TIMBER SUPPLY ANALYSIS:
MOUNTAIN PINE BEETLE IMPACT
ON INTERIOR TIMBER SUPPLY AREAS

Prepared for:

Council of Forest Industries

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Preface to the Report titled

"Timber Supply Analysis: Mountain Pine Beetle Impact on Interior Timber Supply Areas"

British Columbia is experiencing the worst Mountain Pine Beetle (MPB) outbreak in its history – likely the most significant natural event in the history of the Province of BC. Over 411 million cubic meters of interior Lodgepole Pine spread over 17 million hectares of working forest have now been cumulatively attacked by the beetle since 1994. This cumulative attacked volume represents close to ten times the normal interior annual allowable harvest.

In 2003 the province's Chief Forester carried out a timber supply analysis across the 12 management units heavily affected by the MPB at that time. Timber supply analysis can be used to examine the potential impacts of the outbreak on future harvest levels by exploring "what if" questions relevant to different management scenarios. The Council of Forest Industries (COFI) has prepared this 2005 analysis report to fill a current information gap by covering a larger area than was examined by the Chief Forester. This analysis and report examines individually the now 18 Timber Supply Areas (TSA's) affected by or at risk from the MPB. This report uses different assumptions and provides another point of reference against which further TSA mitigation options can be examined by industry, government and communities.

In the last three years the province's Chief Forester has "uplifted" the allowable annual cut by 15 million cubic meters in an attempt, within the bounds of good forest stewardship, to capture as much economic value as possible and reforest these stands before they deteriorate. This COFI report examines the potential medium and long term timber supply impacts on each of the 18 TSA's based on a timber salvage emphasis strategy. The key findings show there are benefits to salvaging the maximum volume of beetle killed stands before they lose their value for production of forest products and before they lose the ability to support the cost of reforestation.

The results of this timber salvage emphasis analysis shows some dramatic forecasts for some areas. In reviewing these results the reader should keep in mind:

- The outcomes of any analysis are influenced by the assumptions, which in this case reflect a timber salvage emphasis;
- The data provided by Ministry of Forests and Range (MoFR) for this analysis report and the state of scientific knowledge is vintage 2005 in a data and knowledge area that is improving steadily; and,
- The results of this analysis are not a forecast of "what will be" but are intended to be a useful benchmark against which to compare and inform the subsequent mitigation analysis that is needed to examine how timber supply might be managed going forward.

To illustrate the kinds of assumptions and information that will need to be more fully examined and customized for each individual TSA in future analysis the following should be considered:

- Improved biological and economic shelf life information will be available fall 2006;
- Information on natural regeneration success in unsalvaged beetle attacked stands is improving;
- The economics and operational knowledge base needed to harvest only beetle damaged trees from mixed species and advanced regeneration stands is improving; and,
- Significant increases in harvest levels in a TSA are potentially constrained by a number of practical limitations such as existing infrastructure, skilled labour supply, harvesting capacity, milling capacity, market capacity and access to capital. At the time of writing this report significant new sawmill capacity is not planned and while interest has been expressed in Oriented Strand Board and bio-energy projects using beetle killed timber, no new projects have yet broken ground.

One way to examine timber supply assumption and information uncertainties is to carry out sensitivity analysis or alternate scenario testing. In this report an example of alternate scenario testing and how it can be done is provided for the 100 Mile House TSA. It is expected that different assumptions and more sensitivity analyses will be examined across all management units as the Province, industry and communities develop strategic and operational options. An example of such additional assumption and analysis work is the April 2006 MoFR 100 Mile House TSA public discussion paper.

It is imperative these further TSA specific sensitivity analyses proceed in a timely way. The results of such analyses will allow planners and decision makers at the provincial, regional and community level better insight into such things as:

- What are the timber salvage implications of a status-quo vs aggressive harvest option on the working forest in their TSA;
- What volume of fibre would be required to be harvested to capture all of the attacked volume from the Timber Harvesting Landbase (THLB) within its economic shelf life;
- Can the full volume of dead pine on the THLB be harvested within it's lumber economic shelf life and if not, what would alternate shelf life scenarios for other economic uses of the fibre do to the timber supply forecasts;

- If it is not possible to salvage some stands, what and where are the opportunities for rehabilitation work to achieve the best economic stability objectives for the industry and for communities;
- Could the harvest level and schedule be efficiently managed between TSA's considering current conversion (milling) and market capacities;
- What volume and size of area on the THLB are or will be available for non-lumber products; and,
- How much and where may there be opportunity to relocate or establish non-timber resource values and interests.

This epidemic is a complex problem that needs a clear, focused issues management framework. Fundamental to the development and success of this framework is complete, reliable and timely information. One of the prerequisite information needs is to understand the short, medium and long-term timber supply impacts of the beetle epidemic and mitigation options.

This COFI 2005 report is a "strategic level" timber supply analysis. It is intended to meet some of the information requirements by providing benchmark timber supply impact information needed to begin answering current questions as well as to motivate the Provincial government, local government, industry and the regional beetle action coalitions to accelerate the work necessary to set clear and well informed strategic directions for the economic, environmental and social management of this epidemic. It is worth noting that the acceleration of this work should be aided by the expected release late this year by MoFR of new timber supply analysis work across 20 management units.

The comments in the "Discussion of Results" and "Management Opportunities" sections for each of the management units in the attached report are those of the consultant, Timberline Forest Inventory Consultants.

We trust that readers of this report find it informative and useful in understanding some of the multitude of issues created by the MPB epidemic. It is our hope that the report generates discussion and assists in accelerating the further analysis needed to prepare the strategic and operational plans required to address the complex issues the epidemic has created.

Council of Forest Industries

Timberline
Forest Inventory Consultants

March 24, 2006

File: 4051031.1.1

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Attention: Peter Affleck, RPF
Vice President, Forestry

Reference: Mountain Pine Beetle Impact Analysis

Dear Peter,

Enclosed please find the Mountain Pine Beetle Impact Analysis report, which includes all 18 B.C. timber supply areas associated with the project. In addition, results of the 100 Mile House TSA sensitivity analysis is provided. Feedback provided by the MOFR, forest licensees, the Beetle Coalitions and COFI staff has also been incorporated.

Thank you for your support during the analysis.

Yours truly,

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EXECUTIVE SUMMARY

A timber supply analysis has been completed to evaluate the impact of the current mountain pine beetle (MPB) outbreak throughout the interior of B.C. The analysis has reviewed potential impact of the MPB attack on timber supply for 18 Timber Supply Areas (TSAs) management units across the interior of the province. Tree Farm License management units were not included in the study.

The forest inventory, non-timber inventory and modeling rules data sets from the most recent timber supply analyses for each of these 18 management units have been used. These were provided either by the Ministry of Forests and Range (MOFR) Forest Analysis Branch or by Timberline, and include data from timber supply review, innovative forest practices agreements, and land use planning analyses recently completed for the land bases.

It was important to incorporate a consistent set of analysis assumptions for all TSAs. This provides increased utility when comparing results. Depending on which region of the province, full attack was considered to be at year zero, five or 10 of the analysis simulation. At full attack 100% of the at-risk MPB pine stands have been attacked (dead). The analysis used the concept of "shelf life" for pine stands attacked by the beetle. Based on recent studies each stand was given a time estimate of 5, 10, or 15 years from the time of attack to be salvaged before that stand lost its economic value for lumber production. If it were possible to harvest the stand prior to the expiration of the shelf life it was assumed that full volume was recovered and the site would be regenerated promptly to a managed stand condition.

Alternatively, if the stand was not harvested before its shelf life had expired, it was left as dead timber that would break up and regenerate to a reduced volume stand type (20% less than what would have otherwise been the "natural stand" volume modelled) and take an additional 15 years to reach merchantable age. These unsalvaged stands were not considered "disturbed" for the purposes of adjacency and other modelling rules and therefore did not limit the possibility of harvest in other available stands within the same management zone (e.g. wildlife habitat, visual quality, watershed, etc.).

Pine stands at risk to attack were identified either by the existing analysis unit definitions from the previous timber supply analysis, or by the individual stand characteristics where the data obtained for this study allowed for this. Stands with at least 40% pine and 60 years of age were assumed to be "at risk" to attack by MPB.

The timber supply indications in the study may significantly depend upon a number of existing and assumed conditions or "assumptions". Important elements of the analyses that affect the results include:

- Time of full attack;
- Shelf life;
- Extent of attack (i.e. percent mortality in pine stands); and
- Current inventory of mature at-risk pine.

Many of the TSAs included in the analysis have a predicted harvest flow similar to the previous analysis completed for the land base (TSR, IFPA, etc.), which includes some level of decline over the mid and long-term. Even though reductions in mid-term harvest can be exaggerated by the MPB epidemic, the MPB epidemic may not be the sole cause of a mid-term fall down in indicated harvest levels.

Each TSA exhibited individual responses to the various scenarios and the assumptions modelled. However, the following important results were noted in most of the TSAs included in the analysis:

- **The mid-term timber supply improved when the harvest during the initial 20 years of simulation was comprised of the maximum available at-risk MPB (dead or dying) pine (> 40% of stand composition, > 59 years old);**
- **Prompt regeneration to a managed stand condition as a result of salvaging MPB pine enabled the harvest level to recover in a shorter period of time from some or all of the falldown experienced in the mid-term. Similarly, timely rehabilitation of sites that will not be salvaged to a productive managed stand will have the same effect;**
- **Raising the annual harvest above the current AAC allowed salvage of virtually the entire MPB "at risk" pine inventory for some of the TSAs included in the analysis, in most cases without impacting the mid or long-term harvest potential;**
- **Increasing the harvest above the current AAC results in additional cut-over area. This additional disturbance can limit harvesting opportunities in non-pine stands adjacent to salvaged areas during the recovery period 15 to 25 years into the future; and,**
- **Harvesting pine at historic levels in conjunction with increased harvest of other species resulted in the lowest mid-term timber supply.**

Based on the results of the analysis, it will be important to consider the following in responding to the MPB outbreak:

- The total inventory of pine at risk to attack, or that has already been attacked.
- Can elevated harvest levels, which will enable improved volume recovery, be achieved operationally?
- Will it be possible to promptly regenerate sites that were not salvaged to a managed stand condition with the associated volume and rotation age gains, or will they remain untreated and grow to a natural stand; and
- What are the social, economic, and environmental consequences of changes to timber supply in the short, mid and long-term.

The MPB analysis provides an overview of the potential timber supply given a concise set of assumptions. More detailed analysis that could include spatial distribution of harvest, management of non-timber values with both at-risk pine and other stands, more thorough review of inventory levels over time, and management rules beyond the current outbreak will enable more informed decision making to take place.

It is important to note that there are many possible ways to approach the strategic analysis of a land base which has a serious outbreak of MPB. Changes to assumptions for shelf life, stands at risk to attack and subsequent loss of merchantability, and constraints related to non-timber resources can provide different results. To provide consistency, this analysis has used one set of assumptions for all TSAs. Given data and model availability the inputs and assumptions used are considered reasonable for modelling the MPB issue but by no means are considered to identify the only approach to assessing MPB impact on timber supply.

Sensitivity analysis is used to evaluate the uncertainty associated with inputs to the analysis. By modifying inputs it is possible to gain a better understanding of how those inputs influence the timber supply for a given land base. A sensitivity analysis was completed on the 100 Mile House TSA in which revisions to some of the assumptions were made as listed below:

- Full attack was delayed until year five of the simulation, effectively extending shelf life by five years;
- The 20% volume penalty for MPB pine stands not salvaged prior to the expiration of the shelf life was removed - these stands regenerated to the normally modelled natural stand condition; and
- Other species (non-MPB pine) were able to contribute up to 20% of the annual harvest in the short-term, the period during which salvage of dead and dying pine occurs.

This sensitivity analysis indicates that the short-term harvest is sustained for an additional 10 years compared to its companion run. Including non-MPB pine stands in the early harvest profile caused only a very minor decline in the mid-term harvest level 40 to 110 years into the future. The long-term harvest level is increased as a result of the 20% volume penalty on unsalvaged sites not being included. Overall this sensitivity analysis demonstrated that, for the 100 Mile House TSA, these changes to the assumptions do not make a significant difference to the results when the short term harvest is not increased above the current AAC as modelled.

Additional understanding of the impact of the MPB outbreak could be facilitated by including additional review of the following in future timber supply analyses:

- Alternative assumptions related to mortality in pure and mixed pine stands at risk to MPB attack;
- More detailed inputs and summary of the species distribution of the harvest and residual forest;
- Inventory levels over time, especially during the recovery period after the outbreak has ended;
- Trade-offs between leaving MPB pine stands in the forest to address non-timber objectives, and how that might reduce the pressure for those objectives to be met in non-pine stands; and
- Spatial distribution of the harvest and the impact of increased harvesting on non-timber objectives;

The analysis has identified a number of areas, which should be addressed to ensure that the best information is being used to estimate the impact of the pine beetle issue:

- Continue to gather information related to shelf life estimates;
- Improve estimates of attack levels and subsequent mortality in both pure and mixed stands of pine;
- Identify ages of pine that are being attacked, this analysis used 60 years as a minimum age but it has been suggested that much younger stands are at risk;
- Estimate the amount of unsalvaged land that can be rehabilitated to a managed regeneration type in order to maximize the productivity from the next stand; and
- Confirm management rules for other forest resources, in order to understand where additional salvage will be permitted.

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1.0 INTRODUCTION

The recent infestation of Mountain Pine Beetle (*Dendroctonus ponderosae*) (MPB) has reached critical levels throughout the interior of British Columbia. Many of the timber supply areas (TSAs) have increased allowable annual cut (AAC) levels to address salvage of dead and damaged timber, or to provide harvesting that will reduce the spread of the beetle. The impact of this far-reaching outbreak of MPB could affect the forest for timber and other resource values.

In response to a request by the Council of Forest Industries (COFI), Timberline is conducting timber supply analysis on 18 TSAs within the province to evaluate the impacts of the MPB outbreak. Data used for the MPB analyses has come from a variety of sources including:

- Ministry of Forests and Range's (MOFR) most recent timber supply review (TSR);
- Land-use planning timber supply analyses completed by Timberline; and
- IFPA analyses completed by Timberline.

The objective of the analysis is to provide general trends in timber supply related to the MPB outbreak. Existing timber supply analysis data sets have been used with minor revisions to address additional harvest and potential losses in pine-leading stands. It was not possible to isolate all pine volume, *ie*. minor pine volume in other stands, to assess how this might affect timber supply because of time requirements and source data used. Therefore general stand type definitions (analysis units) have been used in many cases to identify the at-risk or MPB pine stands.

TSA data sets provided by MOFR were modelled using FSSIM (version 3.0), while those from Timberline archives were modelled using TINC (version 1.3.8) the non-spatial version of CASH6.2.

The analyses used the concept of "shelf life" which defines the length of time beetle-killed pine trees will remain merchantable after attack. Shelf life estimates use site moisture classification methods outlined in the report *Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model (BCMPBv2) and Results of Year 2 of the Project* (CFS/MOFR, April 2005). This report describes the use of BEC subzone to classify sites as wet, moist or dry (Appendix 4). Section 2.4 of this report summarizes the shelf life assumptions for this analysis.

It is important to note that there are many possible ways to approach the strategic analysis of a land base which has a serious outbreak of MPB. Changes to assumptions for shelf life, stands at risk to attack and subsequent loss of merchantability, and constraints related to non-timber resources can provide different results. To provide consistency this analysis has used one set of assumptions for all TSAs. Given data and model availability the inputs and assumptions used are considered reasonable for modelling the MPB issue.

1.1 Analysis Scenarios

Four scenarios were completed for each of the TSAs included in the analysis as described below.

Baseline. This scenario established a new base case for the analysis. Most of the inputs and assumption are taken from the previous (TSR or other) Base Case. However, there have been revisions to the dynamics for at-risk MPB pine growth and yield including shelf life and mortality. Harvest priorities and other management assumptions are consistent with the previous Base Case. Pine shelf life and regeneration inputs are included in this scenario, along with all base case forest cover requirements. Note that the short-term harvest was based on the greater of either the current AAC or the previous Base Case harvest level.

Baseline with MPB Pine Target. Similar to the *Baseline* scenario, this run models the new assumptions for pine at risk to attack by MPB. However, the at-risk pine stands are given the highest priority for harvest in the short-term (15 to 25 years depending on TSA) to maximize the recovery of this timber prior to complete loss. In many TSAs this results in the entire harvest coming from at-risk MPB pine stands.

Harvest All MPB Pine. Using the forest cover requirements defined for the *Baseline*, this scenario attempts to harvest all of the pine at risk to MPB prior to expiration of the shelf life period. Any harvest priorities outlined for the *Baseline* (other than existing MPB priorities) were replaced to allow harvesting of pine stands prior to expiration of their shelf life. If the annual harvest exceeds the current AAC then the entire harvest must be made up of at-risk pine volume.

Harvest All MPB Pine with Relaxed Forest Cover Constraints. As noted in the *Harvest All MPB Pine* scenario, harvest priorities were assigned to the stands at risk to MPB attack. In this scenario disturbance forest cover constraints (FCCs) associated with integrated resource management (IRM) and visual (VQOs) areas were not enforced until after the expiration of dead pine shelf life (the first 15 – 25 years of simulation). This was intended to permit additional access to designated pine stands. These forest cover constraints were in place for all remaining periods of the analysis simulation. It is important to note that wildlife, watershed and seral constraints were enforced during every period of the simulation for this scenario.

2.0 METHODOLOGY

The following sections outline the methodology employed for the MPB analysis.

2.1 TSA Selection

Eighteen TSAs from the interior of B.C. were included in the analysis. These were selected based on discussions with COFI staff regarding existing inventory of Lodgepole pine and the presence of the pine beetle. Table 2.1 lists the TSAs included in the MPB analysis and the modelling format used.

Table 2.1 – Interior TSAs included in the MPB Analysis

Northern Interior	Modelling Format	Southern Interior	Modelling Format
Bulkley	FSSIM	Boundary	CASH6.2
Dawson Creek	FSSIM	Cranbrook	FSSIM
Fort St. John	FSSIM	Invermere	FSSIM
Lakes	FSSIM	Kamloops	FSSIM
Mackenzie	FSSIM	Kootenay Lake	CASH6.2
Morice	FSSIM	Lillooet	FSSIM
Prince George	FSSIM	Merritt	CASH6.2
		Okanagan	CASH6.2
		Quesnel	CASH6.2
		Williams Lake	FSSIM
		100 Mile House	FSSIM

2.2 Data Acquisition

Analysis data files were provided by MOFR Forest Analysis Branch and Timberline, using archives of recent timber supply analyses. The most recent TSR "Base Case" data was used (TSR-2 or TSR-3) to ensure that results are based on current information. For some TSAs, data developed for other analyses (LRMP, IFPA, *etc*.) has been used. This information is considered more up-to-date than the TSR-2 information.

2.3 Data Preparation

Upon receipt of TSA data sets a review of analysis inputs (analysis units, resource emphasis areas, harvest partitions, *etc*.) was conducted. Assignments of these inputs were modified as needed to address assumptions for MPB.

Pine stands at risk were isolated from other pine stands and modelled on separate yield tables to allow modelling of revised assumptions.

2.4 Modelling Assumptions

Modelling inputs and assumptions were developed from the Base Case from the most recent TSR, or other analysis for each TSA. The data source for each TSA is provided in the results section. For most TSAs included in the MPB analysis, it was necessary to update the inventory to reflect harvesting in recent years. This was achieved by modelling the first 5-years of the analysis using known AAC levels and management assumptions from the previous analysis. This addresses depletions and growth over the past five years. Reporting of results for the MPB analysis is from year six (the beginning of the second 5-year period) forward. A description of the methodology for modelling MPB attack, and subsequent mortality on susceptible pine stands follows.

Shelf Life

As stated in the *Introduction* (Section 1.0), each pine stand was assigned to a moisture category using MOFR/CFS methods. Each moisture category was then given a shelf life. Based on discussions with COFI and some licensee representatives, the following assumptions for shelf life were modelled in this MPB analysis:

- Wet sites – five years;
- Moist sites – 10 years; and
- Dry sites – 15 years.

Complete attack by MPB varies between some TSAs. Those areas which have been under attack for some time (*eg*. Lakes, Quesnel) are assumed to have full attack at year one of the simulations. Others are assumed to reach full attack either five or 10 years into the future. The year after full attack is when shelf life begins. The shelf life assignments relate to merchantability of the volume harvested, *ie*. sawlogs, chips, *etc*. Table 2.2 lists the projected year for full MPB attack.

Table 2.2 – Projected year of full MPB attack

Northern Interior	Year of Full MPB Attack	Southern Interior	Year of Full MPB Attack
Bulkley	5	Boundary	5
Dawson Creek	10	Cranbrook	5
Fort St. John	10	Invermere	5
Lakes	0	Kamloops	5
Mackenzie	10	Kootenay Lake	5
Morice	0	Lillooet	5
Prince George	0	Merritt	5
		Okanagan	5
		Quesnel	0
		Williams Lake	0
		100 Mile House	0

It is important to note that at the time of full attack all at-risk MPB pine stands are assumed to be dead and will become unmerchantable for conventional purposes at the end of the assumed shelf life.

Pine Growth & Yield

Existing analysis unit definitions for pine stands were used as a framework for modelling pine stands at risk to attack. Pine stands at least 60 years old and either pine leading or 40% pine in other stands, were assumed to be at risk to MPB attack. A duplicate set of pine analysis units was developed based on the existing framework and the distribution of the BEC shelf life categories. A duplicate yield table (typically natural stand yield) was used to model the growth of these pine stands during the first 15 to 25 years of simulation.

At-risk pine stands harvested within the assumed shelf life period contributed full volume to the periodic harvest and regenerated to their managed silviculture regime. If any pine stands were not harvested before their shelf life expired they did not contribute to the periodic harvest. In addition, these unsalvaged sites were modelled to regenerate to a reduced natural stand yield table (80% of Base Case) with a 15-year regeneration delay. This was intended to represent no managed regeneration on these unsalvaged areas and a loss of productive area due to additional debris on the site.

Forest Cover & Salvage

The following assumptions were used in modelling dead pine stands that were not salvaged prior to the expiration of their shelf life:

- MPB pine stands not harvested before the expiration of their shelf life are not considered "disturbed" and therefore do not contribute to the disturbance constraint for any management zone (VOQ, watersheds, IRM/adjacency, *etc*.);
- The regeneration age for these dead sites was set to an age older than all disturbance ages for the various management zones to ensure that the areas were older than the minimum green-up age;
- Rather than applying an extended regeneration delay (which affects green-up related to forest cover constraints) the rotation ages for the regeneration type assigned to these dead stands were extended by at lease 40 years (15 years to account for the regen delay and 25(+) years to account for the advanced age of the regeneration.

This set of assumptions applied only to the *Baseline*, *Baseline with MPB Pine Target*, and *Harvest All MPB Pine* scenarios.

Harvest Priority & Profile

Pine stands at risk to attack were given the highest priority for harvest in the harvest queue, except in the Baseline scenario where historic harvest priorities were modelled. Those stands assumed to be unaffected by MPB attack did not contribute to the periodic harvest during the first 15 years of simulation (the salvage period) until salvage harvest opportunities had been exhausted. This input was included to force as much of the harvest as possible into pine stands.

Other harvest profile assumptions from the previous Base Case were ignored in all but the Baseline scenario to allow priority harvesting of pine stands. Non-pine stands could only contribute to the periodic harvest if the at-risk pine had been salvaged before the expiration of the shelf life, up to 25 years. Some TSAs have a minor component of dry sites and therefore harvesting of other stands is necessary to satisfy existing AAC targets during the last five years assigned to salvaging dead pine stands.

In the analysis scenarios which attempted to harvest all dead or dying MPB pine prior to expiration of the shelf life; the following harvest flow methodology was used:

- Identify the at-risk pine volume within each shelf life category;
- Distribute this volume evenly over the shelf life time frame and the years to reach full attack (15 – 25 years), recognizing that on TSAs with more wet and moist site conditions, there might be a need to force more of the harvest into the earlier periods of simulation; and
- Reduce the harvest as required to address other non-timber resources.

It is important to note that for some TSAs the short-term harvest rate is higher than the current AAC. This increased level was modelled in the previous timber supply analysis for the TSA. Modelling at the elevated harvest level is necessary to:

- Include non-recoverable losses identified for the land base; and/or
- Ensure the productive capacity of the land base is understood.

Modelling Periods

The first 20 years of simulation was modelled with 5-year periods, the remainder of the 250-year planning horizon used 10-year periods. The following define the time frames used to describe timber supply in the report:

- *Initial* – harvest rate during the first 5-year simulation period;
- *Short-term* – the period during which pine salvage occurs, up to 25 years;
- *Mid-term* – the recovery period after all salvage has been completed and replacement stands grow to merchantable age, typically 25 to 100-150 years into the future; and
- *Long-term* – the time during which the sustainable harvest rate is in place to the end of the 250-year planning horizon.

2.5 Reporting of Analysis Results

This section summarizes the analysis results for each TSA. The columns listed in summary tables are described below:

- *Simulation Year* – last year of each simulation period;
- *Annual Harvest* – volume in cubic meters per year harvested from the entire timber harvesting land base (THLB) including historic non-recoverable losses;
- *Dead Pine Target* – the dead (attacked) pine volume that was entered as a target in the simulation model;
- *Dead Pine Harvest* – portion of the *Annual Harvest* provided by dead pine stands or pine stands that will be dead within the first 10 years of simulation. This volume is only reported until the shelf life for these pine stands expires. These stands are assumed to be unmerchantable after the expiration of the shelf life (up to 25 years from now)

- *Unsalvaged Pine Inventory* – the volume in cubic meters of dead pine that remains in the forest after each simulation period. It is assumed that the shelf life for all pine will expire between 15 and 25 years from the beginning of the simulation depending on the current projection for complete attack by MPB for each TSA. As wet, moist and dry sites reach the limit of their assumed shelf life there is an accumulation of unsalvaged volume. The sites occupied by these unsalvaged stands will not contribute to the periodic harvest for at least 60 years after the sites have regenerated naturally and reached mature status.

Below each of the summary figures, historic AAC (to the nearest 1000 cubic meters) is provided for comparison to the analysis results. The results presented in the following sections have been organized into groups based on timing of full MPB attack: year 0, 5 or 10.

3.0 ANALYSIS RESULTS – FULL ATTACK AT YEAR 0

The TSAs included in the sections below are assumed to have reached full MPB attack at the beginning of the analysis. Therefore the shelf life for all MPB pine stands will reach expiration at year 15 of the planning horizon.

3.1 Quesnel TSA

Quesnel TSA data used in the MPB Analysis was provided by Timberline. It incorporates TSR-2 assumptions that were used in the Quesnel Short-Term Timber Assessment (STTA) completed in June 2004.

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 126 million cubic meters of pine volume at risk in the Quesnel TSA. Table 3.1 summarizes the area and volume (THLB only) for the Quesnel TSA.

Table 3.1 – Quesnel TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	364,138	
THLB		
Wet MPB	7,161	1,970,000
Moist MPB	143,785	33,792,000
Dry MPB	482,621	91,511,000
Non MPB	444,105	32,765,400
Total THLB	1,077,673	158,068,000
Total productive forest	1,441,811	

Baseline

Table 3.2 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 3.2 – Annual harvest – Quesnel Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	5,280,000	n/a	3,534,886	1,258,000
10	5,280,000	n/a	4,325,780	26,361,000
15	5,280,000	n/a	4,343,460	57,774,000
20 – 50	452,000			
60	739,000			
70	1,178,000			
80	1,178,000			
90 – 250	1,964,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 3.3 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 3.3 – Annual harvest – Quesnel Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	5,280,000	5,280,000	5,280,000	1,258,000
10	5,280,000	5,280,000	5,280,000	18,425,000
15	5,280,000	5,280,000	5,280,000	39,595,000
20 - 60	1,060,600			
70	1,295,000			
80	1,664,000			
90 – 250	1,964,000			

Harvest All MPB Pine

Table 3.4 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 3.4 – Annual harvest – Quesnel Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	6,489,000	6,925,000	6,489,000	1,258,000
10	6,489,000	6,925,000	6,489,000	8,058,000
15	6,375,000	6,925,000	6,375,000	22,030,000
20 – 60	1,106,000			
70	1,393,000			
80	1,951,000			
90	1,951,000			
100	1,951,000			
110 – 250	2,024,000			

Harvest All MPB Pine with Relaxed FCC

Table 3.5 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 3.5 – Annual harvest – Quesnel Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	6,808,300	6,925,000	6,808,300	621,000
10	6,798,300	6,925,000	6,798,300	7,919,000
15	6,518,300	6,925,000	6,518,300	17,025,000
20 – 60	1,104,600			
70	1,437,600			
80	1,817,600			
90	1,817,600			
100	1,817,600			
110 – 250	2,044,600			

Discussion of Results

Given the extent of MPB attack in the Quesnel TSA, and the fact that over 60% of the THLB is occupied by mature (age 60+) pine, the impact of MPB is severe in the TSA. In all Quesnel scenarios there is a falldown in mid-term harvest during years 20 to 80 of the simulation. This is a result of lost pine volume combined with insufficient volume in the remaining spruce, balsam and Douglas-fir stands to support the historic harvest over that period.

The Baseline scenario allows non-pine stands to contribute to the periodic harvest. This results in the largest decline in mid-term harvest because less salvage is completed. If pine is not salvaged after attack those sites are assumed to regenerate naturally at a slower rate than areas that have been harvested and replaced with managed regeneration. These stands provide less volume at maturity compared with managed pine stands, which would be more likely to include site preparation, density control and seedlings with genetic gains. In addition, non-pine stands that would support the harvest during the mid-term while the pine stands regenerate have been utilized during the first 20 years of the simulation.

Similar results were observed when higher salvage rates are modelled in the Baseline with MPB Pine and Harvest All MPB Pine scenarios. The decline in the mid-term is not as severe as noted for the Baseline, but it is still only 50% of the historic AAC for the Quesnel TSA. The advantage with these scenarios is that pine sites are regenerated promptly to a managed stand, which provides the maximum productivity from the site.

In the Harvest All MPB Pine scenarios there is additional short-term harvest of pine, which will provide more volume to manufacturing facilities, but it has little impact on the mid-term falldown or the long-term harvest rate. Even with relaxed forest cover constraints there is only a 6% increase in the harvest level over the next 10 years.

Management Opportunities

It will be important to utilize as much of the attacked pine as possible which in this TSA. Equally important will be getting those sites back into a managed stand state as quickly as possible to reduce the potential mid-term falldown in harvest. In addition to providing more volume, this licensee harvesting would also lessen the operational and financial burden on the Province to eventually regenerate these sites.

Given the extent of the attack the analysis indicates that there is little else can be done to avoid the mid-term falldown for the land base.

Figure 3.1 presents the annual harvest rates developed for the Quesnel TSA MPB scenarios.

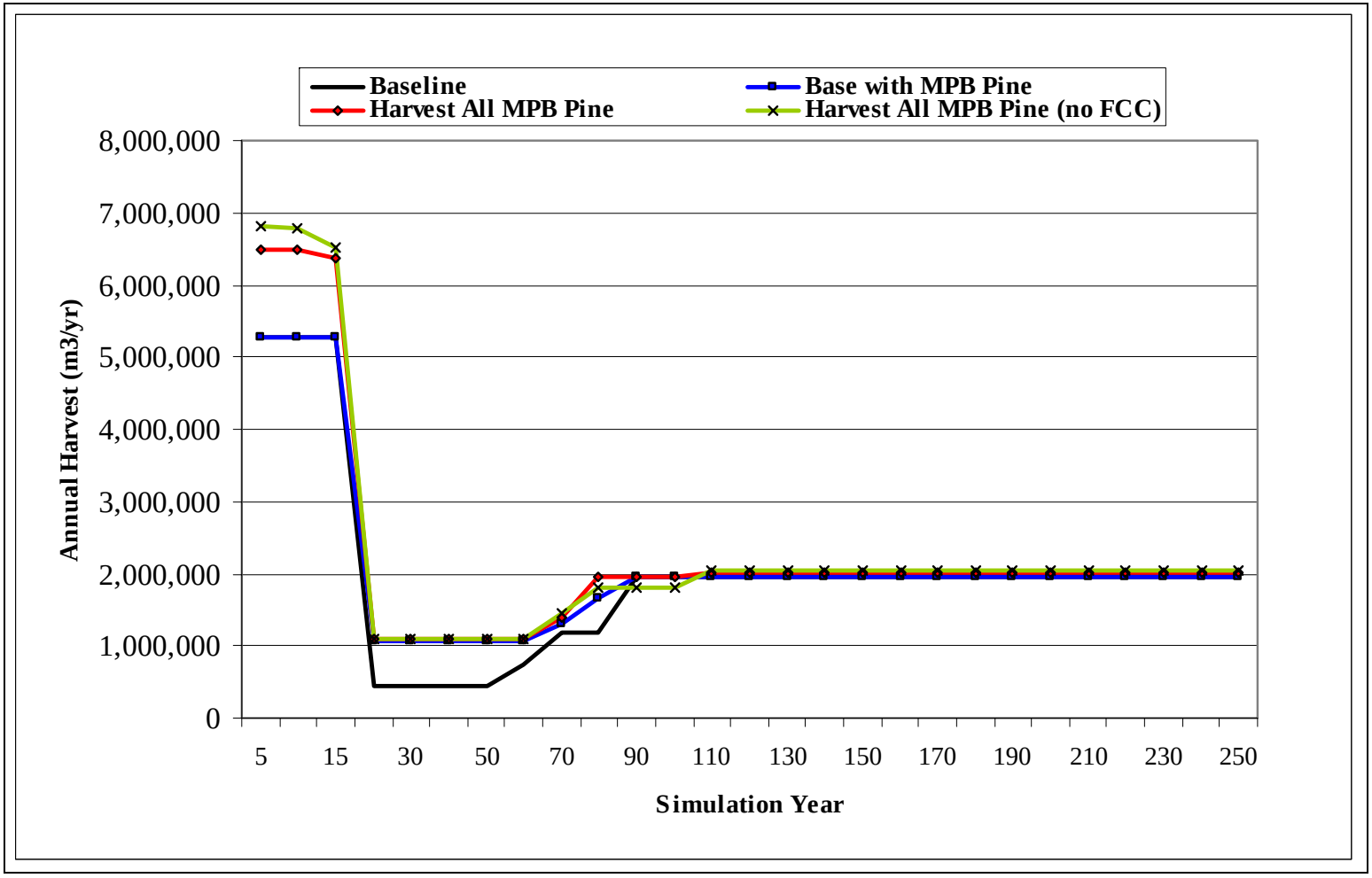

Figure 3.1 – Annual harvest levels – Quesnel TSA MPB scenarios

Historic AAC: 2,300,000 (1981); 2,340,000 (1996); 3,248,000 (2001); 5,280,000 (2004)

3.2 Williams Lake TSA

MOFR Forest Analysis Branch provided the Williams Lake TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Williams Lake Timber Supply Area Analysis Report* (MoF, September 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 113 million cubic metres of pine volume at risk in the Williams Lake TSA. Table 3.6 summarizes the area and volume (THLB only) for the Williams Lake TSA.

Table 3.6 – Williams Lake TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	933,219	
THLB		
Wet MPB	20,891	2,639,000
Moist MPB	150,246	24,974,000
Dry MPB	1,037,715	85,932,000
Non MPB	889,089	87,858,000
Total THLB	2,097,700	201,403,000
Total productive forest	3,031,160	

Baseline

Table 3.7 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 3.7 – Annual harvest – Williams Lake Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,768,400	n/a	2,033,739	2,639,000
10	3,768,400	n/a	2,076,898	22,858,000
15	3,303,500	n/a	1,791,789	84,033,000
20	2,843,000			
30	1,167,000			
40 - 70	877,000			
80 - 100	1,453,000			
110 - 250	2,259,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 3.8 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 3.8 – Annual harvest – Williams Lake Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,768,400	3,768,400	3,768,400	1,741,000
10	3,768,400	3,768,400	3,768,400	14,669,000
15	2,920,000	3,768,400	2,110,822	65,307,000
20	2,920,000			
30	2,609,000			
40	1,324,000			
50 – 70	922,000			
80	1,349,000			
90 - 110	1,595,000			
170 - 250	2,359,000			

Harvest All MPB Pine

Table 3.9 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 3.9 – Annual harvest – Williams Lake Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,998,100	7,569,600	4,998,100	1,611,000
10	3,735,000	7,569,600	3,735,000	12,492,000
15	3,312,000	7,569,600	1,464,000	62,560,000
20	2,997,000			
30	2,166,000			
40	1,404,000			
50 - 70	916,000			
80	1,261,000			
90 - 110	1,593,000			
120 - 250	2,347,000			

Harvest All MPB Pine with Relaxed FCC

Table 3.10 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 3.10 – Annual harvest – Williams Lake Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	7,569,600	7,569,600	7,569,600	1,694,000
10	7,569,600	7,569,600	7,569,600	5,655,000
15	3,744,000	7,569,600	3,744,000	19,129,000
20 - 100	1,431,500			
110 - 160	2,279,400			
170 - 250	2,746,400			

Discussion of Results

There are a number of complicating factors within the Williams Lake TSA including multiple districts, partitions for the western supply blocks, partial cutting requirements and various wildlife requirements. These are likely to play a role in managing for MPB in the TSA.

The results of the analysis indicate that there is a decline in mid-term harvest for all scenarios as a result of MPB attack. The timing and duration of the mid-term harvest level varies between scenarios, but it is clear that focusing, to the extent possible, harvest into MPB pine increases the mid-term harvest rate. Also the long-term harvest is below the historic AAC level.

Reduced harvest of pine in the Baseline scenario shows a more rapid decline to the mid-term compared with the Baseline with MPB Pine or Harvest All MPB Pine scenarios. The effect of reduced second growth volume, which would have been provided by pine 50 to 70 years into the future, forces the harvest to decline.

Only by relaxing forest cover constraints, which increases the opportunity to salvage more pine stands, is it possible to increase the mid-term harvest rate. This is a result of replacing the dead pine with managed regeneration. The short-term volume improvement will dramatically increase the volume available to mills. Increasing the pine salvage in the initial 15 years also improves the long-term harvest potential because more sites are immediately regenerated to shorter rotation, higher volume managed stands compared with other scenarios. However increases in harvest must consider the implications for non-timber resources and how removal of these stands will impact non-timber objectives.

Management Opportunities

It appears that there is an opportunity to increase the current harvest from the TSA in order to recover dead and dying pine. In addition to providing more volume, this licensee harvesting would also lessen the operational and financial burden on the Province to eventually regenerate these sites. The mid-term falldown noted in the Harvest All MPB Pine with Relaxed FCC scenario could likely be reduced if administrative rules for adjacency and green-up were relaxed for an additional 20 years to allow more flexibility in harvesting remaining non-pine stands.

Figure 3.2 presents the annual harvest rates developed for the Williams Lake TSA MPB scenarios.

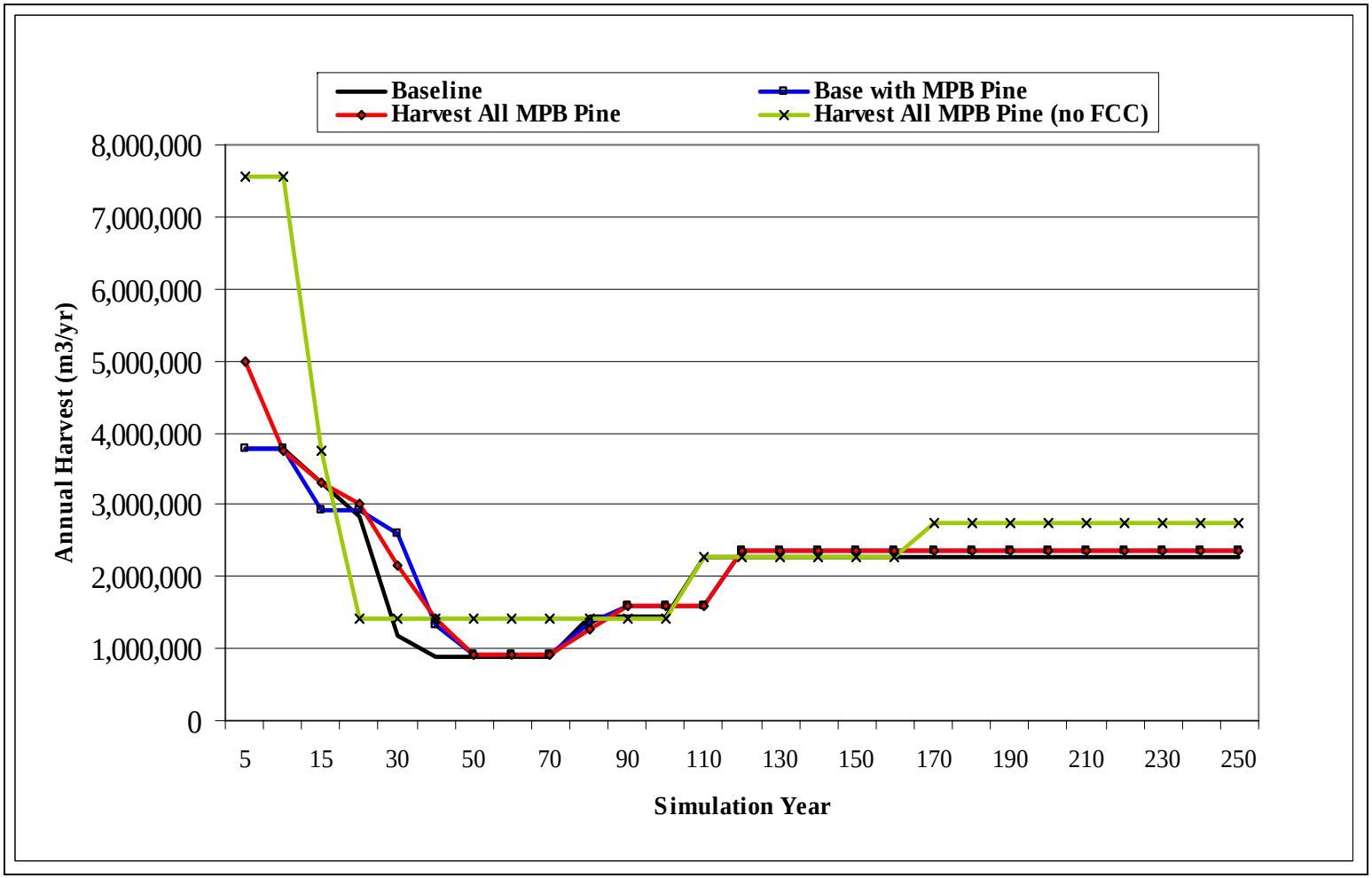

Figure 3.2 – Annual harvest levels – Williams Lake TSA MPB scenarios

Historic AAC: 2,500,000 (1981); 3,750,000 (1985); 4,350,000 (1989); 3,807,000 (1995); 3,768,000 (2002)

3.3 100 Mile House TSA

MOFR Forest Analysis Branch provided 100 Mile House TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *100 Mile House Timber Supply Area Analysis Report* (MoF, July 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 63 million cubic metres of pine volume at risk in the 100 Mile House TSA. Table 3.11 summarizes the area and volume (THLB only) for the 100 Mile House TSA.

Table 3.11 – 100 Mile House TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	158,971	
THLB		
Wet MPB	5,849	1,257,000
Moist MPB	20,188	4,400,000
Dry MPB	262,835	57,310,000
Non MPB	444,105	48,901,000
Total THLB	800,719	111,868,000
Total productive forest	959,689	

Baseline

Table 3.12 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 3.12 – Annual harvest – 100 Mile House Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	1,369,970	n/a	845,735	1,143,000
10	1,369,970	n/a	1,221,308	4,798,000
15	1,369,970	n/a	286,832	51,198,000
20 - 130	1,005,000			
140 - 250	1,161,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 3.13 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 3.13 – Annual harvest – 100 Mile House Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	1,369,970	1,369,970	1,369,970	1,117,000
10	1,369,970	1,369,970	1,369,970	4,421,000
15	1,369,970	1,369,970	1,369,970	42,418,000
20	1,369,970			
30 - 120	1,095,000			
130 - 250	1,205,900			

Harvest All MPB Pine

Table 3.14 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 3.14 – Annual harvest – 100 Mile House Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,197,800	4,397,700	4,144,996	264,000
10	4,024,800	4,152,300	3,087,529	1,673,000
15	1,369,970	3,722,800	1,011,100	21,749,000
20	1,369,970			
30 - 250	1,115,500			

Harvest All MPB Pine with Relaxed FCC

Table 3.15 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 3.15 – Annual harvest – 100 Mile House Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,197,800	4,197,800	4,196,400	7,000
10	4,197,800	4,197,800	4,197,800	8,000
15	4,197,800	4,197,800	4,197,800	8,000
20	1,315,900			
30	1,315,900			
40	1,315,900			
50	1,315,900			
60	1,315,900			
70	1,315,900			
80 - 250	1,175,000			

Discussion of Results

The analysis demonstrates clear trends for the various management assumptions. As demonstrated by the Baseline scenario, electing to leave attacked pine stands in the forest compromises the mid-term harvest potential as these sites are regenerated and grown on a delayed natural regeneration scheme that produce lower volumes compared to the managed stand regime.

Increasing salvage of pine stands as shown in the other three scenarios indicates subsequent improvement in the mid-term harvest rate. By harvesting all of the dead pine the harvest is maximized throughout most of the 250-year planning horizon. In the Harvest All MPB Pine with Relaxed FCC scenario virtually all pine is salvaged and the highest overall harvest rate is provided for the 250-year planning horizon.

Management Opportunities

Based on the assumptions of this analysis, harvesting as much of the attacked pine as possible is the will maximize the timber supply in the TSA. With minor revisions to management rules for green-up for the term of stand's shelf life - 5 to 15 years - the timber supply is maximized and sites are maintained in their most productive managed stand condition.

Figure 3.3 presents the annual harvest rates developed for the 100 Mile House TSA MPB scenarios.

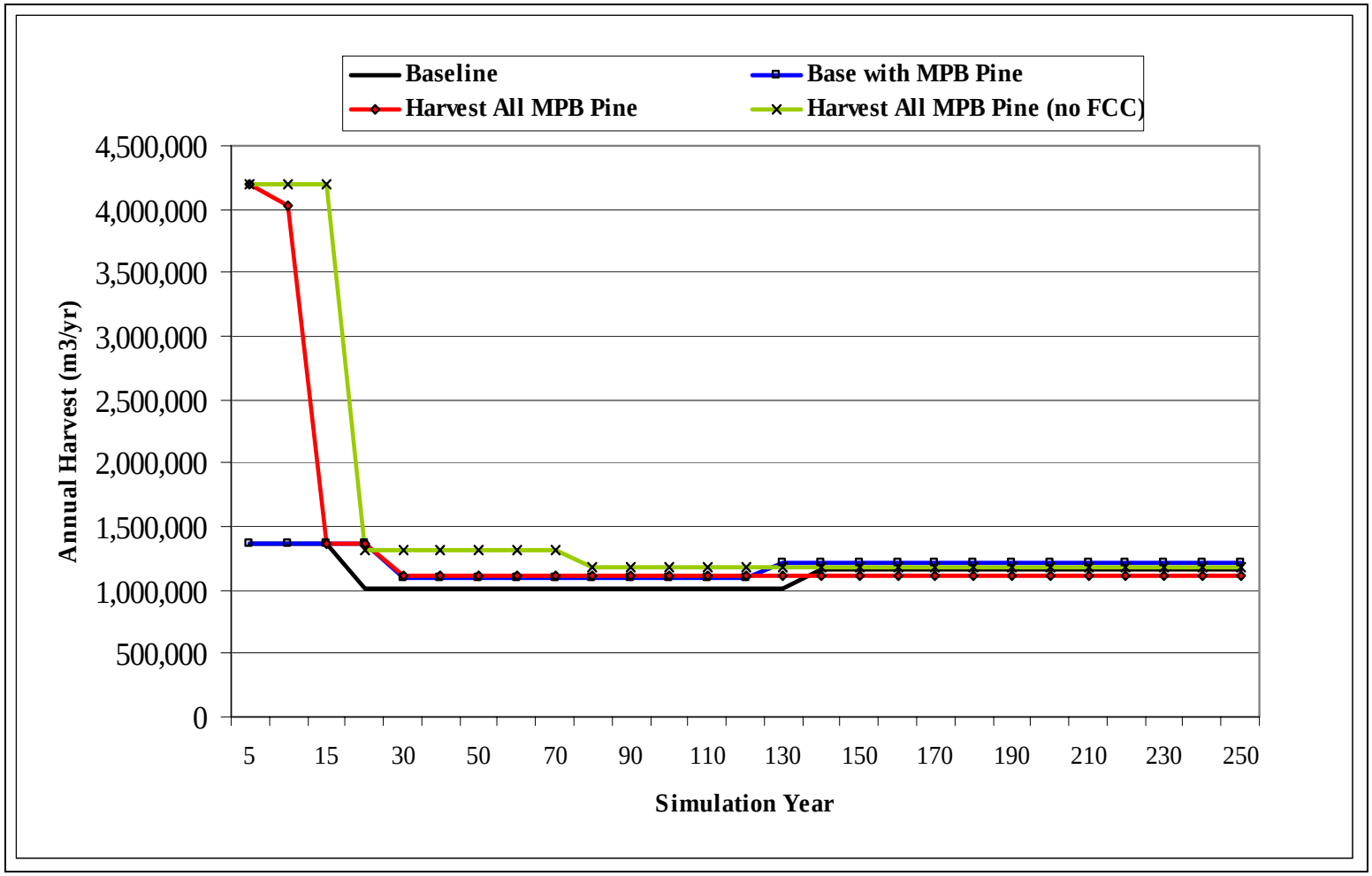

Figure 3.3 – Annual harvest levels – 100 Mile House TSA MPB scenarios

Historic AAC: 1,250,000 (1981); 1,362,000 (1996); 1,334,000 (2002)

Sensitivity Analysis

An additional scenario was completed for the 100 Mile House TSA in which some of the MPB modelling assumptions were modified to evaluate the impact on timber supply. This sensitivity analysis is based on the assumptions used in the *Baseline with MPB Pine Target* scenario for the TSA. Updated assumptions for the sensitivity analysis were:

- Full attack was delayed until year five of the simulation, effectively extending shelf life by five years;
- No volume penalty for MPB pine stands not salvaged prior to the expiration of the shelf life. These stands regenerate to their previous natural stand condition; and
- Other species were able to contribute up to 20% of the annual harvest in the short-term, the period during which salvage of dead and dying pine occurs.

Table 3.16 summarizes the annual harvest results for the 100 Mile House sensitivity analysis.

Table 3.16 – Annual harvest – 100 Mile House Harvest Sensitivity Analysis

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	1,369,970	1,095,970	1,095,970	
10	1,369,970	1,095,970	1,095,970	1,031,000
15	1,369,970	1,095,970	1,095,970	4,111,000
20	1,369,970	1,095,970	1,095,970	41,048,000
30	1,369,970			
40	1,109,970			
50 - 110	1,069,970			
120 - 250	1,296,970			

The results of the sensitivity analysis demonstrate that by extending shelf life by five years the short-term harvest is maintained for an additional 10 years. There is a minor 2% decline in mid-term harvest resulting from the harvest of non-pine types (up to 20% of the annual harvest) during the first 20 years of simulation. This reduces the available volume of timber during the period when many pine sites are regenerating after salvage or natural regeneration.

Long-term harvest is approximately 7% higher than developed for the Baseline with MPB Pine scenario, a result of improved volumes from dead pine stands that were not salvaged prior to the expiration of the shelf life.

Figure 3.4 displays the annual harvest of the sensitivity analysis with comparison to the other scenarios completed for the 100 Mile House TSA.

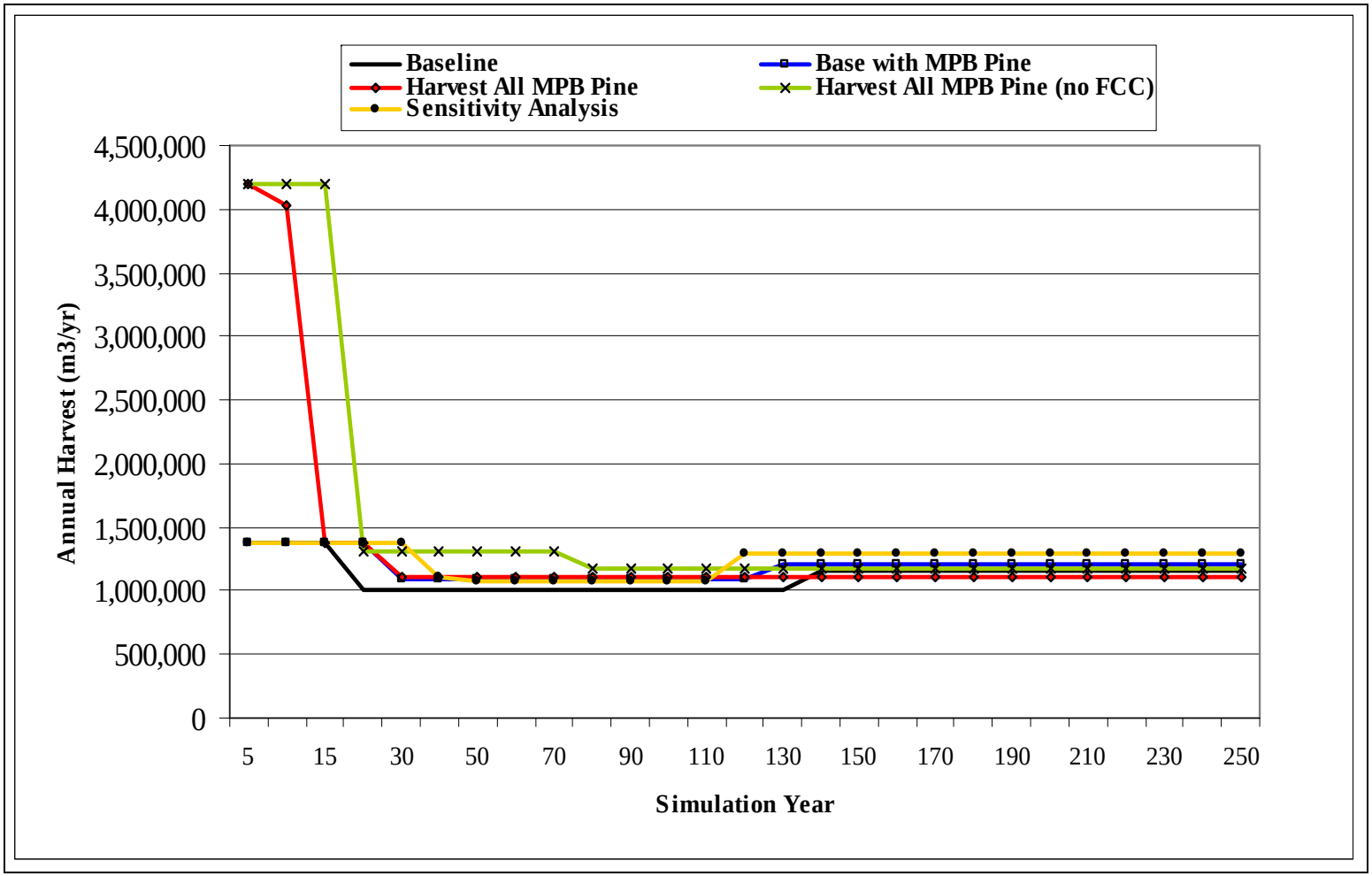

Figure 3.4 – Annual harvest levels – 100 Mile House TSA MPB scenarios & sensitivity

Historic AAC: 1,250,000 (1981); 1,362,000 (1996); 1,334,000 (2002)

3.4 Lakes TSA

MOFR Forest Analysis Branch provided Lakes TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Lakes Timber Supply Area Analysis Report and Information for Urgent Allowable Annual Cut Increase* (MoF, March 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 76 million cubic metres of pine volume at risk in the Lakes TSA. Table 3.17 summarizes the area and volume (THLB only) for the Lakes TSA.

Table 3.17 – Lakes TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	154,907	
THLB		
Wet MPB	20,226	4,586,000
Moist MPB	112,854	28,119,000
Dry MPB	166,335	43,167,000
Non MPB	290,573	35,795,000
Total THLB	589,988	111,667,000
Total productive forest	754,895	

Baseline

Table 3.18 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 3.18 – Annual harvest – Lakes Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	3,162,000	n/a	2,687,085	4,428,000
10	2,599,900	n/a	2,281,170	23,752,000
15	2,105,200	n/a	937,180	46,672,000
20	915,100			
30	547,500			
40	547,500			
50 - 100	1,057,000			
110 - 150	1,611,000			
160 - 250	1,731,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 3.19 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 3.19 – Annual harvest – Lakes Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	3,162,000	3,162,000	3,162,000	4,299,000
10	2,453,100	3,162,000	2,399,936	21,587,000
15	2,105,200	3,162,000	1,052,020	43,129,000
20	925,100			
30	559,500			
40	559,500			
50 - 90	1,074,400			
100 - 150	1,594,000			
160 - 250	1,849,900			

Harvest All MPB Pine

Table 3.20 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 3.20 – Annual harvest – Lakes Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	4,106,000	5,058,100	4,106,000	3,213,000
10	1,502,000	5,058,100	1,502,000	18,365,000
15	1,038,000	5,058,100	1,038,000	42,969,000
20 - 90	1,038,000			
100 - 140	1,504,000			
150 - 250	1,766,000			

Harvest All MPB Pine with Relaxed FCC

Table 3.21 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 3.21 – Annual harvest – Lakes Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	4,686,900	5,058,100	4,686,900	1,856,000
10	3,939,800	5,058,100	3,939,800	7,737,000
15	3,591,600	5,058,100	1,844,703	23,842,000
20	109,400			
30	535,900			
40	623,000			
50 - 90	1,312,200			
100 - 140	1,494,200			
150 - 250	1,746,900			

Discussion of Results

The Lakes TSA is similar to the Quesnel TSA in that the vast majority of the inventory is pine, and most of that pine has been attacked by MPB. Therefore any factors that affect pine stands will have an immediate impact on the harvest potential in this TSA. Regardless if the dead pine stands are salvaged or left to break up in the forest, there is significant drop in harvest compared with the historic AAC.

Limiting the annual harvest to the current AAC, as shown in the Baseline and Baseline with MPB Pine Target scenarios, causes a rupture in supply during years 20 to 40 of the simulation. A full recovery to a level similar to the long-term level predicted in previous analyses is not achieved for 110 years.

Alternatively, salvaging more of the dead pine and subsequently regenerating these sites to managed stands doubles the mid-term harvest as demonstrated in the Harvest All MPB Pine scenario. However removing too much timber in the Harvest All MPB Pine with Relaxed Constraints scenario leaves an excess of the land base in a disturbed condition. A recovery period of approximately 20 years is required for these stands to reach green-up before harvesting can resume.

Management Opportunities

The results indicate that to maintain a reasonable harvest level in the Lakes TSA, harvesting all of the dead MPB pine may not be the optimal management strategy, unless other constraints can be relaxed after the salvage period has expired. This would permit some additional harvesting in remaining non-pine stands while the cutover areas greened up after completion of salvage and regeneration on MPB pine sites. It is crucial that rehabilitation of attacked sites take place to return these areas to their optimal managed stand condition.

Figure 3.5 presents the annual harvest rates developed for the Lakes TSA MPB scenarios.

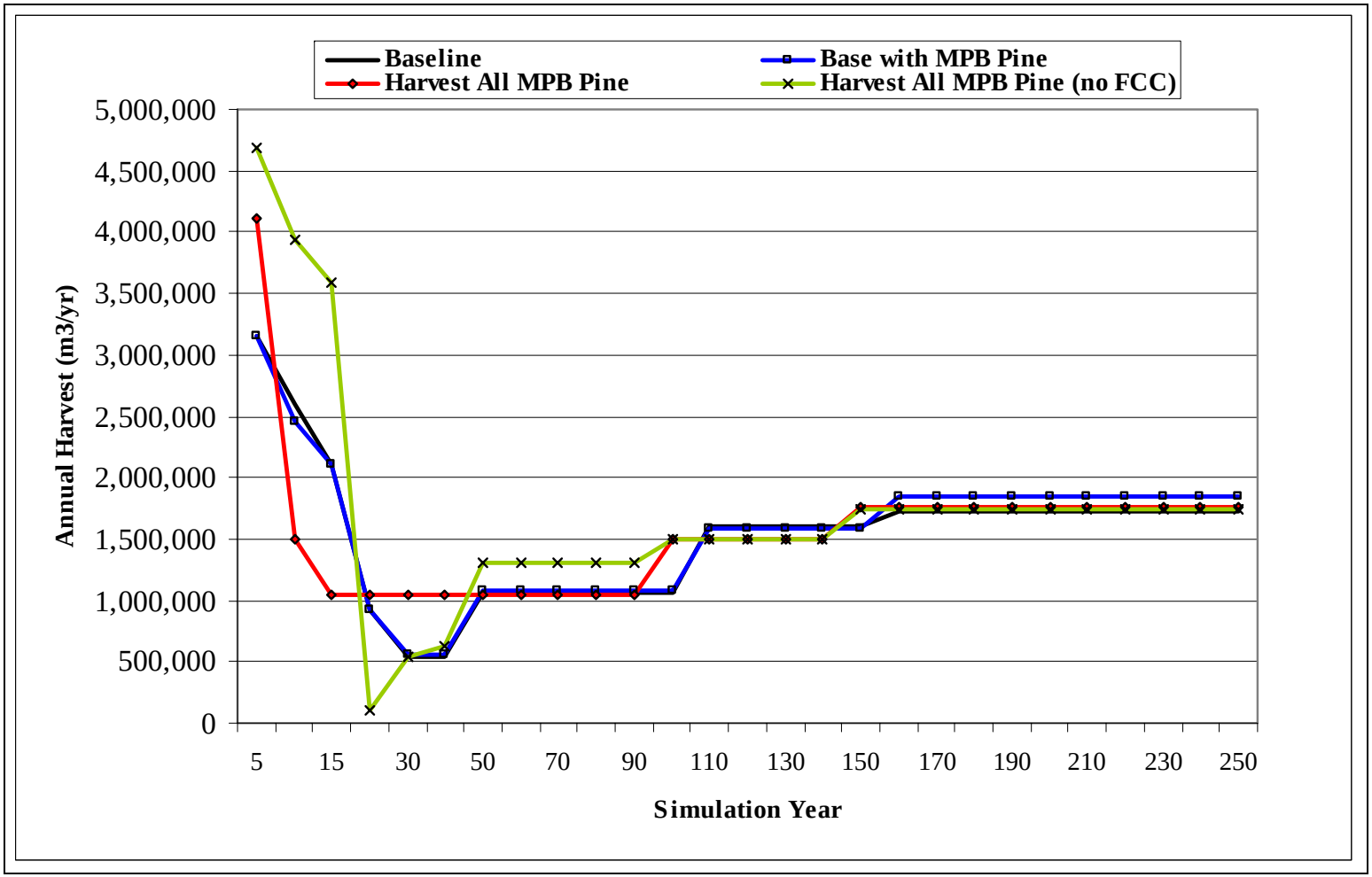

Figure 3.5 – Annual harvest levels – Lakes TSA MPB scenarios

Historic AAC: 1,500,000 (1981, 1987, 1996); 2,962,000 (2001); 3,162,000 (2004)

3.5 Prince George TSA

MOFR Forest Analysis Branch provided Prince George TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Prince George Timber Supply Area Analysis Report* (MoF, September 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 327 million cubic metres of pine volume at risk in the Prince George TSA. Table 3.22 summarizes the area and volume (THLB only) for the Prince George TSA.

Table 3.22 – Prince George TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	1,939,129	
THLB		
Wet MPB	231,722	64,796,000
Moist MPB	881,180	236,334,000
Dry MPB	103,040	25,625,000
Non MPB	2,130,274	342,183,000
Total THLB	3,346,216	668,938,000
Total productive forest	5,285,345	

Baseline

Table 3.23 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 3.23 – Annual harvest – Prince George Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	14,944,000	n/a	14,944,000	12,769,000
10	14,944,000	n/a	14,944,000	151,690,000
15	8,855,000	n/a	3,518,032	159,725,000
20 - 130	7,662,000			
140 - 250	8,692,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 3.24 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 3.24 – Annual harvest – Prince George Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	14,944,000	n/a	14,944,000	12,769,000
10	14,944,000	n/a	14,944,000	151,690,000
15	8,855,000	n/a	3,518,032	159,725,000
20 - 130	7,662,000			
140 - 250	8,692,000			

Harvest All MPB Pine

Table 3.25 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 3.25 – Annual harvest – Prince George Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	19,503,000	30,113,000	19,503,000	12,769,000
10	19,503,000	30,113,000	19,503,000	110,060,000
15	9,164,000	25,624,600	1,744,618	123,002,000
20 - 110	7,559,600			
120 - 250	8,911,000			

Harvest All MPB Pine with Relaxed FCC

Table 3.26 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 3.26 – Annual harvest – Prince George Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	30,113,000	30,113,000	30,113,000	1,198,000
10	30,113,000	30,113,000	30,113,000	8,829,000
15	9,074,000	25,624,600	2,658,400	12,332,000
20 - 160	8,391,000			
170 - 250	8,991,000			

Discussion of Results

It is important to note that the three forest districts that comprise the Prince George TSA were not modelled individually, and therefore the harvest during each simulation period could be taken from a variety of locations, which may not be consistent with the current harvest distribution. However, given the severity of the pine beetle outbreak the overall timber supply is considered to be more of an issue for this area.

In all analysis scenarios there are distinct ruptures in supply during years 100 and 160 of the planning horizon, which correspond approximately to the timing of regenerated pine stands (either managed or natural) contributing to the annual harvest in the next rotation. This is the reason for an extended mid-term harvest level for the land base.

The harvest potential improves with increased salvage of dead pine in this TSA. Limiting the short-term harvest to the current (uplift) AAC results in the lowest mid-term harvest compared to the harvest achieved in the Harvest All MPB Pine scenarios.

Increasing pine salvage in both Harvest All MPB Pine scenarios improves the mid-term harvest by as much as 8% compared with the Baseline. This is the result of regenerating pine sites to their prescribed managed stand regime immediately after harvest. Based on the assumptions used in the analysis, it may be possible to recover approximately 95% of the dead pine volume.

Management Opportunities

The Prince George TSA has the advantage of size and with approximately 50% of the inventory in non-pine species there is flexibility to move about the TSA to harvest other stands while pine sites recover either naturally or after salvage and regeneration to managed stands. It has been demonstrated that most of the damaged pine volume can be recovered, which in turn improves the mid-term harvest rate by regenerating sites to an optimal managed stand condition.

However, regardless of the harvest level assigned to the TSA, it is clear that site rehabilitation can improve the mid-term harvest potential. As much as 832,000 m^3/year of additional harvest could be provided if sites were regenerated to managed stands rather than leaving them to regenerate naturally.

Figure 3.6 presents the annual harvest rates developed for the Prince George TSA MPB scenarios.

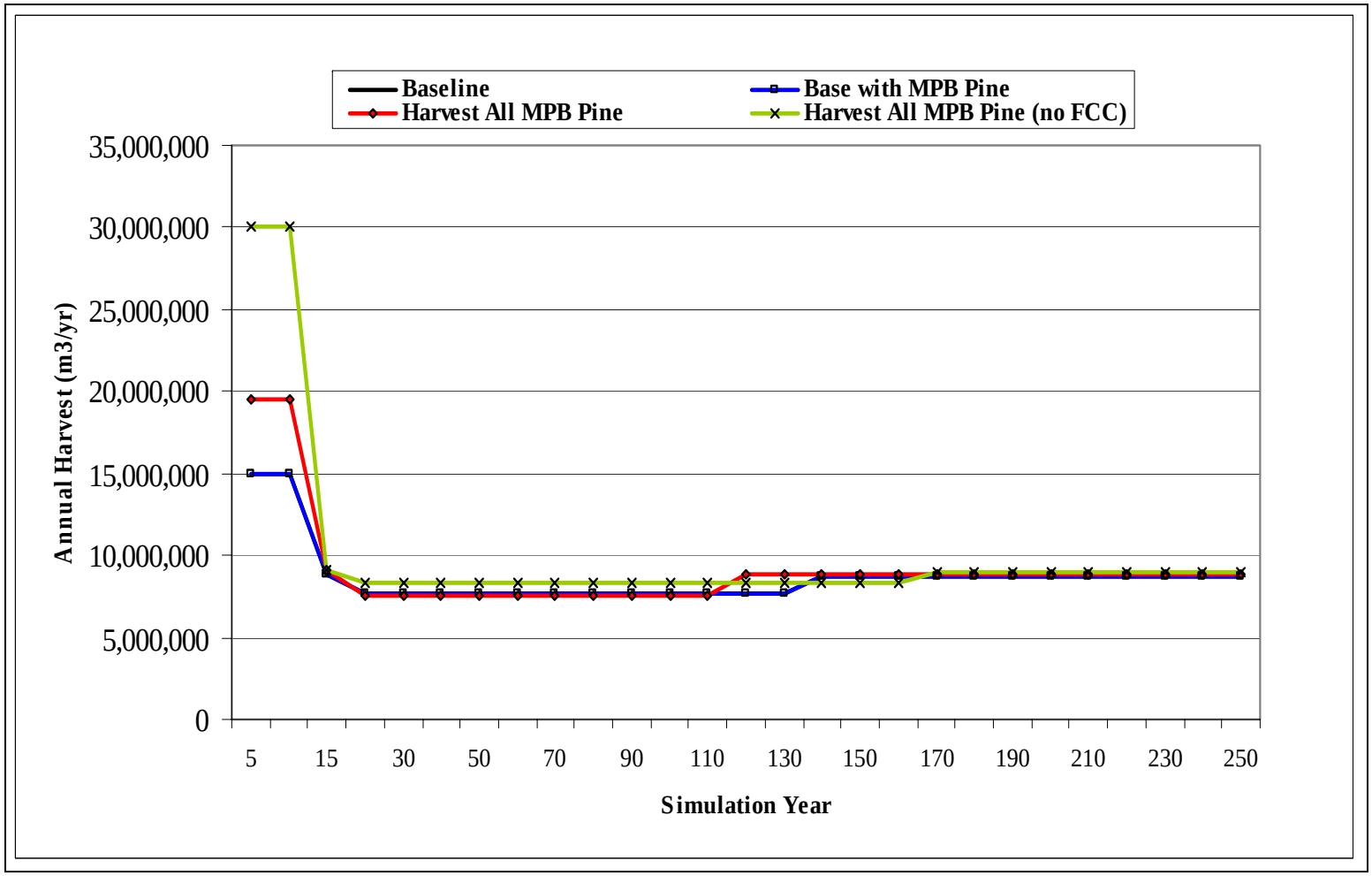

Figure 3.6 – Annual harvest levels – Prince George TSA MPB scenarios

Historic AAC: 8,605,000 (1986); 9,280,000 (1991); 9,364,000 (1996); 12,244,000 (2002); 14,944,000 (2004)

3.6 Morice TSA

MOFR Forest Analysis Branch provided Morice TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Morice Timber Supply Area Analysis Report* (MoF, September 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 59 million cubic metres of pine volume at risk in the Morice TSA. Table 3.27 summarizes the area and volume (THLB only) for the Morice TSA.

Table 3.27 – Morice TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	277,946	
THLB		
Wet MPB	31,229	8,712,000
Moist MPB	163,314	44,872,000
Dry MPB	19,629	5,234,000
Non MPB	469,790	69,136,000
Total THLB	683,962	127,955,000
Total productive forest	961,908	

Baseline

Table 3.28 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 3.28 – Annual harvest – Morice Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	2,133,076	n/a	39,637	8,694,000
10	2,133,076	n/a	0	53,404,000
15	2,133,076	n/a	0	58,620,000
20	2,053,000			
30	1,544,000			
40 - 70	924,000			
80 - 110	1,371,000			
120 - 160	1,583,000			
170 - 250	2,005,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 3.29 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 3.29 – Annual harvest – Morice Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	2,133,076	2,133,076	2,133,076	6,348,000
10	2,133,076	2,133,076	2,133,076	34,367,000
15	2,133,076	2,133,076	545,535	34,760,000
20 - 40	2,133,076			
50 - 100	1,404,000			
110 - 150	1,668,000			
160 - 250	2,005,000			

Harvest All MPB Pine

Table 3.30 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 3.30 – Annual harvest – Morice Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	3,811,000	5,707,400	3,811,000	5,344,000
10	2,133,076	5,707,400	1,869,812	27,873,000
15	2,133,076	349,000	404,527	28,392,000
20 - 40	2,133,076			
50 - 110	1,421,000			
120 - 150	1,723,000			
160 - 250	2,005,000			

Harvest All MPB Pine with Relaxed FCC

Table 3.31 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 3.31 – Annual harvest – Morice Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Pine Inventory (m^3)
5	5,700,800	5,707,400	5,700,800	200,000
10	5,700,800	5,707,400	5,700,800	266,000
15	810,000	349,000	276,900	425,000
20	709,000			
30 - 250	1,957,500			

Discussion of Results

The results of the analysis for the Morice TSA demonstrate the relationship between maximizing salvage and minimizing the mid-term falldown in timber supply. The Baseline harvest schedule shows the opportunity cost of leaving the majority of the dead pine in the forest. Under this scenario the mid-term level is approximately 34% lower than either the Baseline with MPB Pine or Harvest All MPB Pine scenarios. The results indicate a reduction in the mid-term harvest caused by under-utilizing MPB pine during its available shelf life. Using the normal harvest queue rules the non-pine stands, which are critical for supporting the harvest after the salvage of the affected pine, have been utilized in the first 20 years of the Baseline scenario. Consequently, the combination of this non-pine harvest and the termination of the shelf life of the affected pine stands leaves insufficient volume to support the mid-term harvest.

Increasing pine harvest in the Baseline with MPB Pine or Harvest All MPB Pine scenarios captures some of the dead pine volume thereby leaving important non-pine stands for the mid-term harvest. The main benefit of increasing pine harvest in the Harvest All MPB Pine scenario is to capture additional dead pine volume. There is no significant difference in the mid or long-term harvest rates for these scenarios, which indicates there could be more flexibility in management decisions for the Morice TSA.

Relaxing forest cover constraints in order to salvage virtually all of the dead pine creates a considerable, albeit brief, falldown in harvest rate as demonstrated by the Harvest All MPB Pine with Relaxed FCC scenario. This brief falldown is a result of the harvesting of a significant portion of the timber harvesting land based that in turn must green-up before harvest operations are permitted to continue.

Management Opportunities

Similar to the Lakes TSA, liquidating all of the dead pine may not be the optimal management strategy as there is a subsequent falldown in timber supply 15 to 30 years into the future. However, if disturbance constraints could be adjusted after the salvage period has expired; additional harvesting in remaining non-pine stands might be possible and reduce this observed falldown. In addition rehabilitation of unsalvaged stands into managed stands will reduce the falldown in the mid-term, increasing the harvest rate to a level displayed in the Harvest All MPB Pine with Relaxed FCC scenario. This would also lessen the operational and financial burden on the Province to eventually regenerate these sites.

Figure 3.7 presents the annual harvest rates developed for the Morice TSA MPB scenarios.

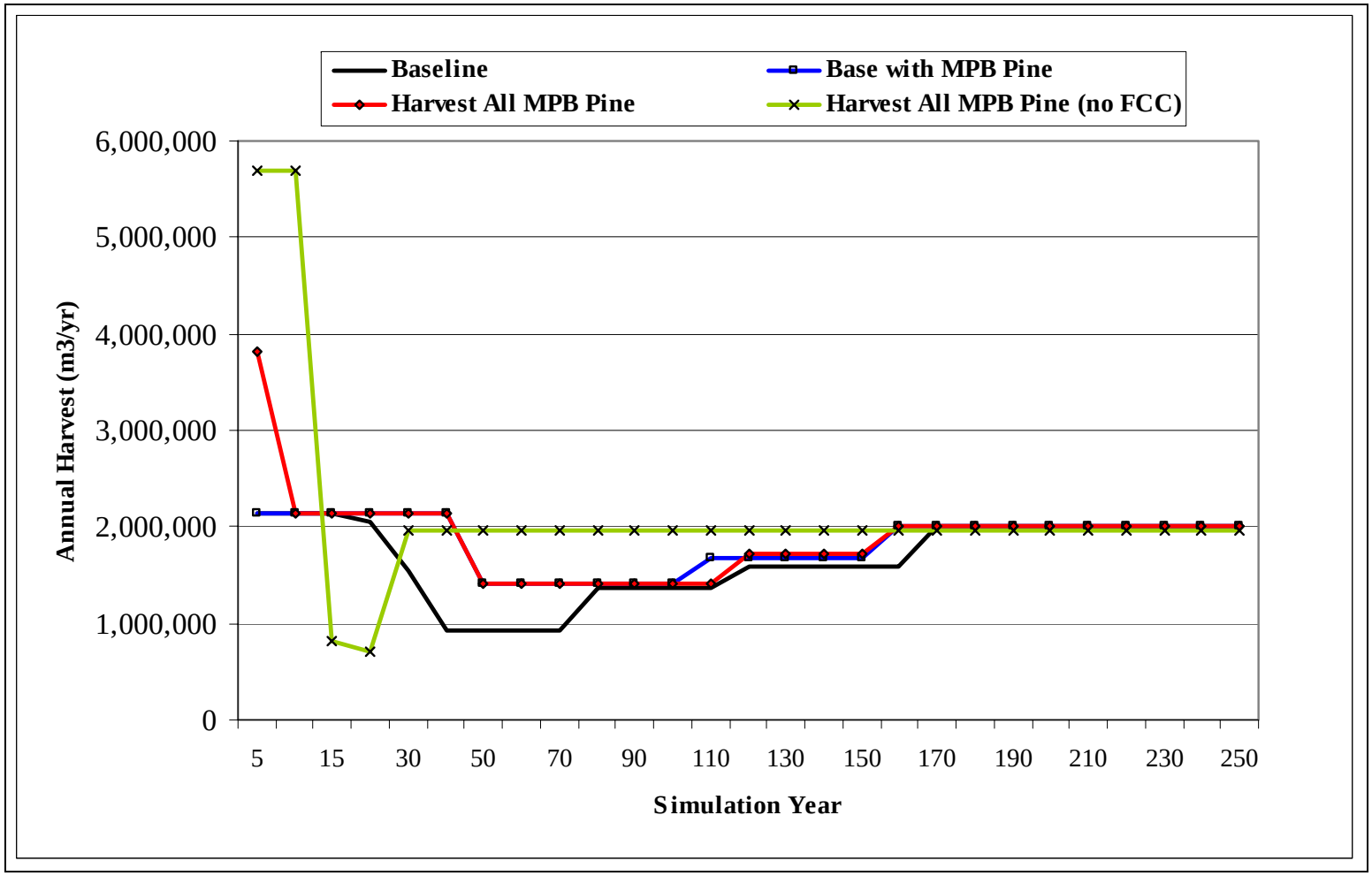

Figure 3.7 – Annual harvest levels – Morice TSA MPB scenarios

Historic AAC: 2,000,000 (1981); 1,985,000 (1996); 1,961,000 (2002)

4.0 ANALYSIS RESULTS – FULL ATTACK AT YEAR 5

The TSAs included in the sections below are assumed to have reached full MPB attack at year 5 of the analysis. Shelf life will therefore expire at year 20 of the planning horizon for dry site MPB pine stands. Note that the *Dead Pine Harvest* entry for simulation year 5 in the summary tables includes some live pine that is expected to be attacked (dead) by the end of that initial five-year period.

4.1 Bulkley TSA

MOFR Forest Analysis Branch provided Bulkley TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Bulkley Timber Supply Area Analysis Report* (MoF, April 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 14.4 million cubic metres of pine volume at risk in the Bulkley TSA. Table 4.1 summarizes the area and volume (THLB only) for the Bulkley TSA.

Table 4.1 – Bulkley TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	156,048	
THLB		
Wet MPB	7,048	2,082,500
Moist MPB	37,063	11,345,600
Dry MPB	3,181	941,300
Non MPB	292,582	62,123,100
Total THLB	339,874	76,492,600
Total productive forest	495,922	

Baseline

Table 4.2 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.2 – Annual harvest – Bulkley Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	855,900	n/a	83,851	0
10	770,300	n/a	160,035	1,908,000
15	693,300	n/a	135,268	11,542,000
20 – 90	623,900	n/a	0	12,474,000
100 – 250	603,900			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.3 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.3 – Annual harvest – Bulkley Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	855,900	855,900	855,900	0
10	770,300	770,300	770,300	328,000
15	693,300	693,300	693,300	1,831,000
20 - 130	693,300	693,300	120,632	2,169,000
140 – 250	633,300			

Harvest All MPB Pine

Table 4.4 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.4 – Annual harvest – Bulkley Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	951,000	951,000	951,000	0
10	951,000	951,000	951,000	299,000
15	951,000	951,000	540,270	1,863,000
20	951,000	104,400	224	2,157,000
30	839,900			
40	762,400			
50 – 250	651,600			

Harvest All MPB Pine with Relaxed FCC

Table 4.5 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.5 – Annual harvest – Bulkley Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	951,000	951,000	951,000	0
10	951,000	951,000	951,000	299,000
15	951,000	951,000	555,794	1,720,000
20	951,000	104,400	0	2,081,000
30	849,900			
40	762,400			
50 – 250	651,600			

Discussion of Results

The Baseline results for the Bulkley TSA analysis indicate that the mid and long-term harvest levels are negatively affected without early salvage of dead or potentially dead MPB pine. This is caused by the harvest of non-pine stands during the first 20 years of the simulation, which reduces harvesting opportunities later in the planning horizon.

Focusing, to the extent possible, all of the current AAC into pine salvage in the Baseline with MPB Pine Target scenario improves the mid-term harvest considerably. This mid-term level is approximately 6% higher than achieved in either Harvest All MPB Pine scenario from year 50 to 130 of the simulation.

Results for the two Harvest All MPB Pine scenarios were virtually the same for the entire planning horizon. Approximately 14% of the affected pine stands remain in the forest at the end of 20 years. After the pine stands have been harvested there is a similar harvest flow to that developed in the Baseline scenarios. The reduced mid-term harvest rate is the result of maintaining a higher transition harvest rate in years 21 to 40 of the simulation.

Management Opportunities

Based on the assumptions of the analysis, it is possible to salvage the majority of the pine attacked by MPB without negatively impacting mid or long-term timber supply. Results indicate that maximizing salvage in the short-term, and the additional volume recovered, outweighs the minor drop in mid-term harvest as noted in the Harvest All MPB Pine scenarios as long as non-timber objectives have not been compromised.

Figure 4.1 presents the annual harvest rates developed for the Bulkley TSA MPB scenarios.

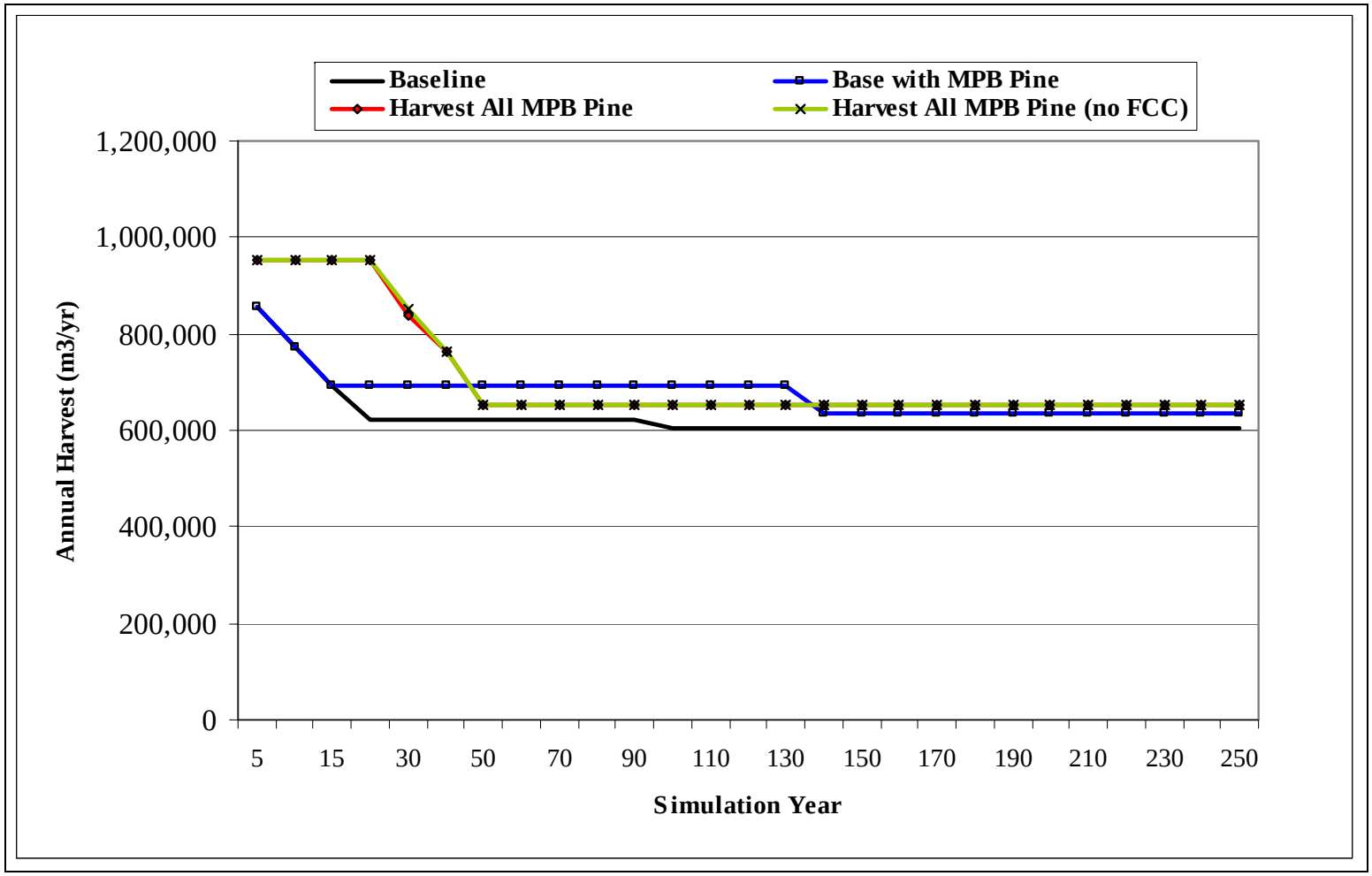

Figure 4.1 – Annual harvest levels – Bulkley TSA MPB scenarios

Historic AAC: 895,000 (1995); 882,000 (2002)

4.2 Lillooet TSA

MOFR Forest Analysis Branch provided Lillooet TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Lillooet Timber Supply Area Analysis Report* (MoF, January 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 15.5 million cubic metres of pine volume at risk in the Lillooet TSA. Table 4.6 summarizes the area and volume (THLB only) for the Lillooet TSA.

Table 4.6 – Lillooet TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	210,130	
THLB		
Wet MPB	1,889	393,100
Moist MPB	41,137	6,970,200
Dry MPB	50,631	8,662,400
Non MPB	202,146	24,460,600
Total THLB	295,803	40,486,300
Total productive forest	505,933	

Baseline

Table 4.7 summarizes the harvest level and pine volumes for the Baseline scenario. Note that in all scenarios modelled for the Lillooet TSA 25,000 cubic metres per year were harvested from Pulpwood Agreement 16 (PA16) during the first five year simulation period. This harvest volume was always modelled in addition to the main TSA volume. None of the MPB harvest target was ever drawn from PA16.

Table 4.7 – Annual harvest – Lillooet Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	687,700	n/a	129,262	0
10	662,700	n/a	235,202	376,000
15	599,000	n/a	200,324	6,527,000
20	541,700	n/a		13,202,000
30	490,200			
40	443,800			
50	418,100			
60	305,500			
70	238,000			
80 - 120	251,000			
130 – 250	394,100			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.8 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.8 – Annual harvest – Lillooet Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	687,700	687,700	662,700	0
10	662,700	662,700	662,700	52,000
15	599,000	599,000	511,380	1,622,000
20	541,700	541,700	0	6,842,000
30	490,200			
40	443,800			
50	418,100			
60 – 250	394,100			

Harvest All MPB Pine

Table 4.9 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.9 – Annual harvest – Lillooet Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	777,000	777,000	777,000	0
10	777,000	777,000	777,000	193,000
15	599,000	777,000	322,383	2,163,000
20	541,700	777,000	0	6,644,000
30	490,200			
40	418,100			
50 – 250	386,500			

Harvest All MPB Pine with Relaxed FCC

Table 4.10 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.10 – Annual harvest – Lillooet Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	777,000	777,000	777,000	0
10	777,000	777,000	777,000	193,149
15	777,000	777,000	777,000	2,163,310
20	599,700	777,000	0	4,370,714
30	490,200			
40	418,100			
50 – 250	386,500			

Discussion of Results

As noted for many other TSAs, there is a significant mid-term penalty for leaving too many MPB pine stands unsalvaged in the Lillooet TSA. During years 51 and 130 the harvest rate is approximately 35% lower in the Baseline scenario compared to all other scenarios modelled for the TSA. Non-pine stands harvested in the first 20 years of simulation reduces the availability of timber during the mid-term.

Increasing the salvage during the initial 20 years of simulation does not impact negatively on the harvest rate for the remainder of the planning horizon. Additional salvage equivalent to the current AAC removes approximately 56% of the pine attacked by MPB in the Baseline with MPB Pine Target scenario.

Attempting to salvage all of the damaged pine in the Harvest All MPB Pine scenarios increases the initial harvest by approximately 21% over the current AAC. However, it is only possible to remove a maximum of 74% of the pine at risk to MPB as shown in the Harvest All MPB Pine with Relaxed FCC scenario. Other forest cover issues prevent additional harvest in the pine stands at risk to MPB. The difference in long-term harvest is insignificant compared with the Baseline runs.

Management Opportunities

The Lillooet TSA is comprised of approximately 40% pine volume, which is assumed to be at risk to MPB attack. Based on the assumption that there could be up to 20 years to address salvage or preventative harvesting of pine stands, the majority of the pine can be removed prior to the end of their shelf lives. This salvage can take place without negatively affecting the mid or long-term timber supply potential for the TSA. However, based on the fact that some MPB pine is unavailable due to forest cover requirements, it is important to assess whether it is better to leave some of those MPB pine stands in the forest. It is crucial to focus harvesting during the next 20 years in the pine stands at risk to attack in order to recover maximum volume and return the sites immediately to a managed stand condition after harvest. This will contribute to a stable mid-term timber supply.

Figure 4.2 presents the annual harvest rates developed for the Lillooet TSA MPB scenarios.

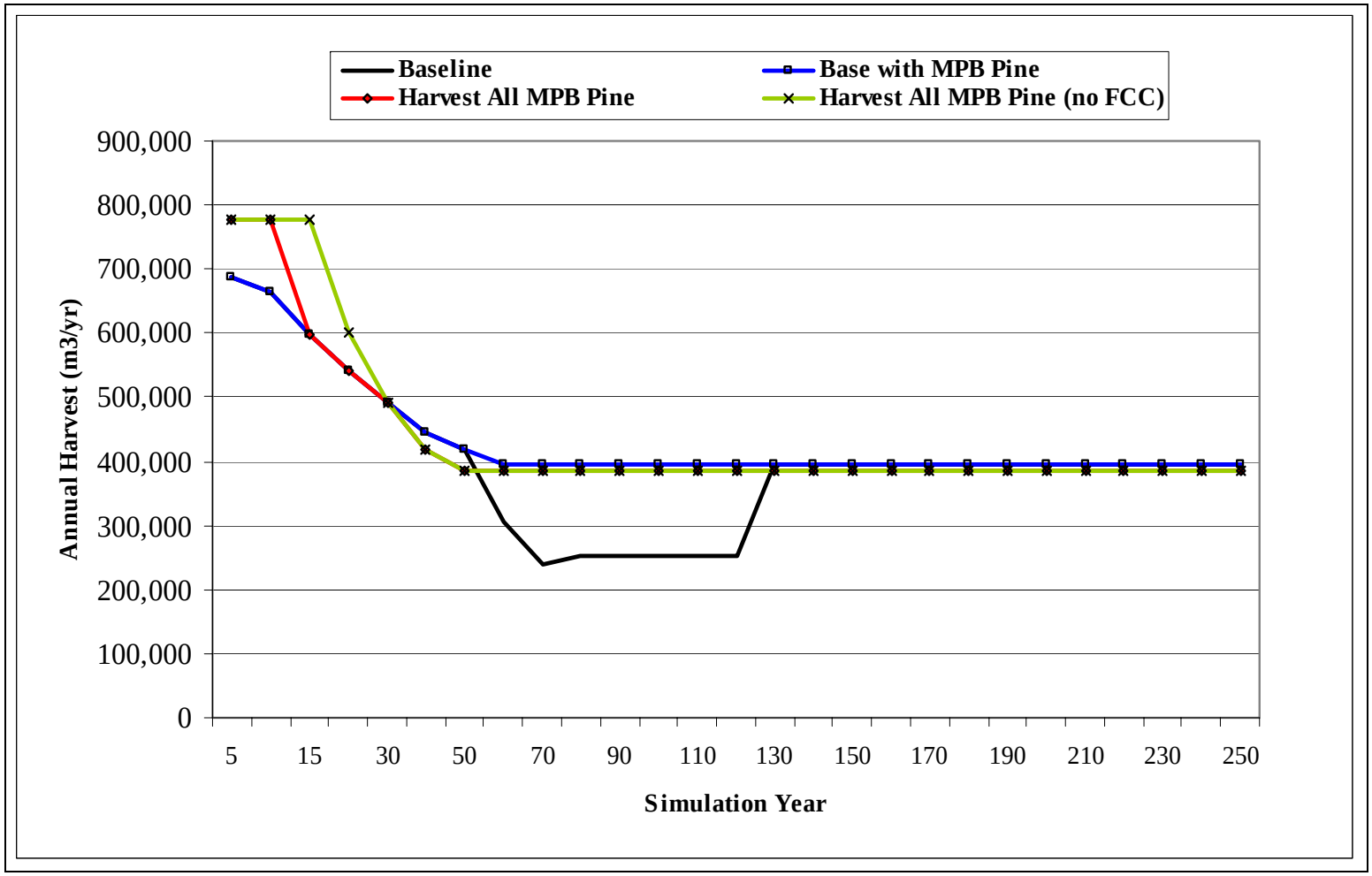

Figure 4.2 – Annual harvest levels – Lillooet TSA MPB scenarios

Historic AAC: 650,000 (pre-1982); 800,000 (1982); 650,000 (1988); 643,000 (1996); 625,000 (2002)

4.3 Kamloops TSA

MOFR Forest Analysis Branch provided Kamloops TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Kamloops Timber Supply Area Analysis Report* (MoF, July 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 58.7 million cubic metres of pine volume at risk in the Kamloops TSA. Table 4.11 summarizes the area and volume (THLB only) for the Kamloops TSA.

Table 4.11 – Kamloops TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	368,250	
THLB		
Wet MPB	4,483	1,157,500
Moist MPB	15,697	4,052,800
Dry MPB	204,827	52,921,500
Non MPB	815,849	118,930,400
Total THLB	1,040,856	177,062,200
Total productive forest	1,409,106	

Baseline

Table 4.12 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.12 – Annual harvest – Kamloops Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,352,800	n/a	2,377,642	0
10	2,424,500	n/a	1,278,061	743,000
15	2,424,500	n/a	1,711,140	2,653,000
20	2,424,500	n/a	1,090,755	25,844,000
30	2,424,500			
40 - 70	1,849,000			
80 - 130	1,889,000			
140 - 250	2,308,600			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.13 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.13 – Annual harvest – Kamloops Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,352,800	4,352,800	4,352,800	0
10	2,424,500	2,424,500	2,424,500	53,000
15	2,424,500	2,424,500	1,420,532	191,000
20	2,424,500	2,424,500	1,486,879	9,708,000
30	2,424,500			
40	2,424,500			
50 - 130	2,119,000			
80 – 250	2,308,600			

Harvest All MPB Pine

Table 4.14 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.14 – Annual harvest – Kamloops Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,352,800	4,352,800	4,352,800	0
10	2,424,500	2,424,500	2,414,151	51,000
15	2,424,500	2,424,500	1,447,398	213,000
20	2,424,500	2,424,500	1,460,021	9,761,000
30	2,424,500			
40	2,424,500			
50	2,308,600			
60 - 130	2,092,000			
140 – 250	2,308,600			

Harvest All MPB Pine with Relaxed FCC

Table 4.15 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.15 – Annual harvest – Kamloops Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	4,352,800	4,352,800	4,352,800	0
10	2,424,500	2,424,500	2,422,517	10,000
15	2,424,500	2,424,500	2,424,500	11,000
20	2,424,500	2,424,500	2,424,500	11,000
30	2,424,500			
40	2,260,000			
50	2,260,000			
60	2,260,000			
70	2,260,000			
80 – 250	2,308,600			

Discussion of Results

Based on the assumption that it will take five more years for the pine beetle to attack all pine stands, and the fact that only one third of the inventory is in those pine stands, there is an improved chance of salvaging the affected stands within the Kamloops TSA.

The current uplift AAC of 4,352,700 m^3/year could be maintained for five years prior to declining to 2,424,500 m^3/year for the next 25 to 35 years in all scenarios. However, it is important to prioritize dead pine stands for salvage otherwise the mid-term harvest will be compromised by as much as 370,000 m^3/year as shown in the Baseline scenario.

Prioritizing pine salvage improves the mid-term harvest in the Baseline with MPB Pine Target and Harvest All MPB Pine scenarios. There is approximately 17% of the pine remaining in the forest at the end of 20 years of simulation in both of these scenarios.

Relaxing disturbance forest cover constraints permits additional salvage of pine stands in the Harvest All MPB Pine with Relaxed FCC scenario. Virtually all damaged pine can be recovered using this set of modelling rules. The harvest rate over the long-term is not affected by focusing, to the extent possible, harvest operations into dead or dying pine stands.

Management Opportunities

It is important to note that the harvest rate does not need to exceed current uplift AAC levels to salvage all of the dead pine. It is important to prioritize pine harvest in the short-term to ensure maximum recovery of existing volume, and to return harvested areas to a productive managed stand condition. This will ensure maximum mid-term harvest potential.

Figure 4.3 presents the annual harvest rates developed for the Kamloops TSA MPB scenarios.

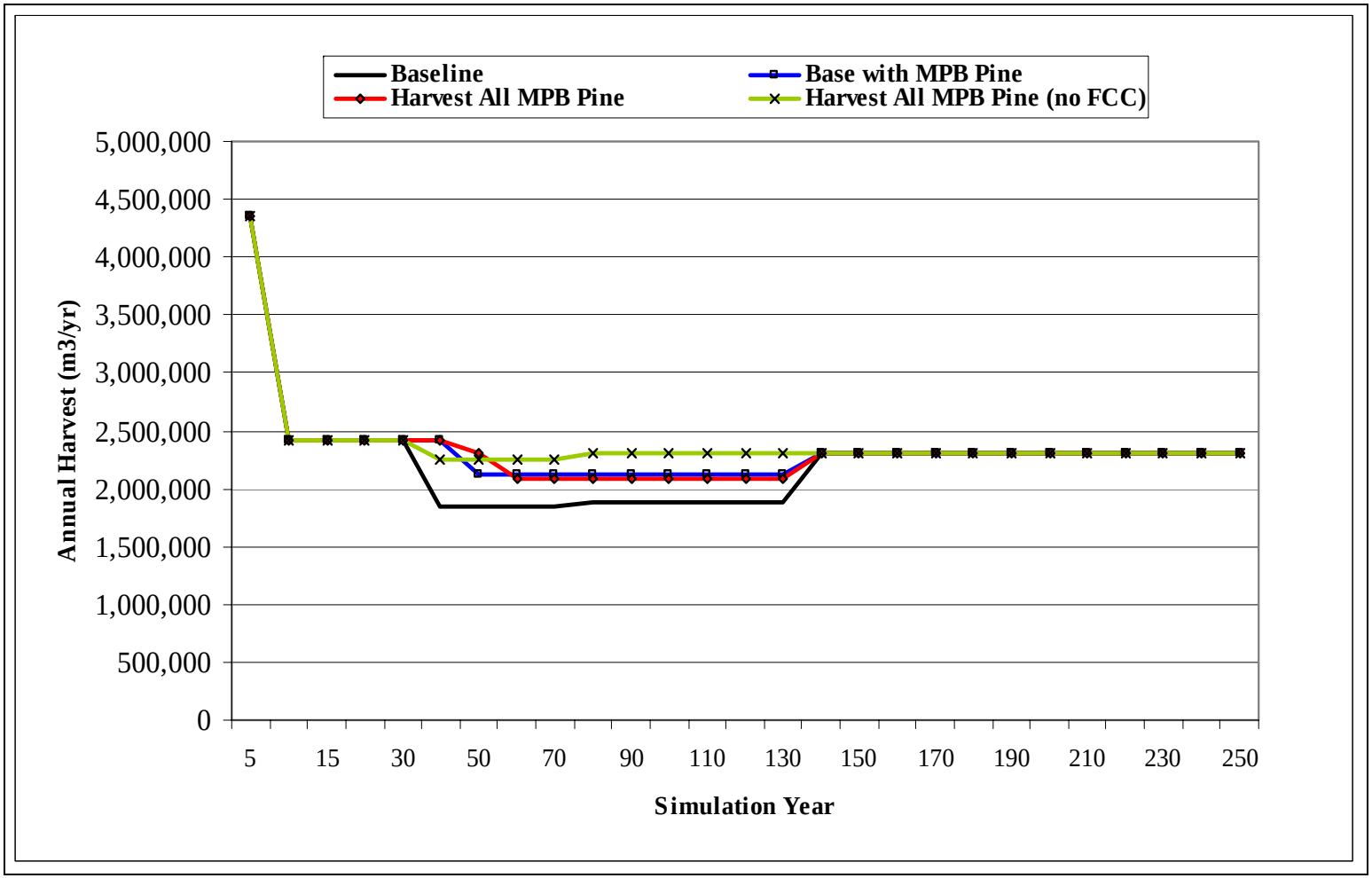

Figure 4.3 – Annual harvest levels – Kamloops TSA MPB scenarios

Historic AAC: 2,350,000 (1981); 2,413,000 (1989); 2,679,000 (1996); 2,683,000 (2003); 4,353,000 (2004)

4.4 Merritt TSA

Merritt TSA data used in the MPB Analysis was provided by Timberline. It incorporates input data and assumptions that were used in the Composite Analysis (scenario K) of the *Nicola-Similkameen Innovative Forestry Society Innovative Forestry Practices Agreement Innovative Timber Supply Analysis* (April 2003). The results of this scenario were submitted to MoF as the basis for the AAC determination.

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 68.3 million cubic metres of pine volume at risk in the Merritt TSA. Table 4.16 summarizes the area and volume (THLB only) for the Merritt TSA.

Table 4.16 – Merritt TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	243,165	
THLB		
Wet MPB	6,002	1,598,800
Moist MPB	100,588	24,986,400
Dry MPB	195,438	41,695,300
Non MPB	368,185	40,851,300
Total THLB	670,214	109,131,800
Total productive forest	913,379	

Baseline

Table 4.17 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.17 – Annual harvest – Merritt Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,814,200	n/a	1,150,360	
10	2,814,200	n/a	1,782,116	985,000
15	2,814,200	n/a	2,036,309	12,774,000
20	2,379,000	n/a	1,824,520	32,359,000
30	903,000			
40	903,000			
50	956,000			
60	956,000			
70 - 100	1,684,000			
110 - 250	2,058,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.18 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.18 – Annual harvest – Merritt Baseline with MPB Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,814,200	2,814,200	2,813,192	
10	2,814,200	2,814,200	2,810,809	677,000
15	2,814,200	2,814,200	2,810,006	6,869,000
20	2,684,000	2,814,200	2,454,185	11,885,000
30 - 60	1,529,000			
70 - 100	1,856,000			
110 – 250	2,058,000			

Harvest All MPB Pine

Table 4.19 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.19 – Annual harvest – Merritt Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,001,000	3,414,000	2,999,993	
10	3,001,000	3,414,000	2,997,609	665,000
15	3,001,000	3,414,000	2,988,921	6,153,000
20	2,342,000	3,414,000	2,113,146	10,827,000
30 - 60	1,529,000			
70 - 100	1,856,000			
110 – 250	2,058,000			

Harvest All MPB Pine with Relaxed FCC

Table 4.20 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.20 – Annual harvest – Merritt Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,368,500	3,414,000	3,365,041	
10	3,368,500	3,414,000	3,365,184	666,212
15	3,368,500	3,414,000	3,364,260	4,086,147
20	3,368,500	3,414,000	3,184,075	4,086,147
30 - 60	1,582,000			
70	1,887,000			
80 - 100	1,986,000			
110 – 250	2,113,000			

Discussion of Results

The results of the analysis for the Merritt TSA indicate that it will be important to salvage as much of the dead or dying pine as possible to reduce the mid-term falldown in annual harvest. In the Baseline scenario the current AAC can only be maintained for 10 years after which the annual harvest declines by 68% to the mid-term harvest rate. It takes 110 year for the harvest to recover to the long-term level, which is similar for all analysis scenarios. Harvesting non-pine stands in the first 20 years of simulation forfeits the opportunity to salvage pine stands before they become unmerchantable. In addition those non-pine stands are not available for harvesting during the mid-term, which is the period when pine sites recover. Approximately 47% of the pine sites regenerate to a reduced natural stand condition in the Baseline scenario, which also limits harvest level over the mid-term.

It is possible to focus the majority of the current AAC into MPB pine stands for the next 20 years as demonstrated in Baseline with MPB Pine Target scenario. The mid and long-term levels are similar for the Baseline with MPB Pine Target and both Harvest All MPB Pine scenarios. By harvesting the MPB pine volume and regenerating immediately to managed stands these sites provide considerably more volume than the naturally regenerating stands that are established in the unsalvaged areas.

Increasing the short-term harvest above the current AAC permits the salvage of an additional 1 million cubic metres of pine in the Harvest All MPB Pine scenario. The subsequent mid and long-term harvest is the same as that developed for the Baseline with MPB scenario. An additional 6.8 million cubic metres can be salvaged with relaxed cover constraints as shown in the Harvest All MPB Pine with Relaxed FCC scenario. As a result the mid and long-term harvest is improved slightly. It might be possible to reduce the falldown between years 30 and 60 of the planning horizon if disturbance constraints were relaxed while pine sites are regenerated.

Management Opportunities

Based on the results of the analysis, there is opportunity to recover additional dead or dying pine in the Merritt TSA. It is important however to ensure this is not at the expense of non-timber resources. As with other land bases it is important to focus harvesting into the stands at risk, and to regenerate these sites promptly to managed stands. . In addition to providing more volume, this would also lessen the operational and financial burden on the Province to eventually regenerate these sites. Rehabilitation of sites that were not salvaged will improve the mid-term timber supply and provide greater flexibility in future harvesting. Figure 4.4 presents the annual harvest rates developed for the Merritt TSA MPB scenarios.

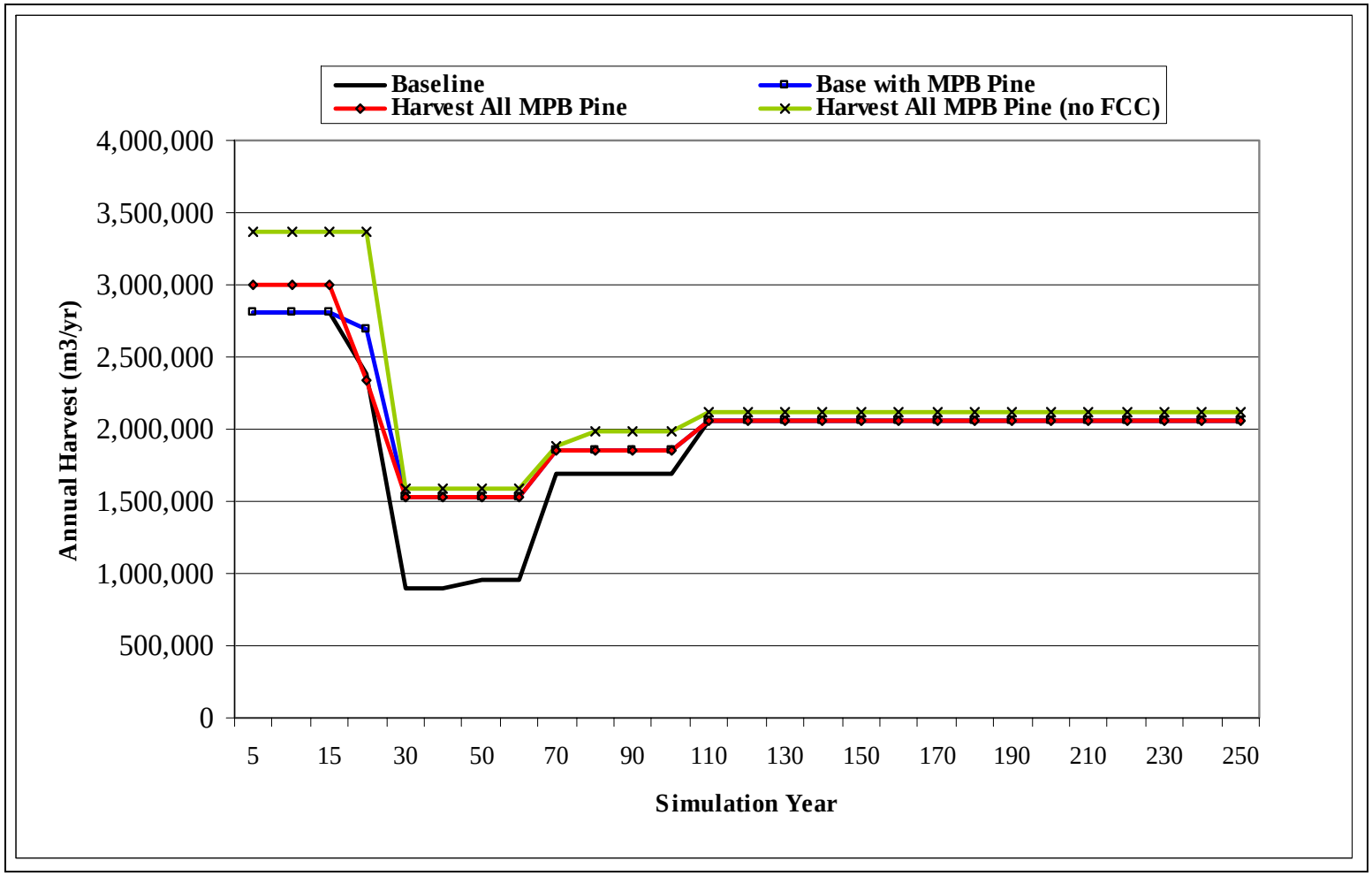

Figure 4.4 – Annual harvest levels – Merritt TSA MPB scenarios

Historic AAC: 1,454,000 (1996); 2,004,000 (1999); 1,508,000 (2001); 1,839,000 (2004); 2,814,000 (2005)

4.5 Okanagan TSA

Okanagan TSA data used in the MPB Analysis was provided by Timberline. It incorporates input data and assumptions that were used in the 2010 Scenario, which became the Base Case for the urgent timber supply review in the Okanagan TSA. This information is documented in the MOFR report *Urgent Timber Supply Review for the Okanagan Timber Supply Area – Public Discussion Paper* (July 2005).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 53.5 million cubic metres of pine volume at risk in the Okanagan TSA. Table 4.21 summarizes the area and volume (THLB only) for the Okanagan TSA.

Table 4.21 – Okanagan TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	394,161	
THLB		
Wet MPB	29,808	8,060,400
Moist MPB	160,330	39,293,100
Dry MPB	27,511	6,141,700
Non MPB	827,920	139,007,000
Total THLB	1,045,570	192,502,500
Total productive forest	1,439,731	

Baseline

Table 4.22 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.22 – Annual harvest – Okanagan Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,375,000	n/a	38,133	
10	3,375,000	n/a	182,734	8,056,000
15	2,655,000	n/a	326,901	44,976,000
20	2,655,000	n/a	141,504	50,049,000
30 - 70	2,086,000			
80 - 110	2,258,000			
120 – 250	3,000,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.23 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.23 – Annual harvest – Okanagan Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,375,000	3,375,000	3,375,000	
10	3,375,000	3,375,000	3,375,000	3,173,000
15	2,655,000	2,655,000	2,655,000	5,742,000
20	2,606,000	1,294,000	66,000	6,140,000
30 - 120	2,847,000			
130 – 250	3,000,000			

Harvest All MPB Pine

Table 4.24 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.24 – Annual harvest – Okanagan Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,375,000	3,375,000	3,375,000	
10	3,375,000	3,375,000	3,375,000	3,173,000
15	2,655,000	3,375,000	2,655,000	5,742,000
20	2,606,000	574,000	66,000	6,140,000
30 - 120	2,847,000			
130 – 250	3,000,000			

Harvest All MPB Pine MPB with Relaxed FCC

Table 4.25 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.25 – Annual harvest – Okanagan Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,375,000	3,375,000	3,375,000	
10	3,375,000	3,375,000	3,375,000	3,288,000
15	2,655,000	3,375,000	2,655,000	5,771,000
20	2,655,000	574,000	100,200	5,969,000
30 - 120	2,844,000			
130 – 250	3,000,000			

Discussion of Results

The harvest targets used in the analysis of the Okanagan TSA reflect the new (January 2006) uplift AAC of 3,375,000 m^3/year. The Baseline scenario did not focus harvest in pine stands at risk to MPB and as a result harvests primarily other species. The result is a mid-term harvest level 21% below the historic AAC (2,655,000 m^3/year) and as much as 27% lower than the mid-term harvest in other scenarios modelled in this analysis. Only 7% of the dead or dying pine volume is salvaged in the Baseline scenario.

Focusing, to the extent possible, harvest into pine stands in the Baseline with MPB Pine Target scenario improves the recovery of damaged pine to 88% of the total pine volume. The uplift AAC can only be sustained for 10 years and therefore all pine cannot be salvaged from the land base. There is only a single 5-year period during which the harvest rate is marginally (2%) lower than the historic AAC. After that time the harvest level recovers and improves to the long-term level in year 130 of the simulation. Results for the Harvest All MPB Pine scenario were the same as the Baseline with MPB scenario. This is because the uplift AAC is projected to recover the majority of the damaged pine prior to expiration of the shelf life.

There is a similar volume of pine recovered, approximately 89%, in the Harvest All MPB Pine with Relaxed FCC scenario. In addition the mid-term harvest rate is slightly different compared to the Baseline with MPB Pine Target scenario. The annual harvest is maintained at, or above the historic AAC for the entire 250-year planning horizon.

Management Opportunities

The results of the analysis concur with the uplift AAC recently determined for the Okanagan TSA, even with different assumptions regarding shelf life in the current analysis. The harvest and salvage of damaged MPB pine should be given priority to ensure maximum short-term volume recovery. In addition this will contribute to prompt site regeneration to managed stand condition and lessen the operational and financial burden on the Province to eventually rehabilitate and regenerate these sites.

Figure 4.5 presents the annual harvest rates developed for the Okanagan TSA MPB scenarios.

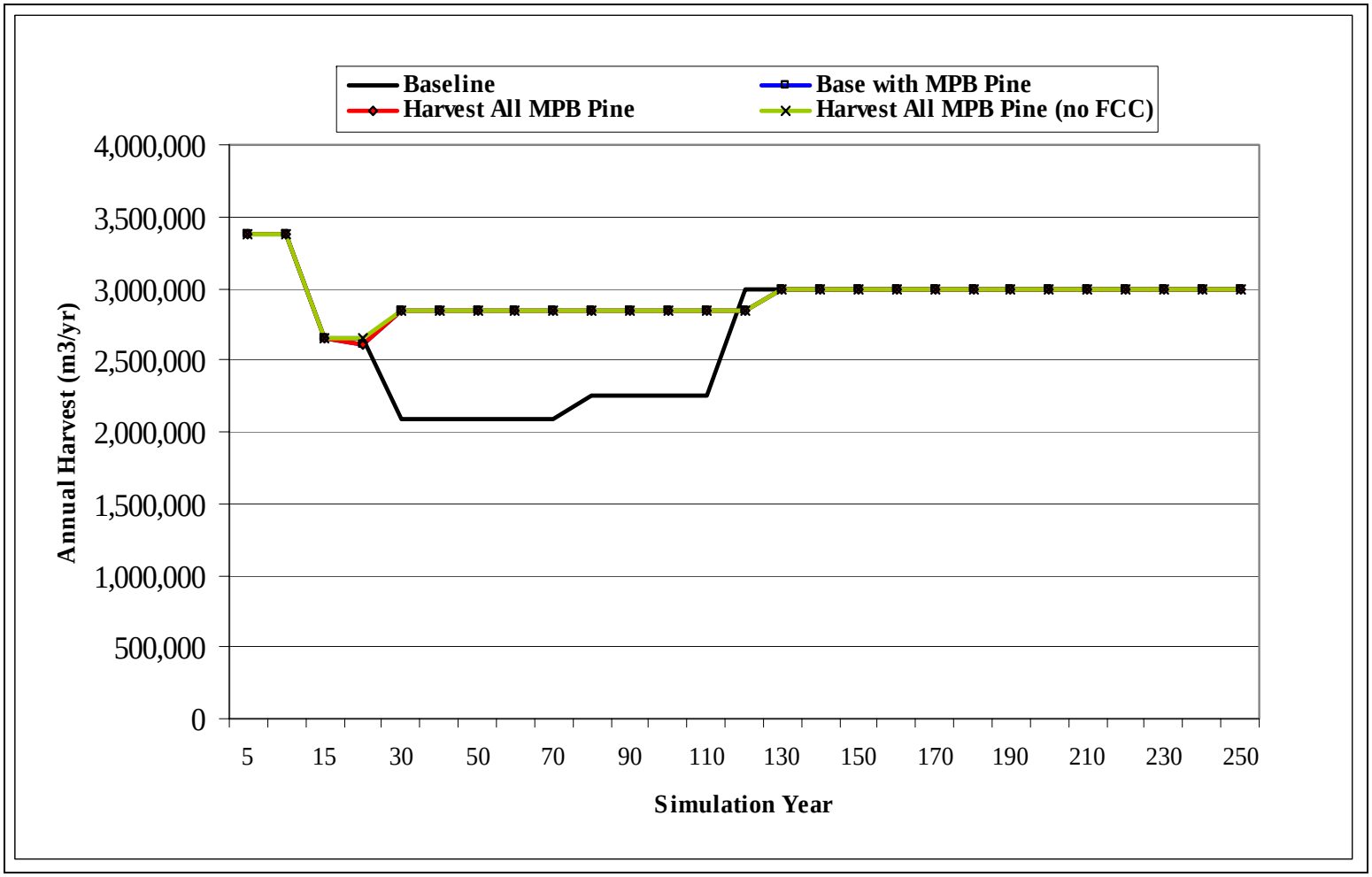

Figure 4.5 – Annual harvest levels – Okanagan TSA MPB scenarios

Historic AAC: 2,700,000 (1980); 2804,000 – 3,200,000 (1987 – 1993); 2,615,000 (1994); 2,655,000 (2001); 3,375,000 (2006)

4.6 Boundary TSA

Timberline provided the data used for the Boundary TSA. The *KBHLPO 2002 Base Case* scenario has been used for the MPB Analysis as outlined in the report *Spatial Timber Supply Analysis with Environmental and Economic Trend Reporting for the Kootenay-Boundary Higher Level Plan Order on the Boundary TSA* (March 2004).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 8.8 million cubic metres of pine volume at risk in the Boundary TSA. Table 4.26 summarizes the area and volume (THLB only) for the Boundary TSA.

Table 4.26 – Boundary TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	140,798	
THLB		
Wet MPB	4,171	928,400
Moist MPB	31,497	7,339,700
Dry MPB	2,186	500,100
Non MPB	231,169	27,940,400
Total THLB	269,023	36,708,500
Total productive forest	409,821	

Baseline

Table 4.27 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.27 – Annual harvest – Boundary Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	706,000	n/a	73,728	0
10	706,000	n/a	137,040	845,000
15	706,000	n/a	168,520	6,444,000
20	706,000	n/a	24,855	6,748,000
30 - 110	614,000			
120 – 250	706,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.28 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.28 – Annual harvest – Boundary Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	706,000	706,000	705,535	0
10	706,000	706,000	1,441	572,000
15	706,000	706,000	705,160	1,540,000
20	706,000	341,600	442	1,705,000
30 - 120	688,600			
130 – 250	706,000			

Harvest All MPB Pine

Table 4.29 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.29 – Annual harvest – Boundary Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	706,000	706,000	705,535	0
10	706,000	706,000	1,441	572,000
15	706,000	706,000	705,160	1,540,000
20	706,000	341,600	442	1,705,000
30 - 120	688,600			
130 – 250	706,000			

Harvest All MPB Pine with Relaxed FCC

Table 4.30 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.30 – Annual harvest – Boundary Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	706,000	706,000	705,535	0
10	706,000	706,000	1,441	572,000
15	706,000	706,000	705,229	1,507,000
20	706,000	341,600	442	1,705,000
30 - 120	688,600			
130 – 250	706,000			

Discussion of Results

Results for the Boundary TSA MPB analysis indicate that the MPB does not play a significant role in determining the timber supply. This is in part due to the lower pine inventory, approximately 26% of the timber harvesting land base, and the additional time that is assumed to reach full attack across the TSA. Therefore it appears that a large portion of the affected timber can be salvaged without impacting mid and long-term supply.

As shown in the Baseline scenario, the cost of leaving most (76%) of the damaged pine in the forest results in a 13% falldown during the mid-term. Long-term harvest, which begins in year 121 of the simulation, is not impacted, mainly due to the availability of other species, which comprise 74% of the available forest.

In all remaining scenarios the results were the same. Approximately 80% of the damaged pine can be salvaged. There were large shifts in the amount of pine harvested during the first 20 years of simulation. This is the result of some forest cover constraints requiring a recovery period of five years before additional harvesting could continue in those areas of the TSA. In reality, this harvest flow could be distributed more evenly during the initial 15 years, which would provide a better chance of recovering all damaged pine before the shelf life expired.

Relaxing forest cover constraints in visual and IRM areas does not allow the harvest of pine to increase, which indicates that other non-timber concerns (wildlife habitat, old growth) play a role in accessing these pine stands. Mid-term harvest levels drop by less than 3% before recovering to the long-term level, which in the case of the Boundary TSA is the same as the short-term harvest target.

Management Opportunities

There is an opportunity to recover a considerable portion of the dead or dying pine volume in the Boundary TSA. This salvage can likely be accomplished without changes to the current AAC or without having to adjust management rules for other forest resources. The primary issue is to ensure that at-risk pine stands are the focus of harvesting during the next 15 years.

Figure 4.6 presents the annual harvest rates developed for the Boundary TSA MPB scenarios.

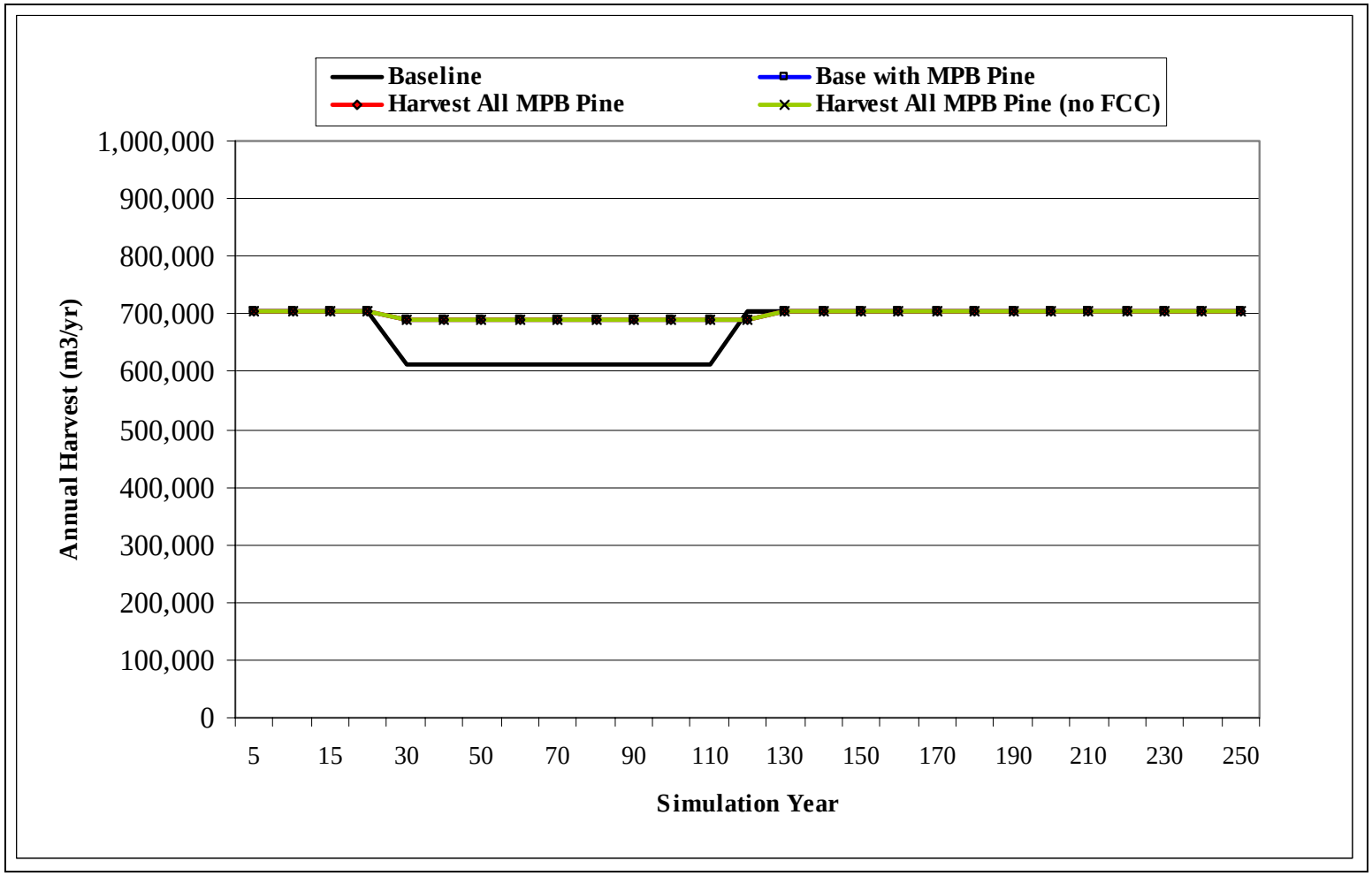

Figure 4.6 – Annual harvest levels – Boundary TSA MPB scenarios

Historic AAC: 700,000 (1982); 900,000 (1993); 700,000 (2002)

4.7 Kootenay Lake TSA

Timberline provided the data used for the Kootenay Lake TSA. The *KBHLPO TSR2 Base Case* scenario has been used for the MPB Analysis as outlined in the report *Spatial Timber Supply Analysis with Environmental and Economic Trend Reporting for the Kootenay-Boundary Higher Level Plan Order on the Kootenay Lake TSA* (March 2003).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 10.4 million cubic metres of pine volume at risk in the Kootenay Lake TSA. Table 4.31 summarizes the area and volume (THLB only) for the Kootenay Lake TSA.

Table 4.31 – Kootenay Lake TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	341,506	
THLB		
Wet MPB	17,835	4,454,600
Moist MPB	25,758	5,857,700
Dry MPB	452	112,300
Non MPB	226,768	39,174,400
Total THLB	270,813	49,599,000
Total productive forest	612,319	

Baseline

Table 4.32 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.32 – Annual harvest – Kootenay Lake Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	712,300	n/a	3,126	0
10	712,300	n/a	50,812	4,221,000
15	712,300	n/a	14,673	9,990,000
20	712,300	n/a	679	10,079,000
30 - 100	570,600			
110	631,000			
120 - 250	703,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.33 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.33 – Annual harvest – Kootenay Lake Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	712,300	687,500	662,300	0
10	712,300	687,500	662,300	922,000
15	712,300	687,500	272,300	2,362,000
20	712,300	22,460	0	2,440,000
30 – 130	676,000			
140 – 250	712,300			

Harvest All MPB Pine

Table 4.34 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.34 – Annual harvest – Kootenay Lake Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	712,300	687,500	662,300	0
10	712,300	687,500	662,300	922,000
15	712,300	687,500	272,300	2,362,000
20	712,300	22,460	0	2,440,000
30 - 130	691,000			
140 - 250	712,300			

Harvest All MPB Pine with Relaxed FCC

Table 4.35 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.35 – Annual harvest – Kootenay Lake Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	712,300	687,500	627,300	0
10	712,300	687,500	627,300	1,168,000
15	712,300	687,500	627,300	1,019,000
20	712,300	22,460	0	1,015,000
30 - 130	691,000			
40 - 250	712,300			

Discussion of Results

Similar to the Boundary TSA, there is only a minor (21%) component of pine on the timber harvesting land base in the Kootenay Lake TSA. Therefore it is possible to recover the majority of the damaged pine within the assumed shelf life of 20 years.

The Baseline scenario shows that approximately 35% of the affected pine can be salvaged without introducing new harvest priorities. However, by harvesting non-pine during the initial 20 years of the simulation the mid-term harvest is forced to drop by 18% compared to the Harvest All MPB Pine scenarios. The long-term harvest is marginally lower in the Baseline scenario as well.

Focusing, to the extent possible, the harvest into damaged or dying pine stands in the Baseline with MPB Pine Target scenario improves the mid-term harvest to within 2% of the best outcome noted in the Harvest All MPB Pine scenarios. Approximately 85% of the damaged pine is salvaged in this scenario.

Attempting to harvest all of the pine attacked by MPB in the Harvest All MPB Pine scenario gives a similar result to the Baseline with MPB Pine Target scenario. Although the total pine harvest is the same for these two scenarios, the distribution between pine stands is not, and the result is a slightly higher mid-term harvest in the Harvest All MPB Pine scenario. As with the Baseline with MPB Pine run, 85% of the pine affected by MPB is recovered in the Harvest All MPB Pine scenario.

It is possible to increase the salvage of dead and dying pine as demonstrated in the Harvest All MPB Pine with Relaxed FCC scenario. An additional 1.4 million cubic metres of pine is recovered when disturbance constraints are relaxed.

Management Opportunities

It is important to note that virtually all of the salvage takes place in the first 15 years of the simulations, five years prior to the expiration of the assumed shelf life. Ensuring that pine stands get the highest priority for harvesting prior is critical to maintaining the timber supply. In addition to providing more volume, this would also lessen the operational and financial burden on the Province to eventually regenerate these sites. Additional rehabilitation of unsalvaged sites could offset the minor falldown in supply. Figure 4.7 presents the annual harvest rates developed for the Kootenay Lake TSA MPB scenarios.

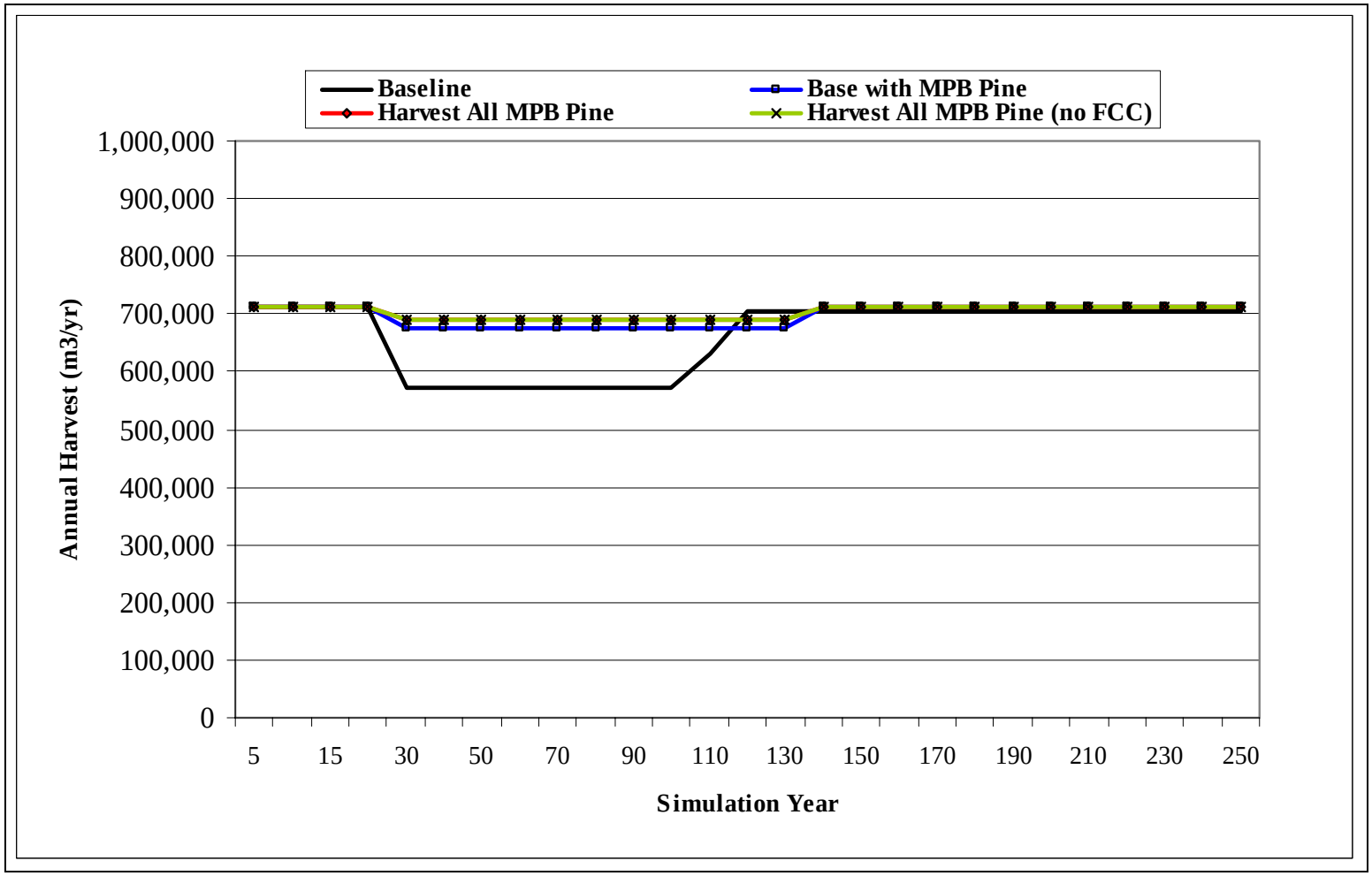

Figure 4.7 – Annual harvest levels – Kootenay Lake TSA MPB scenarios

Historic AAC: 900,000 (1981); 700,000 (1995); 681,000 (2002)

4.8 Invermere TSA

MOFR Forest Analysis Branch provided Invermere TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-3 timber supply analysis, as outlined in the *Invermere Timber Supply Area Timber Supply Review #3 Analysis Report Version 3* (Forsite, May 2004).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 12.5 million cubic metres of pine volume at risk in the Invermere TSA. Table 4.36 summarizes the area and volume (THLB only) for the Invermere TSA.

Table 4.36 – Invermere TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	320,966	
THLB		
Wet MPB	18,977	4,191,200
Moist MPB	34,345	7,585,500
Dry MPB	3,139	693,300
Non MPB	177,222	18,430,400
Total THLB	233,684	30,900,400
Total productive forest	554,650	

Baseline

Table 4.37 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.37 – Annual harvest – Invermere Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	605,900	n/a	71,710	0
10	605,900	n/a	135,404	3,843,000
15	605,900	n/a	218,299	9,799,000
20	605,900	n/a	58,037	10,053,000
30	214,000			
40	214,000			
50 - 90	438,000			
100 - 150	597,000			
160 – 250	645,900			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.38 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.38 – Annual harvest – Invermere Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	605,900	605,900	565,150	0
10	605,900	605,900	605,900	2,219,000
15	605,900	605,900	605,900	3,469,000
20	605,900	605,900	33,713	3,469,000
30	566,900			
40 - 100	502,000			
110 – 250	645,900			

Harvest All MPB Pine

Table 4.39 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.39 – Annual harvest – Invermere Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	785,100	785,100	785,100	0
10	785,100	785,100	785,100	200
15	785,100	785,100	785,100	200
20	605,900	138,600	138,600	500
30 - 90	544,200			
100	620,900			
110 - 250	645,900			

Harvest All MPB Pine with Relaxed FCC

Table 4.40 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.40 – Annual harvest – Invermere Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	785,100	785,100	785,100	0
10	785,100	785,100	785,100	200
15	785,100	785,100	785,100	200
20	605,900	138,600	138,600	500
30 - 100	549,000			
110 - 250	645,900			

Discussion of Results

The results of the analysis for the Invermere TSA indicate that it will be important to focus harvesting into pine stands attacked or at risk of being attacked during the next 15 years. Regardless of the management strategy modelled, it is not possible to maintain the current AAC throughout the planning horizon due to mid-term declines in timber supply as pine sites recover and other species support the entire harvest.

The Baseline scenario, which models existing harvest priorities, shows a mid-term falldown of up to 63% compared to the current AAC. The mid-term harvest is up to 40% less than other scenarios modelled in the analysis. Utilizing non-pine stands in the short-term causes this mid-term decline in supply during which time the pine sites recover. As a result only 20% of the damaged pine inventory is recovered prior to the shelf life expiring in 20 years.

Maintaining the current AAC but shifting harvest into affected pine stands improves both the mid-term supply and recovery of pine volume as demonstrated in the Baseline with MPB Pine Target scenario. Approximately 73% of the damaged pine is salvaged as a result of forcing harvest into pine stands. There is still a mid-term decline of 14% from the current AAC which recovers at year 110 of the simulation.

It is possible to salvage all of the damaged pine in both Harvest All MPB Pine scenarios by increasing the short-term harvest by 35% over the current AAC. Results were virtually the same for these two modelling scenarios. This indicates that salvage of the majority of the damaged pine could be salvaged without alteration to current management for non-timber interests, although there might be benefits to leaving some of the MPB pine stands in the forest unsalvaged to accommodate non-timber objectives.

Management Opportunities

To recover the maximum possible volume in the Invermere TSA, consideration should be given to harvesting beetle affected pine stands. By increasing the current AAC, virtually all pine can be recovered with the added benefit of regenerating these sites to managed stands. . In addition to providing more volume, this licensee harvesting would also lessen the operational and financial burden on the Province to eventually regenerate these sites.

Regardless of the cut level established for the TSA, any rehabilitation of unsalvaged sites will improve the mid-term harvest potential. Figure 4.8 presents the annual harvest rates developed for the Invermere TSA MPB scenarios.

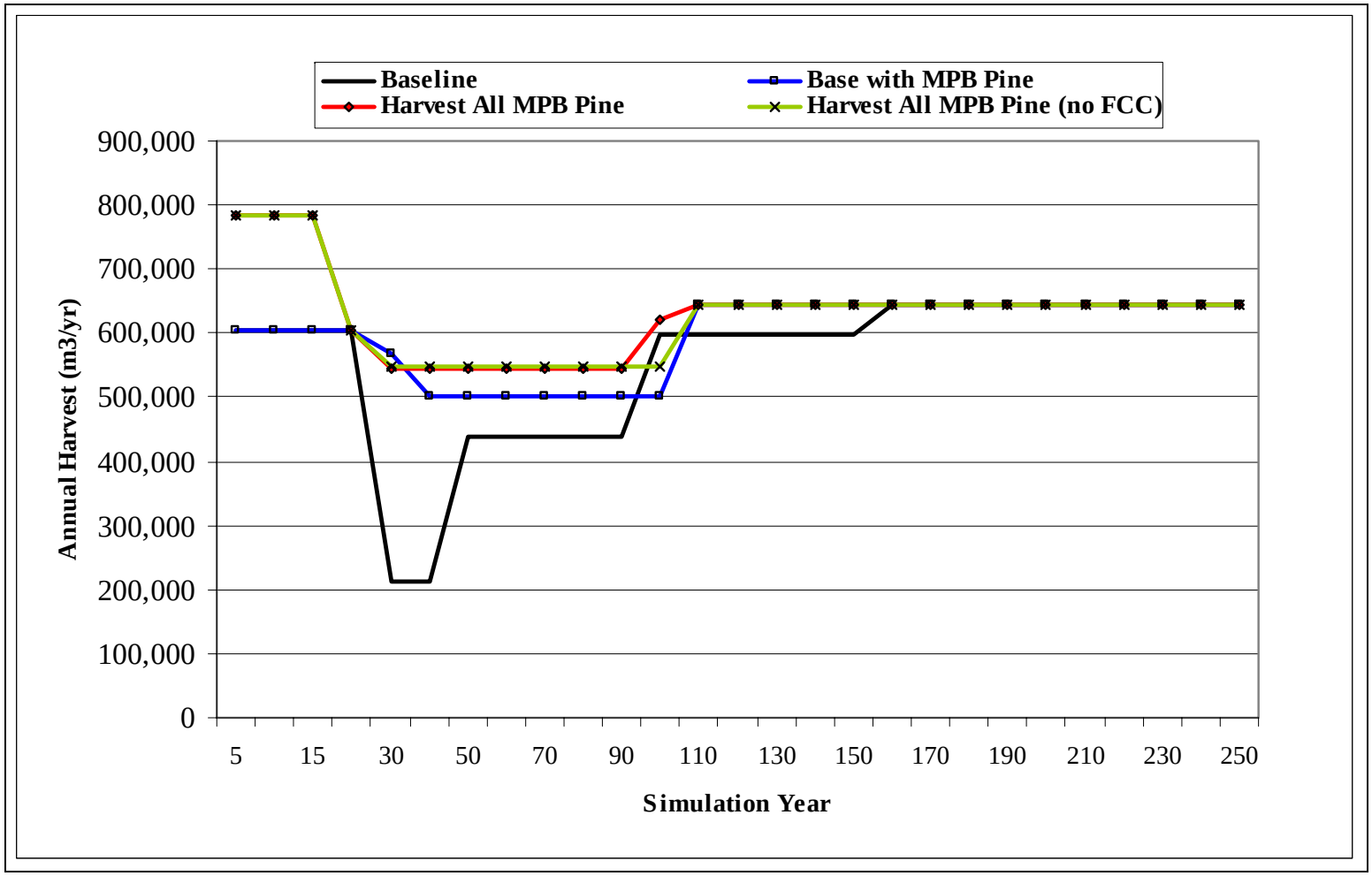

Figure 4.8 – Annual harvest levels – Invermere TSA MPB scenarios

Historic AAC: 670,000 (1981); 1,800,000 (1985); 696,000 (1986); 736,000 (1989); 697,000 (1990); 657,000 (1994); 591,000 (1996); 581,000 (2001); 581,000 (2005)

4.9 Cranbrook TSA

MOFR Forest Analysis Branch provided Cranbrook TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-3 timber supply analysis, as outlined in the *Cranbrook Timber Supply Area Timber Supply Review #3 Analysis Report Version 3* (Forsite, May 2004).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 22 million cubic metres of pine volume at risk in the Cranbrook TSA. Table 4.41 summarizes the area and volume (THLB only) for the Cranbrook TSA.

Table 4.41 – Cranbrook TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	345,526	
THLB		
Wet MPB	36,428	7,266,600
Moist MPB	68,440	13,652,400
Dry MPB	5,519	1,101,000
Non MPB	258,871	26,358,400
Total THLB	415,064	48,378,400
Total productive forest	760,590	

Baseline

Table 4.42 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 4.42 – Annual harvest – Cranbrook Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	957,240	n/a	215,961	0
10	915,240	n/a	198,377	6,569,000
15	747,000	n/a	409,928	17,050,000
20	747,000	n/a	68,381	17,557,000
30	514,000			
40	385,000			
50	474,000			
60	474,000			
70 - 130	723,000			
140 – 250	918,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 4.43 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 4.43 – Annual harvest – Cranbrook Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	957,240	957,240	957,240	0
10	915,240	915,240	915,240	4,105,000
15	915,240	915,240	915,240	7,768,000
20	738,000	738,000	46,214	7,850,000
30 - 110	738,000			
120	781,000			
130	781,000			
140 – 250	918,000			

Harvest All MPB Pine

Table 4.44 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 4.44 – Annual harvest – Cranbrook Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	1,394,600	1,394,600	1,394,600	0
10	1,340,000	1,394,600	1,340,000	1,179,000
15	791,000	1,394,600	791,000	4,206,000
20	686,000	220,200	15,830	4,313,000
30 - 60	686,000			
70 - 130	866,000			
140 – 250	918,000			

Harvest All MPB Pine with Relaxed FCC

Table 4.45 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 4.45 – Annual harvest – Cranbrook Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	1,394,600	1,394,600	1,394,600	0
10	1,394,600	1,394,600	1,394,600	949,000
15	996,400	1,394,600	996,400	2,964,000
20	651,000	220,200	5,317	3,065,000
30 - 60	651,000			
70 - 160	866,000			
170 – 250	918,000			

Discussion of Results

The analysis indicates that a mid-term falldown in timber supply in the Base Case is likely based on the oldest first harvest queue assumptions used. Pine stands represent 46% of the mature inventory on the land base, and this volume would normally be essential to maintain the harvest over the next 70 years. The Baseline scenario exhibits the earliest decline to the mid-term level, which is 60% below the current AAC (941,000 m^3/year) at its lowest point. As a result of the harvest priorities in the Baseline only 20% of the dead or dying MPB pine volume is recovered.

As demonstrated in the Baseline with MPB Pine Target scenario, focusing, to the extent possible, harvest into pine stands maintains a higher short-term harvest, but the mid-term falldown is still experienced, 21% lower than the current AAC for the TSA. However, 65% of the damaged pine is salvaged as a result of this harvest priority assumption.

Increasing the short-term harvest in the Harvest All MPB Pine scenario results in 80% of the dead and dying pine being salvaged prior to stand breakup. The mid-term harvest rate is 27% lower than the current AAC. The recovery of the annual harvest rate takes place 70 years earlier in this scenario compared with the Baseline with MPB Pine Target. This is the result of sites being quickly regenerated to a managed stand condition. The mid-term harvest rate is lower than in the Baseline with MPB Pine Target scenario because the increase in harvested area places more land into a disturbed condition. This can limit harvest in some of the management areas defined for the analysis. Pine stands that die and are left unsalvaged are not considered disturbed so adjacent stands can be harvested immediately. Land managers will need to determine the benefit of leaving some MPB pine stands unsalvaged and if this is the best choice for the forest state.

Relaxing forest cover constraints allows more harvesting in dead and dying pine stands as shown in the Harvest All MPB Pine with Relaxed FCC scenario. As a result 86% of the pine is salvaged. However there is an additional drop in mid-term harvest, 31% below the current AAC, as more area is placed into a disturbed condition.

Management Opportunities

The analysis demonstrates that it is important to salvage dead and dying pine as a priority over the next 15 years. It is possible to increase the current harvest rate for the TSA. It is possible that administrative rules for adjacency and green-up could by modified for at least 20 years to improve both the recovery of dead pine and the mid-term timber supply. However, these changes must be made in consideration of other forest values. Figure 4.9 presents the annual harvest rates developed for the Cranbrook TSA MPB scenarios.

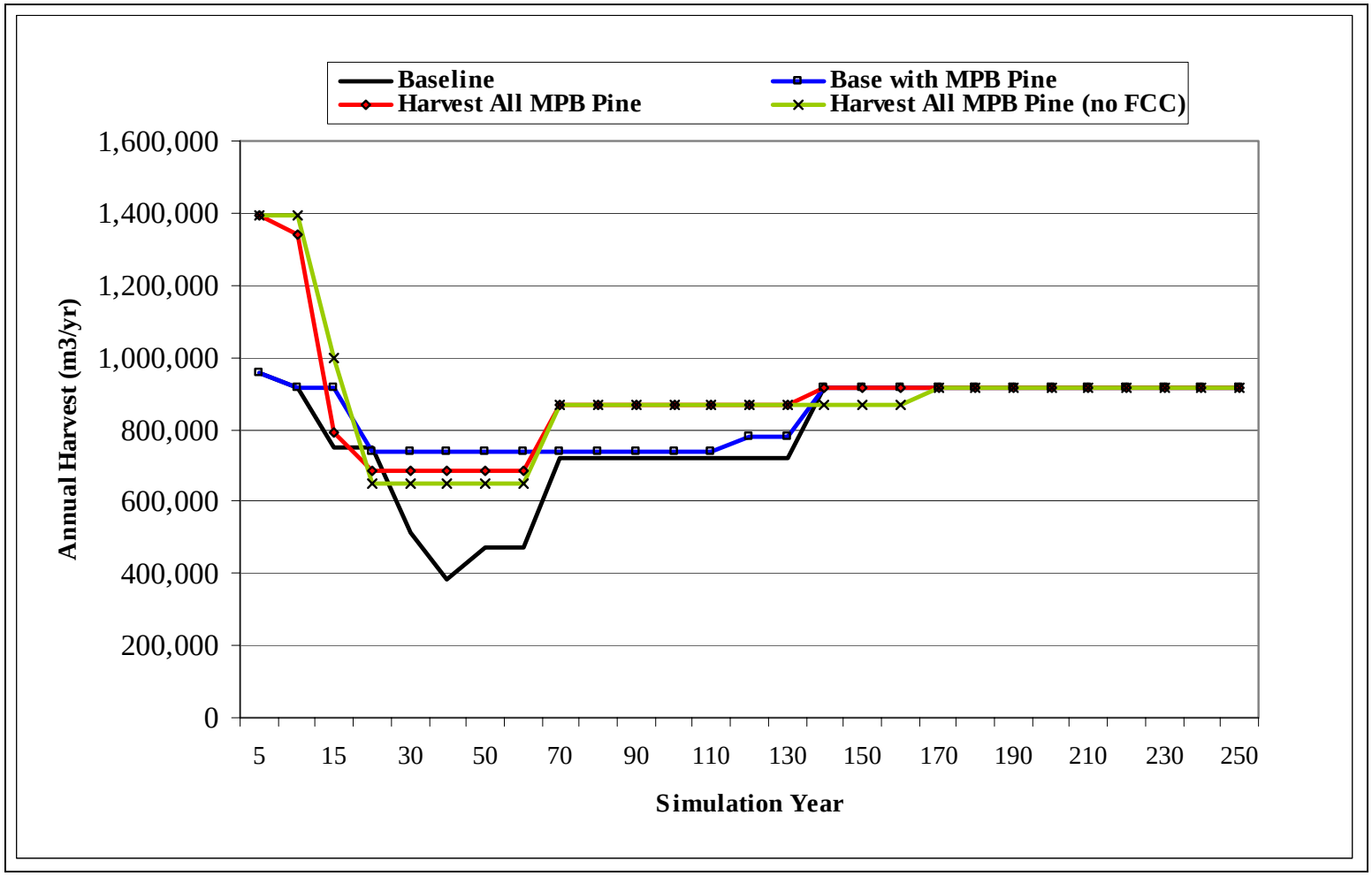

Figure 4.9 – Annual harvest levels – Cranbrook TSA MPB scenarios

Historic AAC: 900,000 (1981); 837,000 (1987); 1,276,000 (1990); 1,184,000 (1991); 920,000 (1993); 901,000 (1995); 850,000 (1996); 871,000 (2001); 941,000 (2004); 974,000 (2005)

5.0 ANALYSIS RESULTS – FULL ATTACK AT YEAR 10

The TSAs included in the sections below are assumed to have reached full MPB attack at year 10 of the analysis. Because the TSAs in this section do not have sites that were classified as dry, the shelf life will therefore expire at year 20 of the planning horizon for moist site MPB pine stands. Note that the *Dead Pine Harvest* entry for simulation years 5 and 10 in the summary tables includes some live pine that will be attacked (dead) by the end of year 10 of the simulation.

5.1 Mackenzie TSA

MOFR Forest Analysis Branch provided Mackenzie TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Mackenzie Timber Supply Area Analysis Report* (MoF, April 2001).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 123.2 million cubic metres of pine volume at risk in the Mackenzie TSA. Table 5.1 summarizes the area and volume (THLB only) for the Mackenzie TSA.

Table 5.1 – Mackenzie TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	1,305,383	
THLB		
Wet MPB	206,880	54,179,700
Moist MPB	263,447	69,030,000
Dry MPB	n/a	n/a
Non MPB	976,067	178,911,000
Total THLB	1,446,394	302,120,700
Total productive forest	2,751,777	

Baseline

Table 5.2 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 5.2 – Annual harvest – Mackenzie Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,477,800	n/a	1,956,994	0
10	3,477,800	n/a	2,038,994	0
15	3,477,800	n/a	1,882,855	41,247,000
20	3,477,800	n/a	1,424,286	86,694,000
30 – 250	3,196,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 5.3 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 5.3 – Annual harvest – Mackenzie Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	3,477,800	3,477,800	3,477,800	0
10	3,477,800	3,477,800	3,477,800	0
15	3,477,800	3,477,800	3,477,800	31,302,000
20	3,477,800	3,477,800	3,477,800	53,654,000
30 - 250	3,477,800	3,477,800		

Harvest All MPB Pine

Table 5.4 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 5.4 – Annual harvest – Mackenzie Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	6,210,400	6,160,400	6,160,400	0
10	6,210,400	6,160,400	6,160,400	0
15	6,210,400	6,160,400	6,160,400	1,100
20	6,210,400	6,160,400	6,160,400	1,700
30 - 250	3,477,800			

Harvest All MPB Pine with Relaxed FCC

Table 5.5 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 5.5 – Annual harvest – Mackenzie Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	6,210,400	6,160,400	6,160,400	0
10	6,210,400	6,160,400	6,160,400	0
15	6,210,400	6,160,400	6,160,400	1,100
20	6,210,400	6,160,400	6,160,400	1,700
30 – 250	3,477,800			

Discussion of Results

The Mackenzie TSA has a large inventory, approximately 123 million cubic metres, of mature pine that is at risk to MPB attack. However, based on the assumption that complete attack will not occur for 10 years, the results indicate that this volume can be recovered without impacting the future supply of timber for the TSA.

The short-term harvest in the Baseline, as well as all other scenarios modelled for the Mackenzie TSA, is at least 15% higher than the current AAC of 3,050,000 m^3/year. Maintaining the current species priorities as modelled in the Baseline, results in a decline of 8% in annual harvest beginning in year 30. By harvesting non-pine stands in the first 20 years of the simulation, volume that should support the harvest in decades 3 to 10 is being utilized prematurely. As a result only 30% of the pine at risk to attack is recovered with the existing species priorities.

Focusing, to the extent possible, harvest into pine stands results in harvest of 56% of the pine inventory prior to stand breakup at the end of the assumed shelf life period, as demonstrated in the Baseline with MPB Pine Target scenario. A harvest rate of 3,447,800 m^3/year is maintained for the entire 250-year planning horizon.

As shown in both Harvest All MPB Pine scenarios, the short-term harvest can be increased by approximately 79%, which enables salvage all of the pine at risk to attack prior to expiration of the assumed shelf life. This can be accomplished without any impact on the mid or long-term harvest levels developed in the other scenarios.

Management Opportunities

Given the size of the Mackenzie TSA, the large inventory of mature non-pine volume, and the assumption that complete attack of MPB is 10 years away, the analysis indicates that all of the pine volume can be recovered prior to stands becoming unmerchantable. Increasing the short-term harvest to remove pine does not impact the mid or long-term supply. It will be critical to ensure that maximizing harvest of MPB pine stands does not compromise other forest objectives. However, if it is important to prevent additional spread of the beetle, additional pine harvest may be required. Figure 5.1 presents the annual harvest rates developed for the Mackenzie TSA MPB scenarios.

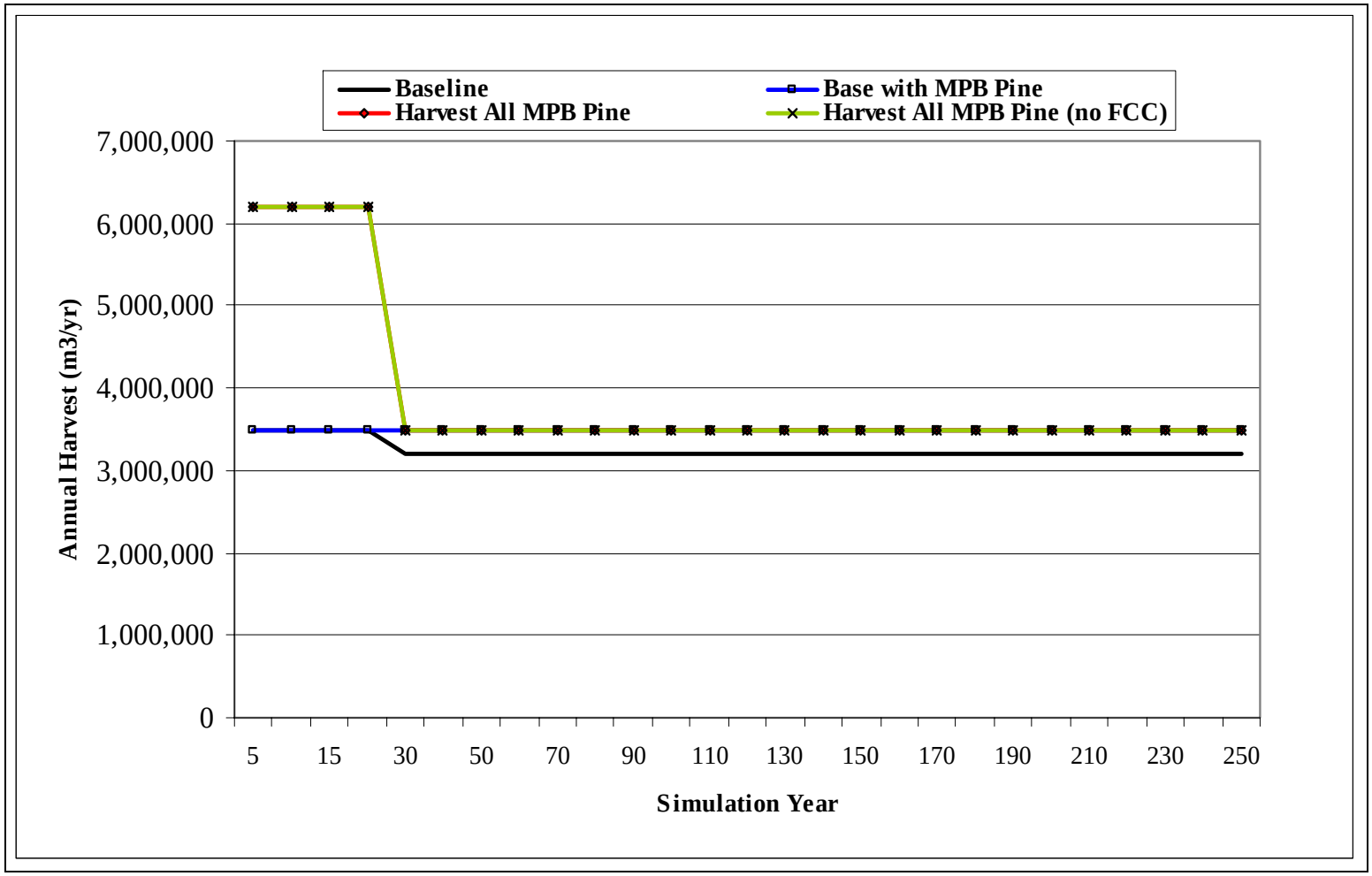

Figure 5.1 – Annual harvest levels – Mackenzie TSA MPB scenarios

Historic AAC: 2,900,000 (1981); 2,951,000 (1989); 2,997,000 (1996); 3,050,000 (2004)

5.2 Dawson Creek TSA

MOFR Forest Analysis Branch provided Dawson Creek TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Dawson Creek Timber Supply Area Analysis Report* (MoF, October 2002).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 22.1 million cubic metres of pine volume at risk in the Dawson Creek TSA. Table 5.6 summarizes the area and volume (THLB only) for the Dawson Creek TSA.

Table 5.6 – Dawson Creek TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	668,535	
THLB		
Wet MPB	52,912	12,917,700
Moist MPB	33,495	9,188,800
Dry MPB	n/a	n/a
Non MPB	643,813	117,204,600
Total THLB	730,220	139,311,100
Total productive forest	1,398,755	

Baseline

Table 5.7 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 5.7 – Annual harvest – Dawson Creek Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,130,000	n/a	870,488	0
10	1,966,000	n/a	934,619	0
15	1,809,000	n/a	916,010	5,749,000
20	1,760,000	n/a	133,424	7,834,000
30 - 250	1,760,000			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 5.8 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 5.8 – Annual harvest – Dawson Creek Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,130,000	0	870,488	0
10	2,130,000	1,105,300	1,105,300	0
15	2,130,000	1,105,300	1,105,300	757,000
20	2,130,000	1,105,300	1,105,300	1,175,000
30	2,130,000			
40	2,130,000			
50	2,049,000			
60	1,969,000			
70	1,898,000			
80 – 250	1,760,000			

Harvest All MPB Pine

Table 5.9 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 5.9 – Annual harvest – Dawson Creek Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,130,000	1,105,300	870,488	0
10	2,130,000	1,105,300	1,105,300	0
15	2,130,000	1,105,300	1,105,300	757,000
20	2,130,000	1,105,300	1,105,300	1,175,000
30	2,130,000			
40	2,130,000			
50	2,049,000			
60	1,969,000			
70	1,898,000			
80 – 250	1,760,000			

Harvest All MPB Pine with Relaxed FCC

Table 5.10 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 5.10 – Annual harvest – Dawson Creek Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,130,000	1,105,300	878,344	0
10	2,130,000	1,105,300	1,105,300	0
15	2,130,000	1,105,300	1,105,300	439,000
20	2,130,000	1,105,300	1,105,300	1,135,000
30	2,130,000			
40	2,130,000			
50	2,049,000			
60	1,969,000			
70	1,877,000			
80 – 250	1,760,000			

Discussion of Results

The volume of pine at risk to MPB attack is considerably smaller in the Dawson Creek TSA, 16% of the total inventory. It does however comprise 26% of the mature coniferous volume. In all scenarios modelled for the TSA annual deciduous harvest is approximately 34% to 42% of the total harvest.

The Baseline scenario did not specify targets for pine at risk to MPB attack. It was however possible to recover 65% of the dead or dying MPB pine volume identified on the land base. The short-term harvest of 2,130,000 m^3/year (15% higher than the current AAC) could only be sustained for five years in the Baseline after which time the annual harvest declined by 17% to the long-term harvest rate.

Forcing harvest into MPB pine stands in the early periods of the simulation results in recovery of 95% of the volume at risk to MPB attack as shown in the Baseline with MPB Pine Target scenario. The short-term harvest rate is maintained for 40 years in this scenario at which time there is a decline of 17% in annual harvest to the long-term level. Identical results were noted for the Harvest All MPB Pine scenario.

In the Harvest All MPB Pine with Relaxed FCC scenario there was negligible improvement in the salvage of pine. This indicates that forest cover constraints are not playing a significant role in determining the harvest opportunities in pine stands at risk to beetle attack. A similar harvest flow and long-term level were developed for this scenario and the Harvest All MPB Pine scenario.

Management Opportunities

It is evident that salvage of pine stands at risk to MPB attack can be achieved in the Dawson Creek TSA with no impact on harvest levels in the future. This is the result of the extended timeline to address the issue and the relatively small inventory of pine on the TSA. Focusing, to the extent possible, harvest into pine stands is the key strategy for recovering merchantable pine volume and regenerating sites to a managed stand type, which will avoid premature falldown in supply.

Figure 5.2 presents the annual harvest rates developed for the Dawson Creek TSA MPB scenarios.

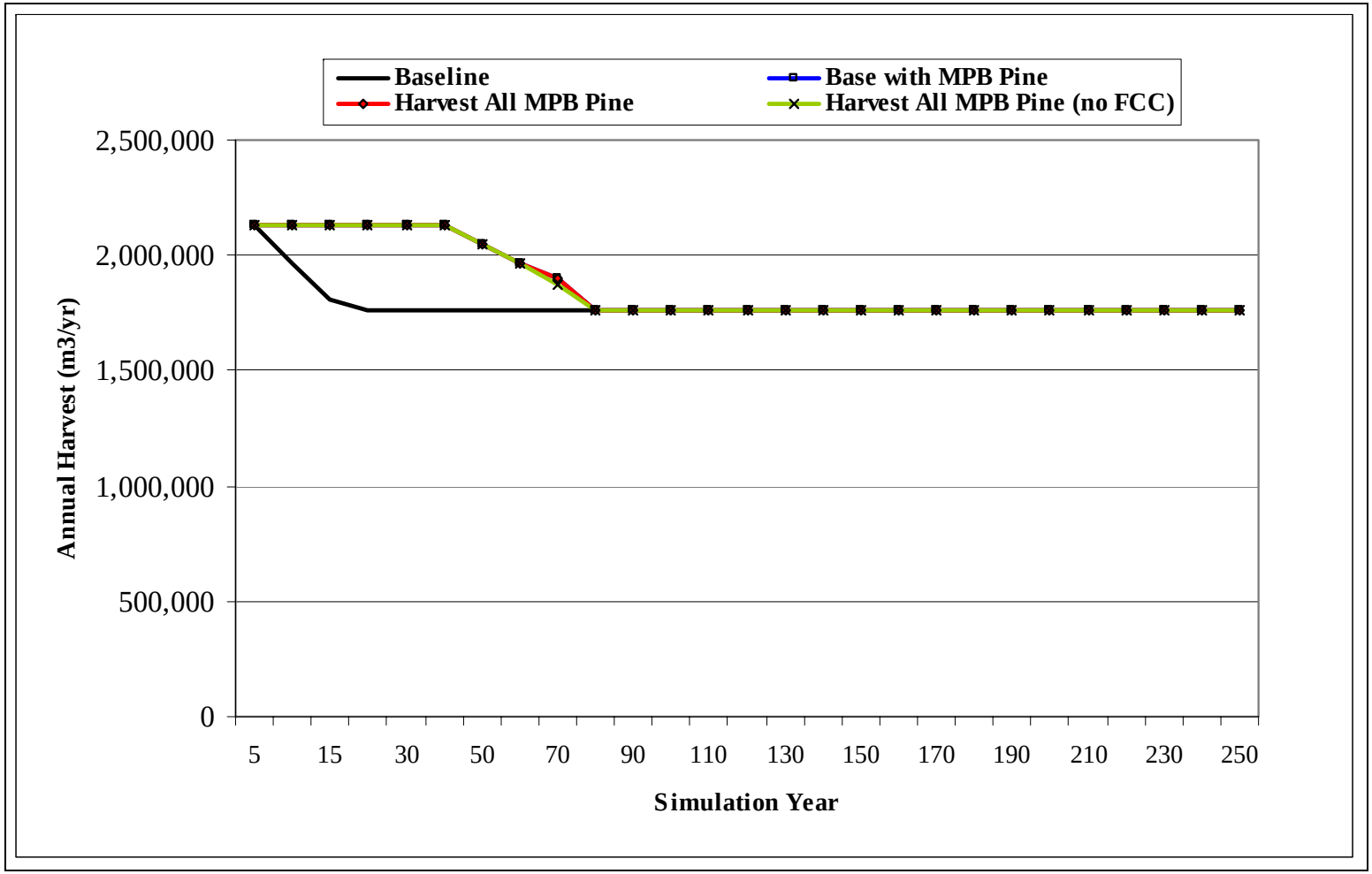

Figure 5.2 – Annual harvest levels – Dawson Creek TSA MPB scenarios

Historic AAC: 1,250,000 (1987); 1,710,000 (1989); 1,860,000 (1990); 1,733,000 (1996); 1,860,000 (2003).

5.3 Fort St. John TSA

MOFR Forest Analysis Branch provided Fort St. John TSA data used in the MPB Analysis. The data and FSSIM input files were used in the TSR-2 timber supply analysis, as outlined in the *Fort St. John Timber Supply Area Analysis Report* (MoF, June 2002).

Based on the assumptions used to assign pine stands to the various MPB categories, there are approximately 53.7 million cubic metres of pine volume at risk in the Fort St. John TSA. Table 5.11 summarizes the area and volume (THLB only) for the Fort St. John TSA.

Table 5.11 – Fort St. John TSA area summary

Land Base Category	Area (ha)	Volume (m^3)
Productive non-THLB	1,184,717	
THLB		
Wet MPB	31,861	6,981,700
Moist MPB	213,227	46,723,900
Dry MPB	n/a	n/a
Non MPB	813,446	115,140,700
Total THLB	1,058,534	168,846,300
Total productive forest	2,243,257	

Baseline

Table 5.12 summarizes the harvest level and pine volumes for the Baseline scenario.

Table 5.12 – Annual harvest – Fort St. John Baseline

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,756,500	n/a	110,100	0
10	2,480,800	n/a	0	0
15	2,232,700	n/a	0	6,846,000
20	2,024,400	n/a	0	53,155,000
30 - 130	2,024,400			
140 – 250	2,099,400			

Baseline with MPB Pine Target

In this scenario the objective was to model the same annual harvest target as in the Baseline scenario, with priority on pine stands at risk to MPB. Table 5.13 summarizes the harvest level and pine volumes for the Baseline with MPB Pine Target scenario.

Table 5.13 – Annual harvest – Fort St. John Baseline with MPB Pine Target

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,756,500	1,731,400	1,731,400	0
10	2,756,500	1,731,400	1,731,400	0
15	2,756,500	1,731,400	1,731,400	4,070,000
20	2,756,500	1,731,400	1,731,400	19,077,000
30	2,480,800			
40 - 250	2,232,700			

Harvest All MPB Pine

Table 5.14 summarizes the harvest level and pine volumes for the Harvest All MPB Pine scenario.

Table 5.14 – Annual harvest – Fort St. John Harvest All MPB Pine

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,756,500	2,604,000	2,603,800	0
10	2,756,500	2,604,000	2,603,800	0
15	2,756,500	2,604,000	2,297,752	1,774,000
20	2,756,500	2,604,000	1,841,312	6,972,000
30	2,554,900			
40	2,472,550			
50	2,398,435			
60 - 130	2,351,400			
140 – 250	2,340,400			

Harvest All MPB Pine with Relaxed FCC

Table 5.15 summarizes the harvest level and pine volumes for the Harvest All MPB Pine with Relaxed Forest Cover Constraints scenario.

Table 5.15 – Annual harvest – Fort St. John Harvest All MPB Pine with Relaxed FCC

Simulation Year	Annual Harvest (m^3/year)	Dead Pine Target (m^3/year)	Dead Pine Harvest (m^3/year)	Unsalvaged Dead Pine Inventory (m^3)
5	2,756,500	2,604,000	2,603,800	0
10	2,756,500	2,604,000	2,603,800	0
15	2,756,500	2,604,000	2,344,864	1,538,000
20	2,756,500	2,604,000	1,926,359	6,312,000
30	2,554,900			
40	2,472,550			
50	2,398,435			
60 - 130	2,351,400			
140 – 250	2,340,400			

Discussion of Results

Pine stands at risk to MPB attack make up 32% of the inventory on the Fort St. John TSA. Results of the Baseline analysis indicate that under current harvest priorities only 1% of these stands will be recovered. The initial harvest level for this scenario is 30% higher than the current AAC of 2,115,000 m^3/year suggesting that harvest levels could be increased to address the MPB issue. As a result of harvesting other species in the first 20 years of simulation the initial harvest rate can only be maintained for five years. Mid and long-term harvest levels for the Baseline are 14% and 10% lower, respectively, than the rates developed for the Harvest All MPB Pine scenarios in the analysis.

Focusing, to the extent possible, harvest into MPB pine stands in the Baseline with MPB Pine Target scenario results in recovery of 64% of the MPB pine at risk to attack. This scenario maintained harvest in some of the non-pine partitions such as mixed wood types, which limited additional recovery. The short-term harvest level is sustained for 20 years in this scenario. Mid and long-term levels were approximately 5% below the level developed in the Harvest All MPB Pine scenarios.

Results of the two Harvest All MPB Pine scenarios were virtually the same. Approximately 88% of the pine volume is salvaged prior to expiration of the shelf life. The mid and long-term harvest rates are 15% below the short-term harvest. However, the long-term harvest levels developed in the Harvest All MPB Pine scenarios are still 10% higher than the current AAC for the TSA.

Management Opportunities

It is clear from the results of the analysis for the Fort St. John TSA that the majority of the pine at risk to MPB attack can be recovered while it remains merchantable. Focusing, to the extent possible, harvest into MPB pine stands over the next 20 years is critical to maximizing salvage and maintaining the highest possible mid-term harvest potential. As with other TSAs rehabilitation of sites that are not salvaged will limit the decline in mid-term harvest noted in the analysis. It is also important to ensure that any increase in the annual harvest of MPB pine stands does not negatively impact non-timber objectives for the TSA.

Figure 5.3 presents the annual harvest rates developed for the Fort St. John TSA MPB scenarios.

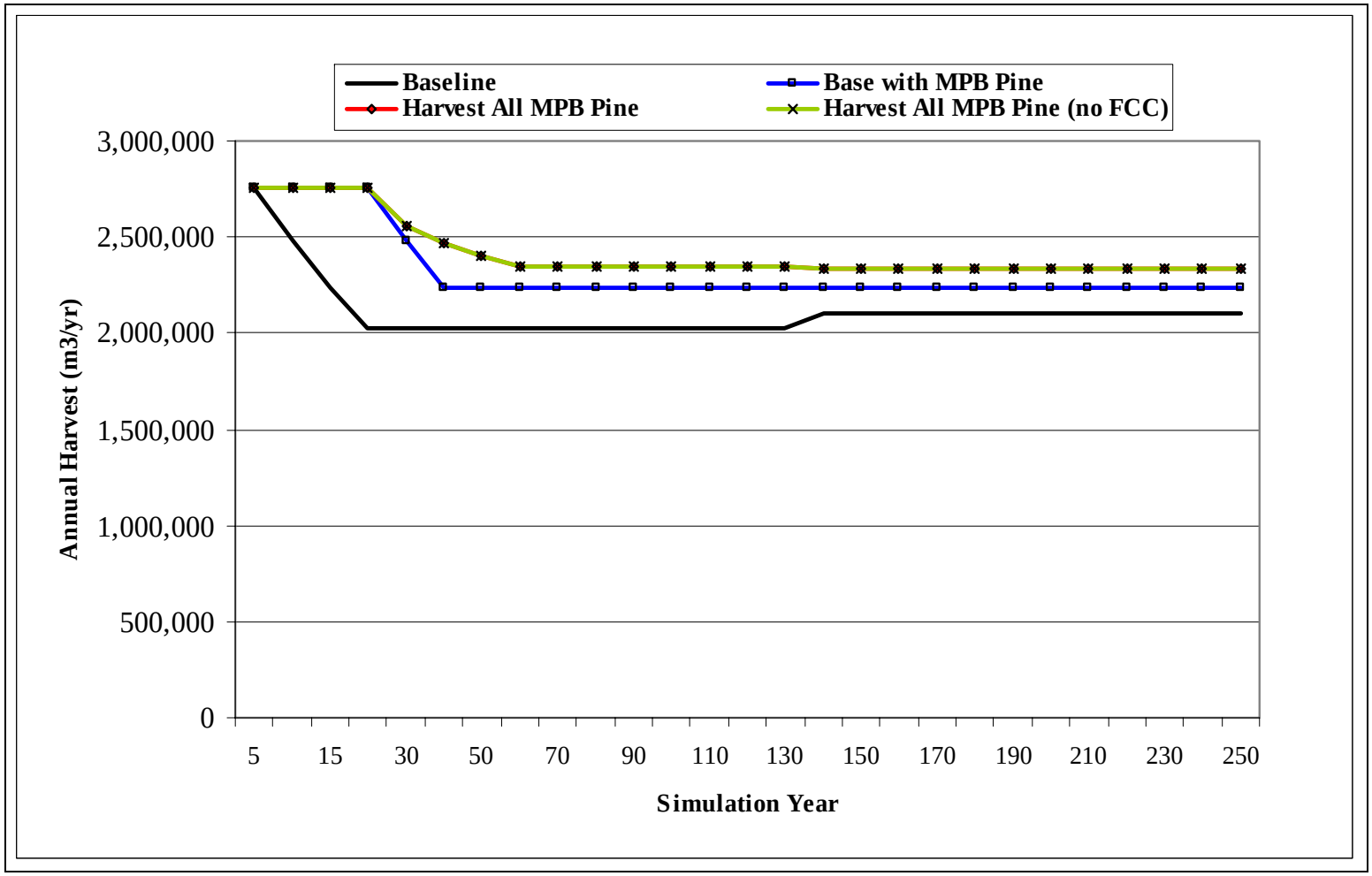

Figure 5.3 – Annual harvest levels – Fort St. John TSA MPB scenarios

Historic AAC: 1,815,000 (1989); 2,015,000 (1996); 2,115,000 (2003).

6.0 DISCUSSION

The MPB analysis has reviewed potential impact of the MPB attack on timber supply for 18 TSAs across the interior of the province. A range of outcomes has been exhibited depending on a number of existing and assumed conditions. Central elements of the analysis that impact results include:

- Time of full attack – depending on the current of MPB outbreak, this was assumed to be now, in 5 years, or in 10 years;
- Shelf life – assumed to be 5 years for wet sites, 10 years for moist sites and 15 years for dry sites. After the shelf life has expired pine stands are considered unmerchantable and regenerate to a reduced volume, slower growing stand;
- The mortality in pine stands attacked by MPB (this analysis assumes 100%); and
- Current inventory of mature pine.

These assumptions play an important role in determining how the timber supply will be affected over the next 100 years. If stands are attacked sooner or if shelf life estimates are optimistic then timber supply levels could be lower than noted in the analysis. Conversely, if it takes longer for the beetle to spread and/or shelf life estimates are conservative, timber supply could be improved compared to the results presented here.

Another important element in the analysis relates to levels of attack. It was assumed that all pine in stands 60 years and older with more than 39% pine will be completely attacked resulting in the entire stand being killed. Given the analysis data sets used and the scope of the analysis it was not always possible to isolate the pine for attack in mixed species stands, which may provide a less detailed result. In addition, volume contained in those stands is at risk to being lost if salvage does not take place within the assumed shelf life period. Recent field observations indicate that attack levels in individual stands are the highest ever observed, in fact in many cases close to 100% of the trees are affected (Eng, 2005).

The current inventory of pine in a given TSA factors into the potential opportunities for salvage. This also plays a role in determining the timber supply over the next 100 years. TSAs with at least 25% mature pine, as measured in the mature coniferous inventory, were included in this analysis. Those areas with the highest component of mature pine are likely to have the worst impact in 20 to 30 years. A falldown in timber supply during the mid term, approximately 25 to 110-150 years into the future, is the result of a combination of factors, including:

- The mature inventory has been severely depleted as the result of accelerated pine harvest and/or breakup of dead pine leaving very little volume to support harvest as those pine sites regenerate to new stands. In some cases the non-pine inventory is unable to sustain the historic level of cut;
- In cases where salvage has taken place (as opposed to pine stands dying and remaining in the forest) levels of disturbance have increased which can prevent harvest of adjacent non-pine stands over the next 10 to 30 years; and
- On sites where salvage has not been possible, the pine regeneration is assumed to become unmanaged and consequently will produce lower volume and take longer to reach merchantable age.

Many of the TSAs included in the analysis have a predicted harvest flow similar to the previous analysis completed for the land base (TSR, IFPA, *etc*.), which includes some level of decline over the mid and long-term. Even though reductions in mid-term harvest can be exaggerated by the MPB outbreak, it is not solely the result of pine beetle attack.

Each TSA exhibited individual responses to the various scenarios modelled. However, in all TSAs timber supply was improved when harvest of dead or dying pine was given the highest priority. Elevating annual harvest above the current AAC allowed salvage of virtually this entire pine inventory for some of the TSAs included in the analysis. In some cases this could be accomplished without affecting the mid or long-term harvest potential. Harvesting pine at historic levels often resulted in the lowest timber supply because of the lack of salvage and the depletion of volume in non-pine stands in the short-term.

Increasing the harvest in MPB pine stands resulted in improved recovery of timber that would otherwise become unmerchantable in 15 to 25 years. However, this also places additional pressure on the remaining non-pine types to support both the periodic harvest and other non-timber values associated with the land base. In some cases management decisions could result in some MPB pine stands remaining unsalvaged in order to meet other forest objectives.

Based on the results of the analysis, it will be important to consider the following in responding to the MPB outbreak:

- The total inventory of pine at risk to attack, or that has already been attacked.
- Can elevated harvest levels, which will enable improved volume recovery, be achieved operationally?
- Will it be possible to promptly regenerate sites that were not salvaged to a managed stand condition with the associated volume and rotation age gains, or will they remain untreated and grow to a natural stand; and
- What are the social, economic, and environmental consequences of changes to timber supply in the short, mid and long-term.

In order to gain additional understanding of the impact of the MPB outbreak future timber supply analyses might include evaluation or consideration of the following:

- More detailed inputs and summary of the species distribution of the harvest and residual forest;
- Inventory levels over time, especially during the recovery period after the outbreak has ended;
- Trade-offs between leaving MPB pine stands in the forest to address non-timber objectives, and how that might reduce the pressure for those objectives to be met in non-pine stands; and
- Spatial distribution of the harvest and the impact of increased harvesting on non-timber objectives.

The analysis has identified a number of areas, which should be addressed to ensure that the best information is being used to estimate the impact of the pine beetle issue:

- Continue to gather information related to shelf life estimates;
- Improve estimates of attack levels in both pure and mixed stands of pine;
- Identify ages of pine that are being attacked, this analysis used 60 years as a minimum age but it has been suggested that much younger stands are at risk;
- Estimate the amount of unsalvaged land that can be rehabilitated to a managed stand condition in order to maximize the productivity from the next stand; and
- Confirm management rules for other forest resources, in order to understand where additional salvage will be permitted.

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