Ques #2 result: 0.7 m^3/ha/yr	**Mixedwood:** Ques #2 result: 0.7 m^3/ha/yr	**Hardwood:** Ques #2 result: 0.8 m^3/ha/yr
Ques #3 result: 0.4 m^3/ha/yr	Ques #3 result: 0.5 m^3/ha/yr	Ques #3 result: 0.5 m^3/ha/yr

7b. Change in rotation expected based on harvestable tree size.

Softwood: Ques #2 result: 6 years	**Mixedwood:** Ques #2 result: 5 years	**Hardwood:** Ques #2 result: 4 years
Ques #3 result: 1 years	Ques #3 result: -1 years	Ques #3 result: -1 years

7c. Change in rotation expected based on Maximum MAI.

Softwood: Ques #2 result: 5 years	**Mixedwood:** Ques #2 result: 4 years	**Hardwood:** Ques #2 result: 3 years
Ques #3 result: 1 years	Ques #3 result: -1 years	Ques #3 result: -1 years