WATER STORAGE OF PINE - A STRATEGY TO MITIGATE LOSSES DUE TO MOUNTAIN PINE BEETLE

By

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ABSTRACT

The pine forests of BC are currently subjected to an epidemic infestation of mountain pine beetle. This paper provides a review of the history and extent of the infestation, a report on the likely economic effects of extensive pine mortality and an evaluation of a strategy to mitigate some of the projected negative economic impacts. Because of the infestation's scale, the limited shelf-life of dead standing timber, and milling capacity constraints, a majority of the affected pine will not be salvaged. The merchantable value of some of the affected timber could be maintained by storing it in lakes. Lake storage involves substantial carrying charges as logging costs are incurred in the near term while the timber will be processed and sold at some time in the future. Incentives will likely be required and it is recommended that the Province defer stumpage, facilitate regulatory approvals and appoint a "Facilitator of Innovation".

DEDICATION

To my daughter Madelaine and my wife Sue.

Thank you for your patience and support.

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I have had the benefit of colleagues who have contributed to this project by providing information, ideas and review. In particular, I would like to thank Paul MacNamara, RPF for his sharp eye on the review and his enthusiasm on the concept of this paper. I also thank Grant Smith, RPF at Canadian Forest Products and Tony Byrne at Forintek for the information they provided. I would also like to thank my Senior Supervisor, Dr. Richard Schwindt who promptly secured a key reference for me that was invaluable in the preparation of this paper.

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1 INTRODUCTION

British Columbia is endowed with large areas of naturally established stands of mature timber. Approximately 96 percent of the forest land in the Province is owned by the Crown.[1] Fire protection over the past 80 years has enabled large tracts of lodgepole pine to reach ages that are more susceptible to attack by mountain pine beetle.[2] These vast areas of susceptible stands, combined with the cyclical population of mountain pine beetle, have led to the most severe pine beetle epidemic in North American history.[3] If the stands of pine[4] did not have economic value, this event would simply be a matter of interest for silviculturists and biologists. The Province of B.C. receives a significant portion of its revenues from timber cutting fees and many rural communities are reliant on the business activity associated with forest products manufacturing. It is expected that by 2013 the pine beetle will have killed 80 percent of B.C.'s 12 million hectares of pine forest.[5] This is expected to significantly impact B.C.'s economy and the revenues that government receives from the industry.

This mountain pine beetle epidemic is expected to continue until the beetle runs out of suitable host trees. The most common control mechanism of mountain pine beetle epidemics is a

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[1] COFI 2000 Factbook, (Vancouver: Council of Forest Industries, 2000), 43.

[2] Mountain pine beetle (*Dendroctonus ponderosae* Hopk.)

[3] "Mountain Pine Beetle Conference," *Presentation to Western Premier's Conference*, Lloydminster, Alberta. May 5 – 6, 2005, 2.

[4] Most of the pine in British Columbia is lodgepole pine *(Pinus contorta)* although other less common species are also susceptible to mountain pine beetle. They include: ponderosa pine *(Pinus ponderosa)*, white pine *(Pinus monticola)*, and whitebark pine *(Pinus albicaulis)*. This paper will refer to these species inclusively as pine except where inventories are explicitly noted, in which case the individual species will be identified.

[5] "Mountain Pine Beetle Conference," 2.

climatic cold event but it is unlikely that such an event would occur simultaneously across the large geographic area of the infestation. The government is left with few options except to mitigate the impact of pine forest mortality. It is the purpose of this paper to evaluate one possible means of mitigation, that is, to store logs in water to preserve the merchantable value of pine until it can be processed into a forest product with economic value.

1.1 Scale of the Infestation

The forested area of British Columbia is approximately 61.6 million hectares.[6] It is estimated that 280 million m3 of pine had been killed by mountain pine beetle as of 2004.[7] That year, the area of infestation grew to 7 million hectares.[8] This was a significant increase from 2003 when the Chief Forester estimated that 4.2 million hectares of pine suffered 'red attack.[9] Red attack means that the trees had already died, resulting in the needles turning red, and the expanded beetle brood[10] had exited the trees to attack green trees, which would become red the following year. The current size of the area affected in British Columbia is shown in Figure 1. A continued expansion of the beetle population threatens the pine in the Boreal Forest, which extends from north-eastern B.C. through to the Maritime Provinces.

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[6] Marvin Eng, et al. "Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model (BCMPB) and Results of Year 1 of the Project," Mountain Pine Beetle Initiative Working Paper 2004-1 (Victoria: Natural Resources Canada and Ministry of Forests Mountain Pine Beetle Initiative, 2004), 18.

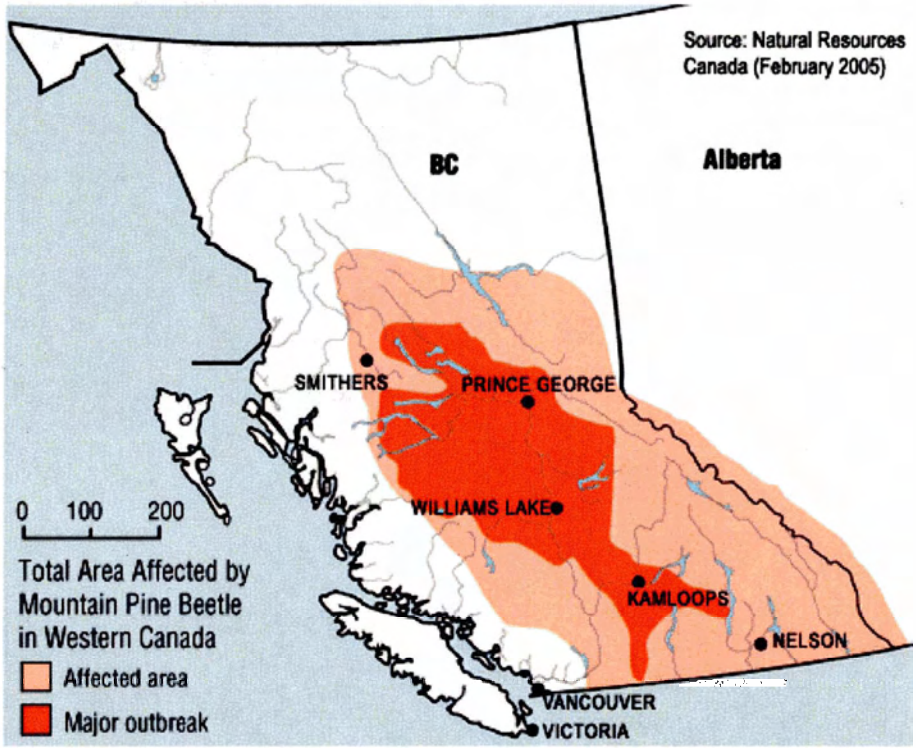
[7] Marvin Eng, et al. "Provincial-Level Projection of the Current Mountain Pine Beetle Outbreak: An Overview of the Model (BCMPB v2) and Results of Year 2 of the Project," (Victoria: Natural Resources Canada and Ministry of Forests Mountain Pine Beetle Initiative, 2005), 26.

[8] Joan Westfall, "Summary of Forest Health Conditions in British Columbia," (Victoria: Ministry of Forests, 2004), In abstract.

[9] Larry Pederson, 2003. "How Serious is the Mountain Pine Beetle Problem From a Timber Supply Perspective?" *In Mountain Pine Beetle Symposium: Challenges and Solutions, Kelowna, BC, October 30, 31, 2003, Information Report BC-X-399*, ed. T.L. Shore, et al., (Victoria: Natural Resources Canada, 2004), 10.

[10] A brood describes the collection of larvae laid by one bark beetle under the bark of a tree.

Figure 1. Scale of the Mountain Pine Beetle Infestation in B.C.



Source: Used by permission - Natural Resources Canada.[11]

1.2 The Shelf Life Concept

The timber that is killed by the mountain pine beetle is merchantable[12] for a limited period of time. The subsequent drying of the trees leads to changes in the physical structure of the wood and a reduction in the value of the timber for lumber and pulp. The shelf life describes the length of time that the timber is useful for a specific product.[13] The actual shelf life of beetle-killed timber is not fully understood but research is currently underway to address this issue.[14]

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[11] Natural Resources Canada, Mountain Pine Beetle Implementation, Online. 2005.

[12] Definition: Useful to produce lumber and wood chips for commercial purposes.

[13] Eng, Year 2, 11.

[14] Kathy Lewis at the University of Northern British Columbia is currently studying this topic under the Mountain Pine Beetle Initiative, a program jointly funded by the Province of BC and the Government of Canada. For more information on the scope of the research see URL accessed July 11, 2005: <http://mpb.cfs.nrcan.gc.ca/research/projects/8-10_e.html>

The Chief Forester of B.C. used an estimate of 13 years in the 2003 forecast on the beetle's impact on timber yields.[15] This estimate is generally considered to be optimistic, although merchantable volumes were salvaged from stands that were killed over 15 years earlier in the Chilcotin area during a preceding epidemic.[16] It is anticipated that degradation is slower in drier ecosystems and therefore current research is considering climate as a potential determinant of shelf life. It is more likely that shelf life may be only 5 to 7 years, according to industry sources.[17] If the dead pine is not salvaged within the shelf life, then the economic value of the timber will be lost to industry, communities and government.

There is a limited amount of time to gather data and undertake the analysis required to accurately determine shelf life. In fact, it is likely that the actual shelf life won't be known until the epidemic is over and all merchantable wood has been processed.[18]

1.3 Potential Economic Losses

There are two sources of economic losses due to mountain pine beetle. First, the timber salvaged will be reduced in value and secondly, there will be timber that cannot be salvaged because of loss in merchantability.

1.3.1 Reduction in Value

There are several reasons why infestation reduces the value of the timber. The beetle brings with it a fungal spore that stains the wood blue. If the infested tree dies before harvesting the wood dries and this results in radial shrinkage and checking.[19]

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[15] Pedersen, 15

[16] Robert E. Rogers "West Central B.C. Mountain Pine Beetle Strategic Business Recommendations Report," (Victoria: Ministry of Forests, September, 2001), 54.

[17] Rogers, 64.

[18] Eng, Year 2, 47.

1.3.1.1 Blue Stain

The mature pine beetle enters the host tree with fungal spores attached to its body. After laying eggs in between the bark and the wood, which is the interface where lateral wood growth occurs, the fungal spores multiply and provide nourishment for the beetle larvae. The fungal growth also reduces the tree's defences by clogging its vascular system. The result is mortality of the tree and blue stain in the sapwood.

Blue stain does not appear to significantly affect the mechanical strength of lumber although increased porosity has been recognized.[20] The impact on the appearance of the lumber is more significant. Blue stained lumber has not been well received in the marketplace and considerable efforts are underway to communicate the impact of blue stain to the marketplace. It was reported in November, 2003 that "Home Depot had recently placed restrictions on the percentage of blue stained timber that they were willing to accept."[21] Recent market research undertaken by Canfor[22] indicates that 'do-it-yourself' type customers begin to resist blue stained lumber in quantities exceeding 30 - 45 percent of a lumber stack whereas home contractor's resistance begins at quantities exceeding 45 percent. The reason for this resistance is a perception that the stain may be a sign of mould. Concern with the safety of blue stain in 2001 led Forintek to co-publish a document on the topic with the University of B.C. School of Occupational and

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[19] Checking refers to the radial crack that develops as the lateral shrinkage creates tension in the wood. Often visible in wood disks that are cut from the butt of a log and left to dry, the checking in timber can run the length of the log or tree.

[20] Tony Byrne, et al., "An Annotated Bibliography on the Effect of Bluestain on Wood Utilization with Emphasis on Mountain Pine Beetle- Vectored Blue Stain," *Mountain Pine Beetle Initiative Working Paper 2005-4* (Victoria: Natural Resources Canada, 2005), 6.

[21] Ian de la Roche, "Check Against Delivery," *Presentation given to Mountain Pine Beetle Symposium, Quesnel, BC, November 21, 2003.* 2.

[22] Lynn Embury-Williams, "Inventing the Future – Can BC Do It?" *Presentation to Association of BC Forest Professionals Meeting, Prince George, February 25, 2005.* 31.

Environmental Hygiene.[23] The Canada Wood Council also published a Factsheet in 2003 to communicate the impact of blue stain.[24] In December, 2002, the Denim Pine Marketing Association received $50,000 in funding from the Government of Canada's Western Diversification Fund to assist in the marketing and promotion of blue stained pine.[25] As the proportion of blue stain timber increases, market resistance may require price discounting to maintain sales of stained lumber.

Wood chips are a by-product of lumber production and the increase in the supply has reduced the market price for chips. The chips represent a major source of fibre for the Province's pulp industry, particularly in the Interior of the Province. Wood chips made from blue stained timber create inefficiencies in the pulping process.[26] The blue stain also causes difficulties in brightening pulp made with the thermo-mechanical process. In addition, current pulping technologies cannot utilize significant volumes of dry wood.

1.3.1.2 Checking

According to a recent study:

> ...Seasoning checks develop as the standing dead trees dry further, and the checks lead to splits in the solid wood produced. Dry wood requires more energy to process, is more brittle, and is liable to break during harvesting and log and lumber processing. Because of checking, more part-sheets of veneer result from rotary peeling.[27]

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[23] Forintek, "Discolorations on Wood Products: Causes and Implications," (Victoria: Forintek Canada Corp., 2001), 8 pages.

[24] Canada Wood Council, "Blue Stain and Construction Lumber," *Technical Note D-1.* (Ottawa: Canada Wood Council, 2003), 1 page.

[25] Denim Pine Marketing Association website. URL accessed May 13, 2005: <http://www.denimpine.ca/>

[26] "The Mountain Pine Beetle Epidemic – Pulp and Papermaking Issues," *Presentation by Paul Watson, Paprican to Forrex, January 25, 2005,* (Vancouver: Paprican, 2005), 38.

[27] Byrne, Annotated Bibliography, 6.

This has a negative impact on harvesting and processing costs and on the grades of lumber and plywood that can be produced. The increased proportion of lumber that is rejected during manufacturing increases the amount of wood chips that are produced. The increase in part-sheets from rotary peeling significantly reduces productivity in plywood manufacturing. For these reasons, checking is considered to be one of the most significant causes of log degradation following mountain pine beetle infestation.

1.3.2 Pine Mortality That Will Not Be Harvested for Pulp or Lumber

The total amount of pine that is estimated to be at risk to mountain pine beetle is 1.8 billion m3.[28] Not all of this pine is within areas that are available for harvesting. Some of this pine is within the non-timber harvesting landbase, which includes parks, reserves and private land. The amount of pine within the timber harvesting landbase that is estimated to be at risk from the mountain pine beetle is 1.2 billion m3. It has been estimated that 80 percent of the pine is likely to be killed during the current epidemic.[29] This places a volume of 960 million m3 of commercially viable pine at risk to mountain pine beetle. Efforts are currently underway to utilize this.

According to Table 1, the volume of lodgepole pine harvested in 2003 from the Northern and Southern Interior Forest Regions totalled 23 million m3. For reference, the annual Provincial harvest of all conifer species from the Timber Supply Areas (TSAs) in the Northern and Southern Interior is authorized to a level of 58 million m3.[30] The epidemic is expected to begin to wane by 2013. The peak of the epidemic is forecast to occur in 2006 with the death of 90 million m3 of

[28] Eng, Year 2, 25.

[29] Mountain Pine Beetle Conference, 2.

[30] From Forest Analysis Branch, Ministry of Forests, British Columbia.

pine.[31] Using the 2003 pine harvest as a base, the total amount of pine that normally would be harvested during the period 2004 to 2013 would be in the range of 255 million m3.

Table 1. Lodgepole Pine Harvest from Crown Land in B.C. 2003[32]

Forest Region	Volume (m3 x 1,000)	Volume billed @ $0.25 per m3[33] (m3 x 1,000)	Value All Stumpage[34] ($ x 1,000)
Northern Interior	11,761	362	$187,994
Southern Interior	11,417	670	$159,164
Subtotal Interior	23,178	1,032	$347,158
Coast	13	-	$342
Total for Province	23,192	1,059	$347,500

Source: Compiled by author.[35]

Recognizing the concept of 'use it or lose it', the Chief Forester has authorized an increase in the annual allowable cut (AAC) for the TSAs that have been most severely affected by the mountain pine beetle. These increases are commonly known as uplifts. The amount of harvest that has been established for pine salvage through uplifts from 2001 through 2013 is estimated to be 77 million m3, as shown in Table 2. Additional uplifts are likely to occur. An uplift for the Okanagan TSA is currently being considered.

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[31] Eng, Year 2, 28.

[32] Lodgepole pine (Pinus contorta)

[33] The government provides an incentive for harvesting timber that has become degraded. According to the Interior Appraisal Manual, Table 6-4, Interior log Grades 3, 4, 5 and 6 are assessed a stumpage rate of $0.25 per m3. These grades are described in Appendix A

. Dead and dry sawlogs are considered Grade 3 and much of the pine mortality is in this category.

[34] Stumpage refers to the fees paid to the Province by the individuals and companies that harvest timber. The stumpage fee represents the Province's financial interest in the timber that is harvested.

[35] Data for this table was derived using a MS Access database and the database of scaling/billing data report #981916 that was downloaded from <http://www4.for.gov.bc.ca/hbs/.> (Caution: the following link will access the following data file, which is 23 mb in size and it is very slow to download.) The data for the report was found at URL accessed on May 19, 2005: <http://www4.for.gov.bc.ca/hbs/ReportDelivery/981916.csv>

By comparing the pine that is forecast to be harvested to the volume that is forecast to be lost, it is possible to estimate the amount of pine that will not be salvaged. The uplift in harvest between the years 2004 and 2013 will be 74 million m3. Adding the estimated regular pine harvest of 255 million m3 to the 74 million m3 uplift suggests that 329 million m3 of lodgepole pine could be harvested between 2004 and 2013. Unless additional uplifts are authorized, and depending on how long the shelf life extends beyond 2013, this indicates that only one third of the pine that is expected to be killed by mountain pine beetle will be harvested.[36] The 631 million m3 of non-salvaged pine represents a very significant potential opportunity cost to the Province of B.C.[37]

[36] Recall that approximately 960 million m3 of commercially viable pine are at risk. If 329 million m3 are harvested over the next ten years, and if the infestation subsides, this suggests that just one-third of the infested timber will be harvested, leaving two-thirds or about 631 million m3 unharvested and unused.

[37] Eng, Year 2, 47 suggests that non-salvaged losses that will accrue by 2024 may vary from 300 million m3 to 700 million m3.

Table 2. Annual Allowable Cut Uplift Summary by TSA[38]

TSA	Volume (m3 x 1,000)													
	Year													
	2001	2002	2003	2004	2005	2006	2007	2008	2009[39]	2010	2011	2012	2013	Sum of Uplifts
Kamloops				1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	10,000
Merritt					1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300	11,700
Williams Lake	850	850	850	850	850	850	850	850	850	850	850	850	850	11,050
Prince George					2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	2,700	24,300
Quesnel					2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	18,000
Lakes					200	200	200	200	200	200	200	200	200	1,800
Total	**850**	**850**	**850**	**1,850**	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**	**8,050**	**76,850**

Source: Compiled by author, with data from the Ministry of Forests - Forest Analysis & Inventory Branch,

URL accessed July 15, 2005: <http://www.for.gov.B.C..ca/hts/aactsa.htm>

[38] The Annual Allowable Cut (AAC) is determined by the Province's Chief Forester. The calculations are complex and subject to public review and comment. The numbers presented are simplified and only include uplifts from 2001 onward for the purposes of this paper. For a detailed account of the setting of the AAC for each of the Province's Timber Supply Areas (TSAs) and Tree Farm Licences (TFLs), the reader is directed to the Ministry of Forest's Forest Analysis & Inventory Branch website, which is the source of the data shown above. URL accessed May 16, 2005: <http://www.for.gov.bc.ca/hts/aac.htm>

[39] Uplifts are for a five year term. It is assumed in this table that the uplifts shown in this table will be extended beyond five years.

1.4 Impact of Economic Losses

The mountain pine beetle epidemic will result in an increase in economic activity as harvest levels are increased to salvage the timber and then, as harvest levels are realigned to sustainable levels, economic activity can be expected to drop below the levels experienced prior to the epidemic. This will particularly impact local communities where the economy is dependent primarily on the forest industry. The economic impact will also have an effect on Provincial stumpage revenues as timber grades are reduced with salvage timber and then later, as harvest levels drop to sustainable levels.

1.4.1 Impact on Forestry Dependent Communities

The impact of the mountain pine beetle epidemic is likely to be most severe on the rural economies that are most dependent on the forest industry. The most pertinent study on this topic was focussed on the areas of the Nadina Forest District and the Prince George Timber Supply Area.[40] The analyses were done using general equilibrium economic impact modelling.

To assess the economic impact of the salvage harvesting and of the subsequent reduction in harvest, several scenarios were run in each of these areas. A baseline summary was provided for each area, indicating the harvest level and economic activity for the period preceding the epidemic. The expanded harvest modelled in Scenario 2 is not sustainable over the long term but it is necessary to salvage timber affected by the epidemic. The expansion of the harvest has the effect of liquidating the growing stock that future harvests depend upon. Scenario 3 represents the reduced harvest, relative to baseline, that will be necessary to re-establish a sustainable

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[40] Mike Patriquin et al., "Regional Economic Implications of the Mountain Pine Beetle Infestation in the Northern Interior Forest of Region of British Columbia," (Victoria: Natural Resources Canada and Ministry of Forests Mountain Pine Beetle Initiative, 2005).

harvest level. Table 3 summarizes the estimated values from the report for the harvest, the total net regional product and the total royalties and indirect taxes for each of the scenarios.

The results of the analyses indicate that an increase in the harvest level, as described by Scenario 2, will increase the net regional product by 42 percent for the Nadina Forest District and 32 percent for the Prince George Timber Supply Area. Royalties and indirect taxes are forecast to increase by 54 and 44 percent for each of the areas respectively.

The reduction in harvest that will be necessary as the salvage comes to an end is shown in Scenario 3. The reduction in harvest, relative to the baseline for the Nadina Forest District and Prince George TSA, will be 10.6 and 15.8 percent respectively. If the reduction is related to Scenario 2, instead of baseline, the drop is more precipitous. The drop in harvest between Scenario 2 and 3 is shown as the difference in column 2 of Table 3. Using the difference as a percentage of Scenario 2, the drop will be 58 percent in the Nadina Forest District and 47 percent in the Prince George TSA.

Table 3. Economic Impact Analysis Northern Interior B.C.

Scenario	Harvest Level (m3 x million)	Increase (Decrease) in Harvest Level from Baseline	Total Net Regional Product ($ x million)	Percent Change Net Regional Product from Baseline[41]	Total Royalties & Indirect Taxes ($ x Million)	Percent Change Royalties & Indirect Taxes from Baseline
Nadina Forest District						
Baseline	1.500	n/a	$403.6	n/a	$105.5	n/a
Scenario 2	3.162	110.8%	$574.8	42%	$162.2	54%
Scenario 3	1.341	-10.6%	$387.3	-4%	$100.1	-5%
Difference between Scenarios 2,3	-1.821	n/a	-$187.5	n/a	-$62.1	n/a
Prince George Timber Supply Area						
Baseline	9.360	n/a	$3,160.8	n/a	$733.8	n/a
Scenario 2	14.944	59.7%	$4,186.0	32%	$1,053.4	44%
Scenario 3	7.880	-15.8%	$2,889.1	-9%	$733.8	0%
Difference between Scenarios 2,3	-7.064	n/a	-$1,296.9	n/a	-$319.6	n/a

Adapted from: Patriquin, et al.[42]

The expansion and contraction of the harvest levels is likely to cause significant dislocation in the communities that are dependent on the forest industry. The scenarios in Table 3

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[41] Percent change for Difference Between Scenario 2 to 3 does not include baseline.

[42] Patriquin, pages 37 – 50.

indicate that the local economies are on a roller coaster ride, with short-term benefits accruing now, but with serious losses looming, once the salvage effort is complete. Many of the communities in these areas do not have factor advantages that could provide opportunities to diversify into other types of manufacturing or service industries. There appear to be two options. The first option is the status quo, where the harvest is focussed on the 'best first' with the goal of maximizing profits over the short term. This will require a significant and rapid curtailment in capacity afterwards. Alternately, a supply of logs could be preserved to help maintain mill production over a longer period and provide local economies greater time to adjust to the lower harvest rates.

1.4.2 Impact on Provincial Stumpage Revenues

This section will consider the impact the mountain pine beetle epidemic is likely to have at the Provincial level. The impact at this level is moderated because of the harvest of other species on the Coast and in the Interior.[43] Nonetheless, the volume of pine harvested in the Interior in 2003 represented over 25% of the total Provincial Annual Allowable Cut, which is currently set at 82 million m3.[44]

Table 1 indicates that in 2003 the amount of pine volume billed at the stumpage rate of $0.25 per m3 totalled 1 million m3, or approximately 5 percent of the total amount of pine harvested in the Province. The revenues from all pine harvested that year totalled $347 million.

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43 Some disruption has already occurred outside of the areas affected by mountain pine beetle. The increase of pine salvage from the Interior has created a surplus of 500,000 m3 of chips that has displaced chips made from pulp grade hemlock on the Coast. This has created a burden for industry on the Coast where timber cutting fees are collected whether or not the timber is utilized. For reference, the Interior Regions are separated from the Coastal Region by the Cascade Mountain Range.
Source: Alexis LaRose, "Chip Crisis," *Truck Logger,* Summer, 2005. Vol 28 No. 2, pages 23, 25.

44 Calculation: (16.7 million TFL AAC + 65.3 million TSA AAC = 82 million m3 Annual Allowable Cut). Recall from Table 1 that the pine harvest was 23 million m3 in 2003.

As the epidemic continues and as more pine trees die, the proportion of pine that is billed at the Grade 3 stumpage rate of $0.25 per m3 can be expected to increase. Assuming the pine harvest of 2005 is the same as in 2003,[45] then the regular pine harvest of 23 million m3, added to the pine uplift of 8 million,[46] would increase the total pine harvest to 31 million m3. If this volume reaches 50 percent Grade 3 with a stumpage rate of $0.25 per m3, then the total value of stumpage from pine would drop from $347 million to $236 million.[47] This would represent a loss to the Province of $111 million.[48] The Provincial revenues from pine are therefore sensitive to the impact of increased volumes of Grade 3 timber.

The Provincial harvest and stumpage levels that will prevail after the pine salvage is complete are uncertain. Research is currently focussing on the sensitivity of losses to various factors such as the end date of the epidemic, the shelf life of dead pine, the priority that different stands are given in harvest decisions and increases in harvest levels.[49] The outcome will undoubtedly include a lumber industry that will have excess capacity and a reduced timber supply. All things being equal, stumpage values are likely to increase in the period after the pine salvage is complete.

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[45] The actual pine volume being harvested in 2005 is likely greater than the volume harvested in 2003 because uplifts have already been implemented. The sensitivity of this assumption is briefly explored in the footnote below.

[46] See Table 2.

[47] In fact, the stumpage appraisal system in the Interior of the Province is much more complex than this. Adjustments applied by the appraisal system may cause appraised stumpage rates to increase in some instances, which on balance through the Interior, would have the effect of negating at least a part of the effect of the Grade 3 stumpage rate.

[48] If the total pine harvest volume reached 45.5 million m3 in this example, stumpage revenues would remain unchanged at $347 million. If the percentage of Grade 3 volume increased from 50 percent to 60 percent, then the loss in stumpage would increase by an additional $46 million from $111 million to $157 million.

[49] Eng, Year 2, 2.

1.5 Loss Mitigation Constraints

There are few opportunities to mitigate the impact of losses to mountain pine beetle. Lumber markets are known to be cyclical. The scale of the problem increases the complexity of potential solutions and the management structure in the public and private forest sector is adapted to manage the forests for sustainability and stability. The temporary value of the dead pine limits the time available to research options and select suitable courses of action. The Ministry of Forests and Range must also consider existing tenures, other resource values and the interests of First Nations peoples.

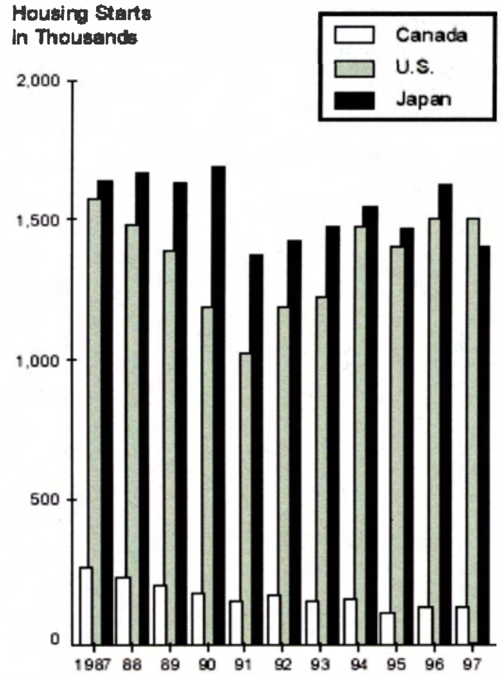
1.5.1 Cyclical Lumber Markets

Lumber mills are currently running at capacity levels, helped to a large extent by the strong housing market in the United States. Housing starts in June, 2005 were at a seasonally adjusted annual rate of 2.0 million, an increase of 9.7% from the rate in June, 2004.[50] These figures are up significantly over the decade that ended in 1997, when US housing starts cycled between 1.0 and 1.5 million annually. The housing starts for Canada, US and Japan for 1987 – 1997 are shown graphically in Figure 2. According to the Council of Forest Industries, "Housing construction represents one of the most important indicators of consumption of wood products."[51] The dependence of the lumber industry on such a cyclical industry means that changes in housing demand will impact the price and production levels of lumber.

[50] US Census Bureau, New Residential Construction, Online. 2005.

[51] Council of Forest Industries, "COFI 1998 Factbook," Online. 1998.

Figure 2. Housing Starts-Canada US & Japan: 1987-1997



Source: Used with permission from Council of Forest Industries.

Lumber prices have not declined significantly for the year ended June, 2005 despite the large supply of lumber that B.C. mills have been producing. The price of lumber in June, 2005 was $397 per mfbm, compared to $419 per mfbm one year earlier.[52,53] A drop in demand for lumber, if significant enough, could lead to curtailment in lumber production and this, in turn, would reduce the amount of mountain pine beetle affected timber that could be salvaged. While the current lumber market is not a constraint to mitigating the losses to mountain pine beetle at this time, it is likely to become a constraint before the pine salvage effort is complete. If this occurs, losses to degradation will increase, as the dead timber ages beyond its shelf life.

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[52] Random Lengths Woodwire, Random Lengths Publications, Inc. Online. 2005.

[53] Definition: One 'mfbm' represents 1,000 board feet and is the standard industry measure of lumber. One board foot is a volume of wood that is twelve inches by twelve inches by one inch thick.

1.5.2 Complexity

Catastrophic events are difficult to manage because there are few examples or protocols to work from. Policy makers and government must make the best decisions without the benefit of experience or the opportunity to acquire the necessary information. Apart from hiring competent and adaptable personnel, the opportunities to address such a large complex problem are limited. While adaptive management can often provide an iterative approach to better solutions, this requires time to complete the monitoring and response cycles.[54]

1.5.3 Structure

While time is a factor in all analyses, the rapid beetle expansion and subsequent degradation of timber means that options must be developed quickly. The culture of forest management in British Columbia has developed with a bureaucratic structure. This structure provides the benefits of stability for industry to raise investment for mills and for communities that rely on stable employment for their residents. The system that has evolved to provide long-term stability is the same system that must adapt quickly to a chaotic and complex environment with the beetle epidemic.

For example, harvest planning is typically done on a 5 year cycle and the Chief Forester models timber harvest scenarios for periods of 200 years to evaluate sustainability. The Interior stumpage appraisal system has been in place since 1989 and replacement with a market price system, such as is now used on the coast, remains stalled. The Revenue Branch of the Ministry of Forests and Range has a mandate to "...Assert the financial interest of the Crown in its forest and range resources in a systematic and equitable manner."[55] The current interpretation of this

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[54] Complexity Theory may offer an additional approach to evaluate alternative courses of action. For more information on this topic from the London School of Economics, see URL accessed July 12, 2005: <http://www.psych.lse.ac.uk/complexity/research.htm>

[55] "Our Mandate," Revenue Branch Overview, Ministry of Forests.

mandate may not be aligned with the need to promptly salvage mountain pine beetle infested timber. In the interest of ensuring that the Province receives best value from the resource, B.C. Timber Sales[56] has maintained high reserve bids for auctions of infested pine and this has resulted in situations where no auctions have been offered but no bids have been received. Re-offering of the auctions at lower reserved bids is normally done but seasonal restrictions often result in harvest delays of 1 to 2 years, resulting in lost opportunity to control the mountain pine beetle and further degradation of the timber. This is provided as an example of how two parts of the structure may not be aligned to provide optimum results in controlling the spread of the mountain pine beetle. On the other had, it also indicates the opportunity that can be realized by better communication and alignment of goals within a government agency. Timber pricing will be discussed in greater detail in Section 2.3.2.

The Ministry of Forests and Range has the power to assign an area the status of an Emergency Bark Beetle Management Area to streamline administration but this amounts to a deferral of the administrative workload to a later date.[57] Some industry foresters have avoided the use of this option because some of the licence obligations are not finalized in advance of the harvesting, and this could create a potentially unacceptable liability afterwards.[58]

1.5.4 Other Resource Interests

There are resources other than timber harvesting that the Ministry of Forests and Range must manage. To harvest the dead pine economically, the preferred silviculture system is by clearcut. Other resource objectives such as habitat for cavity nesting animals may preclude the

[56] B.C. Timber Sales (B.C.T.S) is an agency of the Ministry of Forests with the mandate of selling Crown timber. This agency is discussed in more detail in Section 2.3.2.

[57] Forest Planning and Practices Regulation, B.C. Reg. 14/2004 Section 109: Bark Beetle Management Powers.

[58] Personal communication, industry source.

use of the clearcut silviculture system. The appropriate balance between salvage and maintaining trees for other resource objectives is the subject of ongoing research and beyond the scope of this paper. It is important to note that the area that is available for salvage ultimately depends on planning processes such as Land and Resource Management Planning and by the mandates of the Ministry of Environment and the Ministry of Agriculture and Lands. The government must also conduct meaningful consultations with First Nations to ensure that aboriginal rights are respected.

1.6 Summary

The mountain pine beetle epidemic is a very significant event that will affect many aspects of the economy and landscape of British Columbia over a long period. The following sections will review in more detail the implications of the epidemic and a potential strategy to address them.

2 MOUNTAIN PINE BEETLE EPIDEMIC

2.1 Background on the Epidemic

Mountain pine beetle exists at endemic levels throughout forests that contain the various species of pine. Under normal, non-epidemic conditions, the population growth is curbed by the availability of food sources and beetle mortality due to predation, climate and protective responses by trees that are attacked. At endemic levels, control strategies include single tree treatment of infested trees, bait trees which are used to trap and kill the beetles and harvest of single trees, patches or larger areas. The use of spray insecticides is not feasible because beetles are protected by the bark of the trees and because the emergence of beetles occurs over a period of time, making it difficult to schedule a treatment when they would be vulnerable to the spray.

Predators include woodpeckers that listen for the sound of beetles chewing under the bark of trees, and wasps that can lay eggs on the mature beetles while they are searching for a suitable tree to bore into. The beetle larvae are protected during their hibernation under the bark during the winter season. The larvae undergo metabolic changes that provide some protection against freezing. During this period, the larvae cannot tolerate temperatures below -20 C. However, for the mass of the tree to reach this low temperature, exterior temperatures must remain below this level for one to two weeks (weather conditions that have not prevailed in most of the Interior for the past decade). Under low levels of beetle attack, pine trees will respond with increased pitch production and this can suffocate or expel the beetle from the tree.

The key factors that have led to the current epidemic include large tracts of suitable host trees and a succession of mild winters over the past decade. The presence of large tracts of mature pine can be attributed to the control of forest fires and the doctrine of even flow harvest levels, which allowed stands of pine to reach ages that are generally beyond the age that they would reach normally.[59] The populations of mountain pine beetle have traditionally followed an 8 to 10 year cycle. During the current epidemic, conditions approached a 'perfect storm.' On the upward swing of the population cycle, the beetles encountered ideal pine stands and unseasonably mild winters. The early populations originally escalated within Tweedsmuir Park, which contains large areas of mature pine and is managed with wilderness maintenance objectives. The result has been conditions that have been very suitable for rapid expansion and this has presented difficulties in conventional control techniques. Previous epidemics such as occurred in the Okanagan Valley in the 1980s appeared to slow when the beetles encountered stands containing small diameter pine trees. It was believed that this occurred because the layer between the bark and the wood in the small trees was too narrow to enable the continued viability of the subsequent larvae.

Recent evidence suggests that beetles in the current epidemic may have overcome this limitation as smaller trees as young as 30 years of age are providing successful broods of mountain pine beetle. This has led to speculation that the beetle epidemic could spread eastward out of its normal range to attack vast areas of small diameter pine found in the boreal forests from the prairies through to eastern Canada.

2.2 Forest Management Issues

The mortality of pine due to the epidemic presents several issues for forest managers. The loss of mature growing stock will affect future harvest levels, habitat for fish and wildlife, water quality and quantity and recreational use. In the absence of harvest or treatment, the stand mortality will represent a fire hazard and reforestation costs will be increased because planting cannot be safely done in the vicinity of dead standing trees.

[59] This trend is not limited to pine. There are increasing populations of spruce and Douglas fir bark beetle in some regions of the Province for the same reasons.

2.2.1 Fire Hazard

The risk of fire in a recently killed stands is increased by the presence of fine fuels in the form of the red foliage that remains after the trees die. After several years this foliage falls to the ground and the hazard is reduced. Over a longer period, the dead standing trees fall down due to wind and snow and this creates a fuel loading of larger fuels. This creates connectivity between the logs and branches and trees that remain standing. This increase in fuel loading and the presence of these 'ladder fuels' results in a significantly greater fire hazard over the medium term. It is this type of fuel source, created by successive infestations of mountain pine beetle, that created the conditions that led to the Okanagan Mountain Park Fire in 2003.

Once a fire starts, suppression expenditures will depend on the risk to human safety, dwellings and commercial value of the timber. During periods of extreme drought and where fire threatens the above values, suppression costs can be very significant. The fire fighting costs incurred by the Government of B.C. were $375 million in 2003,[60] an amount which is $320 million over the figure normally budgeted.

Apart from the suppression costs, fire causes economic losses to timber and in some cases, directly to residents by the loss of their homes. During 2003, 334 homes were lost and 260,000 hectares of forest were burned in the Province of B.C. The fire season of 2003 followed the driest three year period of climate on record[61] and the possibility exists that a similar drying trend could re-occur. A report prepared subsequent to the 2003 fire season noted that:

> ...The Okanagan Mountain Park Fire clearly demonstrated that underestimating the impact of wildfire in resource management decisions, can have devastating impacts on British Columbia's society and environment.[62]

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[60] Gary Filmon, "2003 Firestorm Report," (Victoria: Ministry of Forests, 2004), 57.

[61] Ibid, 17.

[62] Ibid, 28.

If a catastrophic fire, such as the type that burned near Kelowna in 2003, developed in an area of heavy dead pine fuels, it could threaten northern communities, fish and wildlife habitat and result in unsalvageable losses of dead pine and healthy timber of other species.

The fire hazard of the dead pine is therefore a significant forest management issue. Treatments such as harvesting are beneficial because they reduce the potential cost of fire suppression and the potential magnitude of loss by reducing fuel loading in the forests.

2.2.2 Habitat

The impact of mountain pine beetle infestations on habitat is complex. Generally, the impact is species specific. For example, ungulates lose winter cover and the ability to move through stands with heavy fuel loading. On the other hand, smaller animals benefit from the increased cover and protection from mammalian and avian predators.

A recent report summarized the pine beetle impact this way:

> The beetle itself will potentially benefit about 65 percent of the resident, terrestrial vertebrate fauna in the short term. Conversely, the kill and associated salvage operations are anticipated to have negative effects on at least 35 percent of the species present.[63]

The report suggests specific actions at the stand and landscape level to mitigate negative impacts. To reduce impact on freshwater fish, the report specifically recommends that log storage within lakes should be avoided. The rationale for this is important to the topic of this paper and it is therefore restated verbatim:

> Large-scale salvage logging will increase the cut over in a short period of time, possibly increasing the need for log storage areas. The formerly common practice of storing logs in lakes should be avoided. When such storage areas are used they usually are located in shallow and sheltered waters. It is these very

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[63] Fred L. Bunnell, Kelly A. Squires, Isabelle Houde, "Evaluating Effects of Large-Scale Salvage - Logging for Mountain Pine Beetle on Terrestrial and Aquatic Vertebrates," *Mountain Pine Beetle Initiative Working Paper 2004-2,* (Victoria: Natural Resources Canada, 2004), 12.

> areas that often offer the highest quality foraging and nesting habitat, with abundant aquatic vegetation and food sources. That practice should be avoided.[64]

The above recommendation can be interpreted to apply to all log storage in lakes, although the rationale for the recommendation is that log storage in shallow and sheltered waters is of most concern. This raises two issues. Firstly, there are likely log storage areas available in lakes where foraging and nesting habitat are of lesser quality and therefore, the recommendation should not be applicable in those instances. Secondly, a high quality log storage area in a lake may offer strategic value to the Province to reduce economic losses and it is the role of government to optimize the tradeoffs between economics and social values. Therefore, in spite of the existence of high quality foraging and nesting habitat along a lakeshore, the government could decide that the value of a lake for log storage is of greater value to the Province than habitat.

For the purpose of this paper, the assumption will be made that the pine killed within the working forest will be available for harvest and the wildlife requirements will be managed at the landscape level according to the respective Land and Resource Management Plans. It is expected that riparian zone protection, to the degree that it is possible following mortality of pine, will be maintained throughout the working forest where salvage activities occur.

2.2.3 Water Quality and Quantity

For the purpose of this paper, it will be assumed that the quality and quantity of water that flows from land where pine is killed will not be significantly different whether the timber is salvaged or not. It is expected that where harvesting occurs, it will not introduce significant levels of debris or sediment into streams and lakes.

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[64] Ibid, 30.

2.2.4 Reforestation

Reforestation is ensured by a contractual obligation that is assigned to the forest company by the Ministry of Forests and Range and Worker's Compensation Board regulations preclude workers from planting near dead standing timber for safety reasons, which means that the dead material must either be cleared, often at significant cost, or left for natural regeneration to occur. Natural regeneration will occur but at a slower rate and with the risk of stocking levels that are too low or too high for optimum timber production. The cost of significant regeneration delays will represent an opportunity cost for the government of B.C. because restocking will be delayed and it will likely not be established to optimum densities for timber production.

2.3 Provincial Management Strategy

Based on the figures estimated in Section 1.3.2, 960 million m3 of pine is expected to be killed and one third or 329 million m3 are expected to be salvaged. This leaves 631 million m3 that may not be utilized and much of this area will not be reforested. The government has utilized two strategies to encourage salvage of the pine: uplifts in annual allowable cut and the provision of favourable timber pricing for salvage.

2.3.1 Uplifts in Harvest Levels

Uplifts in harvest levels provide an opportunity for existing manufacturing to expand and new manufacturers to enter the business. Timber that would otherwise be degraded can be merchandized while it has the most value. Fortunately, the uplifts have occurred during a period when the demand cycle for building materials in North America has facilitated this increase in production without significantly affecting the price for lumber. As noted in Section 1.5.1, a declining market could constrain the effectiveness of uplifts. The likelihood of more uplifts is high and as an example, an uplift for the Okanagan TSA is currently being considered.

The increase in mechanization in milling processes has reduced the number of workers required to process the timber. Most sawmills are in communities where this mechanization trend has resulted in a readily available labour pool. The current increase in manufacturing will draw labour from this pool. When harvest rates are rebalanced and milling capacity is decreased, the increased labour efficiency will translate into a more moderate impact on employment.

Increasing the harvest level can be achieved relatively easily over the short term. Pine stands are often in accessible terrain that can be developed for harvesting in a short period of time although the capacity of main haul roads to handle large numbers of logging trucks was identified as a potential limitation over the short term.[65] Also, there could be a short period of labour shortage for surveyors that can prepare roads and harvesting areas in the forest. The timber is typically of uniform size, which provides the opportunity to mechanize harvesting operations. Both logging and hauling equipment are available and mobile. In summary, the harvesting capacity is not considered to be a constraint to the increased salvage of pine.

2.3.2 Timber Pricing for Salvage

Most of the timber salvage is harvested under tenures held by forest companies. The price of this timber is appraised by the Ministry of Forests and Range. The appraised price of Sawlog Grade timber in the Northern and Interior Regions is based on a complex formula, which is beyond the scope of this paper. For reference, the average appraised price of timber in the Northern Interior for the three month period ending December 31, 2003 was $14.52 per m3.[66] This rate includes adjustments for the proportion of Grade 3 (dead and dry) timber that was included in the calculations for that period.

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[65] Rogers, 43.

[66] Ministry of Forests and Range, Revenue Branch. URL accessed July 15, 2005: <http://www.for.gov.bc.ca/hva/timberp/stumpagebillings/4thquarter2003.pdf>

The government also sells timber through the BC Timber Sales program. One of the goals of the B.C.T.S is to "create a credible reference point for costs and pricing of timber harvested from public land in B.C."[67] The timber auctioned through this system is offered to the market with an upset (or reserve) price that is 70 percent of a market average value as calculated by B.C.T.S. In a period of surplus timber, due to the harvest uplifts for salvage, this has resulted in timber sales that have been offered for sale but have received no bids from buyers.

In fact, B.C.T.S has reported:

> Over supply in some areas of the Province [e.g. beetle epidemic areas] resulted in higher than projected no bid sales [e.g. number of bidders = zero], adversely impacting success in attracting customers, as measured by the average number of bidders per sale.[68]

This has the effect of slowing the rate at which the salvage timber is harvested and utilized. The 2004-05 Service Plan Report indicates that the total volume of sales that were offered for sale without bids being submitted were 1.55 million m3.[69] This represents 13 percent of the volume of timber that was offered for sale for that year.[70] The report states: "Two business areas – Babine and Cariboo-Chilcotin represented 39 percent of the total no-bid sales for the year."[71] Both of these business areas have been heavily impacted by mountain pine beetle. If the no-bid sales contained infested pine, then the failure to harvest the stands prior to the beetle's flight

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[67] "2004 – 2005 Service Plan Report," BC Timber Sales, Ministry of Forests, 3.

[68] Ibid, 4.

[69] Ibid, 20.

[70] Ibid, 4. 11.8 million m3 were offered for sale. Calculation: (1.55 million m3 with no bids is 13.1 percent of 11.8 million m3 offered for sale).

[71] The B.C.T.S volume that was unsuccessfully offered for sale in 2003 – 2004 was 2.1 million m3.
Source: Ministry of Forests and Range, B.C. Timber Sales. "2004 – 2005 Service Plan Report," 48.
Percent of sales refused: 19% of total sales advertised.
The total volume of sales advertised: 11.2 million m3.
Calculation: (11.2 million m3 x 19% sales refused = 2.1 million m3 refused).

represents a conflict between the goals of achieving maximum value by auction and the forest health goal of controlling the beetle epidemic.

2.4 Summary

The mountain pine beetle epidemic is presenting difficult problems for forest managers. The Provincial management strategy being used is an expanded version of what has been utilized during past epidemics. There is a need to offer alternate approaches that can accelerate the harvest and reduce the volume of timber lost to degradation. The next section will focus on a discussion of timber storage as a possible strategy to achieve this.

3 METHODS OF TIMBER STORAGE

The purpose of this section is to describe the various methods of storing timber that has been affected by catastrophic loss. Tree mortality is followed by the inevitable onset of decomposition and reduction in value for manufacturing. The optimum method of timber storage will require a minimum of input costs, result in the least amount of degradation for manufacturing, cause the least risk to the environment, and maximize the productive capability of the forest land.

3.1.1 On The Stump

Pine mortality, if not harvested, will remain available for manufacturing until natural processes degrade it to levels where salvage is no longer economically viable. The lack of accurate information on this topic has led to the initiation of several studies by the Canadian Forest Service - Mountain Pine Beetle Initiative.[72]

Storage of dead pine on the stump has the obvious benefit of requiring no input costs other than fire protection. The cost of fire suppression will be difficult to quantify, as it will depend on the level of fire hazard, based on fuel types and climate patterns, and the potential for ignition, which is often a function of lightening strikes.

It is possible that the retention of merchantable value of dead pine in the Chilcotin area as described in Section 1.2 is due to local climate conditions. The low levels of annual precipitation and wide annual temperature variations may result in less degradation than other parts of the

[72] Mountain Pine Beetle Initiative, Research and Development website, Natural Resources Canada. URL accessed June 23, 2005 <http://mpb.cfs.nrcan.gc.ca/research/index_e.html>

Province where heavy snowfall causes breakage and moist temperate conditions favour increased insect and decay mechanisms. The other aspect of the Chilcotin climate is a lower rate of growth (due to site productivity) and this reduces the opportunity cost of delaying the reestablishment of a thrifty, young forest. Research currently underway is expected to provide guidance on the rate of deterioration in merchantable values.[73]

The advantage of storage on the stump is that it appears to be the most environmentally benign option to store timber for future salvage. It is the option that would require no action or investment, with the possible exception of fire protection. From some viewpoints it would be a preferable option because it would 'leave nature to take care of itself.' In the event lumber markets do not enable the salvage of the pine mortality at profitable rates, then the timber would be left standing for whatever environmental values it can provide. The disadvantage with delayed or entirely deferred harvest is that the restocking for a new stand of timber is either delayed or significantly impaired, resulting in an increase in opportunity cost for the Province. From the ecological perspective, a delay in restocking would slow the ecosystem process of succession from the disturbed state to a fully restocked state. As individual fisheries and wildlife are adapted to various stages along this succession process, the delay could be a value if it preserves conditions for a preferred habitat, or it could be considered a cost if the restoration of a preferred habitat is delayed.

3.1.2 Wet Storage of Logs

Wet storage refers to the sprinkling of log decks with fresh or re-circulated water for the purpose of maintaining the merchantable value of the timber. This practice has been utilized in British Columbia to reduce insect attack and reduce degradation in log inventories normally held

[73] For the scope of current research that is being initiated by the Mountain Pine Beetle Initiative of the Natural Resources Canada and Ministry of Forests and Range: URL accessed July 11, 2005: <http://mpb.cfs.nrcan.gc.ca/research/projects/8-10_e.html>

in mill yards. Wet storage can also inhibit the emergence of beetles from freshly cut logs and prevent their spread to other logs in the inventory.[74]

Wet storage has also been used to preserve logs for longer periods when mortality has occurred at catastrophic levels. Considerable research has been completed on this topic in Europe, where periodic hurricanes have resulted in large-scale windthrow of forests. To do this, sprinklers are used to maintain a wet surface on the logs. This practice was the subject of a comprehensive study in Great Britain, following a windstorm in 1987.[75]

An example of a log deck in Denmark being wet-stored in 2001, following a December 3, 1999 hurricane is shown in Figure 3. The water sprinkling system used a fine spray to maintain wet conditions with a minimum amount of water. Moss is visible at the end of some of the logs.

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[74] Personal communication, Paul MacNamara, July 25, 2005.

[75] Joan Webber and John Gibbs, "Water Storage of Timber: Experience in Britain," *The Forestry Commission Bulletin 117*, (Farnham, United Kingdom, Forestry Commission, 1996), Booklet 48 pp.

Figure 3. Wet Storage of Timber in Denmark, 2001

Source: Photo taken by author at Rold Skov sawmill, Denmark on September 26, 2001.

Researchers in South Carolina found that continuous sprinkling of pine logs for two years was effective in preventing significant degradation.[76] They found that the key determinant appeared to be moisture contents of 104 percent in the outer sapwood and 120 percent in the inner sapwood. The level of sprinkling required for the best protection was found to be 10 centimetres each 24 hour period, although higher stacks of logs would likely require more volumes of water than low stacks. Research in Sweden indicated that sprinkling of 4.5 meter high piles of logs with 60 centimetres of water each 24 hour period has become a standard of practice.[77] The study indicated that the volumes of water could be adjusted, depending on the amount of water lost to evaporation, to better manage the level of run-off, and the amount of water treatment that would

[76] John H, Syme, Joseph R, Saucier, "Effects of Long-Term Storage of Southern Pine Sawlogs Under Water Sprinklers," *Forest Products Journal*, Jan 1995. Vol 45, Iss. 1:p. 49.

[77] Torbjorn Elowsson and Kari Liukko, "How to achieve effective wet storage of pine logs (Pinus sylvestris) with a minimum amount of water," *Forest Products Journal*, Nov/Dec 1995, Vol 45, Iss. 11/12, 40.

be necessary. The study also confirmed the importance of placing logs under sprinkling as quickly as possible after felling, to prevent drying and development of blue stain fungi.

Why wet storage protects logs is not fully understood, although research has investigated some aspects of the phenomenon. It is possible that wet storage can slow the development of blue stain. Wet storage of Scots and Corsican pine for 12 months was found to result in significant (95 percent) depletion of soluble nutrients.[78] That report indicated that wetting also enables the establishment of bacteria that may have an antagonistic effect on the growth of sapstain fungi such as blue stain. Webber and Gibbs reported that there was no increase in pre-existing blue stain fungus in Corsican and Scots pine during three years of wet storage.[79]

Wet storage has been found to be an operationally viable method of maintaining timber quality. Webber and Gibbs found that pine stored with sprinklers exhibited very little defect when stored for three years. [80] According to the mill manager, the Danish timber shown in Figure 3 was successfully milled after five years of storage. The primary defect was discolouration of the outer 2 centimetres of the logs.[81]

Wet storage requires a number of input costs to be incurred. The timber must be harvested, hauled and stockpiled. A sprinkling system must be established and maintained. The water must be managed to reduce environmental impacts. The quality of the timber will degrade during wet storage, although at a lesser rate than if it were stored 'on the stump.' Finally, unless

[78] M.A Powell, J.F. Webber and R.A. Eaton, "Changes in Moisture, Soluble Carbohydrate, and Bacterial Numbers During Water Storage of Pine," *Forest Products Journal*: March 2000, Vol 50, Iss. 3, 79.

[79] Webber and Gibbs, 24.

[80] Ibid, 10.

[81] Email correspondence with Sawmill Director Henrik Thorlacius-Ussing, Lindenborg Gods a/s, Arden, Denmark, March 8, 2005.

storage is at the mill-yard, the timber must be reloaded and hauled and the extra weight of the water soaked logs adds additional transportation costs.

Environmental issues with wet storage of salvage timber are related to the control of the run-off during precipitation events, whether or not the water sprinkling is using fresh or recirculated water. The water will contain organic material and leachate[82] from the logs, which was found by Webber and Gibbs to increase biological oxygen demand in the water and represent a potential toxicity, depending on concentration and duration of loading.[83] Research on log yard runoff in Alberta indicates that the runoff can be highly variable in terms of chemical characteristics and toxicity.[84] This would indicate that a conservative approach would be appropriate in designing management practices. There may be opportunities to mitigate the impact on run-off water. One researcher has found that it may be possible to treat run-off water by using it for irrigation of alder and willows.[85]

Wet storage offers an opportunity to store surplus salvage timber so that it can be processed into forest products at a later date. Existing research indicates viable methods of managing the water that is used for sprinkling and provides guidance on the level of preservation that can be expected. The study by Webber and Gibbs was based on the storage of 70,000 m3 of timber.[86] Although the salvage effort in B.C. is much larger than this, wet storage would appear to be a feasible method of preserving the quality timber in areas threatened by beetle.

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[82] Definition of leachate: "Water that collects contaminants as it trickles through wastes, pesticides or fertilizers. Leaching may occur in farming areas, feedlots, and landfills, and may result in hazardous substances entering surface water, ground water, or soil." United States Environmental Protection Agency. Online. 2005.

[83] Webber and Gibbs, 14.

[84] S. MacDougall, "Assessment of Log Yard Runoff in Alberta - Preliminary Evaluation," (Edmonton: Environment Service, Government of Alberta, 1996), 7.

[85] Maria Jonsson, "Wet Storage of Roundwood: Effects on Wood Properties and Treatment of Run-Off Water," (PhD thesis, Sveriges Lantbruksuniversitet (Sweden), 2004), 29.

[86] Webber and Gibbs, ix.

3.1.3 Water Storage of Logs

Water storage refers to the storage of logs in bodies of water, which can include ocean, lakes or ponds. Marine storage of logs can impact estuaries and inter-tidal zones with leachates and sloughing bark and it has therefore been the topic of considerable research since the 1950s. A comprehensive study by the U.S.D.A provides a good historical account of the use of water to transport and store logs in freshwater and marine environments for forest products manufacturing.[87] Given the difficulties in transporting a raw material as heavy as wood, and given the natural buoyancy of logs, it was logical that the first log transportation systems utilized water. While the last river drive in British Columbia took place on the Quesnel River in 1979, lake transportation and storage has continued to be used on lakes and reservoirs throughout B.C. including the Adams, Arrow, Babine, Kinbasket, Kootenay, Okanagan, Ootsa, Quesnel, Revelstoke, Shuswap, Slocan, and Williston lakes, among others.

The operational advantages of lake storage include reduced maintenance of sawblades because the logs are not exposed to the dirt of the log yard and because moist wood is more easily sawn.[88] Other advantages include ease of transportation and sorting and the preservation of the log's structural qualities until manufacturing. A primary disadvantage is the additional weight of the water-soaked logs if they must be dewatered and trucked to a manufacturing facility. Water storage of logs also represents a significant business risk. The operation of equipment in the vicinity of water increases the potential for an accidental fuel or oil spill, which can affect fish and wildlife habitat and lead to penalties. Storm events can cause breakage of booms and loss of valuable log inventory. Drifting bundles can lead to property damage to structures such as watercraft, bridges and wharves.

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[87] James R. Sedell and Wayne S. Duval, "Influence of Forest and Rangeland Management on Anadromous Fish Habitat in Western North America – Water Transportation and Storage of Logs," *General Technical Report PNW – 186, August, 1985,* (Portland: United States Department of Agriculture, Forest Service, 1985).

[88] Webber and Gibbs, 9.

Log storage in lakes typically involves the assembly of bundles, which are created when logs are first trucked from the bush. The bundling reduces the amount of bark that is lost when the bundle is lowered into the water.[89] Bundles also reduce the number of logs lost to sinkage by sharing buoyancy between the logs.[90] The logs are usually weigh-scaled just before unloading. The weight of the bundle is used to calculate the volume of wood for stumpage billing and contractor payments. The bundle is lifted from the truck and is then lowered, usually on skids, into the water. The bundles are then sorted by tug-boats into the appropriate location for storage until required for manufacturing. A few of the logs on the tops of the bundles remain above the water. It is likely that some degradation occurs to the logs that are exposed to the air, although information on this is not readily available. Exposure is likely to be reduced as the moisture content of the logs increases and buoyancy is reduced.

Companies such as Adams Lake Lumber, a Division of International Forest Products Ltd. and Federated Cooperatives Ltd. have salvaged 'sinker' logs from booming grounds on Adams and Shuswap Lakes over the past twenty years. There are anecdotal reports that some of the salvaged logs bear timber markings that indicate the logs have been under water for forty years. Apparently these logs have been manufactured into lumber with good results.

Most of the research on the environmental impact of log storage has been focussed on the storage of logs in the marine environment. Log storage operations in marine environments are usually located in estuaries where freshwater from the mouths of streams and rivers can reduce the impact of marine wood borers. Estuaries are proximal to inter-tidal zones with rich marine species diversity and are particularly sensitive to the effects of leachates and bark sloughing. The U.S.D.A report listed major chemical impacts of log storage such as "increased biochemical

[89] Sedell and Duval, 17.

[90] Ibid, 13.

oxygen demand (BOD), hydrogen sulphide and ammonia production during the decomposition of bark and woody debris, and the release of soluble organic compounds (leachates)."[91] It also noted that biochemical oxygen demand is likely to be insignificant in the vicinity of log storage where there are currents of 0.01 meters per second or more.[92] In addition, the leaching process appears to be less rapid in fresh water than in salt water.[93]

Log storage in lakes where the practice has been in use for 80 years continues to be permitted and there are instances where capacity is being increased. Water storage of logs is a system that can be readily implemented and increased in scale of operation. Due to the increased weight of water soaked logs, the main disadvantage is the increased cost of dewatering and hauling. Therefore, the development and expansion for log storage favours locations where manufacturing facilities are already located adjacent to the lake.

The balance of this paper will focus on the water storage of logs as a potential strategy because it is already in use on many of the lakes and reservoirs in the Province and would represent the lowest cost option, other than storage on the stump.

3.1.4 Impact of Wet and Water Storage on Quality of Timber and Manufacturing

A number of reports indicate that wet and water storage of logs leads to increases in porosity of the lumber.[94] The review also identified discolouration and a slight decrease in the

[91] Sedell and Duval, 21.

[92] Ibid.

[93] Sedell and Duval, 23.

[94] Tony Byrne, "Water Storage of Logs with Implications for Preventing Deterioration of Mountain Pine Beetle-Killed Trees - Project No. 2001 - 1161," (Vancouver; Forintek Canada Corp., 2001), 4.

strength of lumber made from the sapwood. Webber and Gibbs concluded that the value of the wet stored wood was affected by five factors:[95]

1. Increased weight, as it affected the hauling costs to mill sites,
2. Reduced bark yield, because bark sales provides supplementary revenues in the UK,
3. Reduced quality of wood chips, due to discolouration,
4. Increased preservative uptake, due to increased porosity and
5. Increased ease of sawing.

Much of the research indicates that wet and water storage of logs is a viable means of retaining merchantable value. The research also indicates that best results are obtained when the logs are stored as soon as possible after felling. The current pine beetle epidemic began over five years ago and current harvest activities are focussed on the most recent areas of attack that contain the best timber values. This means that much of the timber that has already been attacked, and is surplus to current milling capacity, is either already degraded or it soon will be. Large volumes of sawlog grade timber remain at risk and water storage of logs offers an opportunity to maintain log quality for manufacturing.

[95] Webber and Gibbs, 45.

4 FEASIBILITY

The use of lakes to store logs provides an opportunity to salvage timber that might otherwise be degraded beyond the value required for manufacturing. For lake storage to be a viable option it must be feasible in operational and economic terms. It must also be acceptable to regulators. The latter issue is addressed in detail in Sections 5 and 6.

4.1 Operational Feasibility

The harvest and storage of salvage timber depends on the implementation of efficient systems of harvesting, transportation and log handling. Some operations may be better configured to adapt quickly to a system of log storage.

Timber is heavy and can be extremely heterogeneous. As a result, large, often expensive, equipment is required to harvest and transport it to a manufacturing facility. When the wood is very dry and near the end of its merchantable value, it has low weight, high bulk so that conventional trucks cannot be used to their optimum weight capacity. Conversely, after water or wet storage the logs are heavy and more expensive to transport. This is because weight restrictions, which are in place to protect the roads, reduce the volume that can be hauled on each truck load.

The factors that determine the operational feasibility of lake storage of logs are already well established. The factors are observable in the operations of forest companies that utilize this method of inventory. The characteristics of a successful lake storage system would include: the location of dumps and storage areas, the proximity of the manufacturing facility to the log storage area and the presence of water currents in the vicinity of the dump and storage area.

The build up of an inventory of logs for long term storage is unlikely to be done in one year. A more gradual approach to build up a 7 year inventory would involve the additional harvest and storage of one seventh of the intended inventory annually, and at year 7, the timber stored the first year would be utilized. A similar approach could be used for a 3 or 4 year inventory. The volume of wood removed from the long-term storage inventory could be adjusted to market demand.

4.1.1 Dump Site Location

The location where bundles are lowered into the water should be both deep and large enough to permit a boom boat to move the freshly dumped bundles out of the way of the next load and push them into the appropriate log grade and species 'sorts.' The dump-site will require stable terrain to permit the erection of an engineered structure to lift the bundles off the logging truck. Fluctuation of water levels is an additional limitation to the location of dump-sites on reservoirs. Finally, the site should be optimally located to a large supply of timber that is accessible with a safe and efficient road system.

4.1.2 Log Boom Storage Location

Log bundles will be collected into booms and stored until required. Booming locations are typically in remote areas, and often accessible only by water. Depending on the size and orientation of the lake, wind may threaten the integrity of the booms and therefore, the use of bays and areas that are in the lee of prevailing winds are preferred locations for boom storage.

Fluctuating water levels is a limitation to the location of booming sites on reservoirs. A consideration on lakes and reservoirs is the impact of winter conditions on the availability of the water-stored logs. On most of the large lakes in the Southern Interior where water storage of logs occurs, the incidence of freeze-up has not been common over the past two decades. If the formation of ice is likely to occur, it is often possible to maintain access by frequent passages with tug and boom boats. This may not be the case on northern lakes and it may be necessary to maintain sufficient dewatered inventory through the period of freeze-up as required.

4.1.3 Proximity of Mill to Water Storage

Timber can be dewatered from lakes and hauled to manufacturing facilities. As the cost of dewatering and hauling is significant, the preferred option is to store logs on a lake where the logs can be transported by water to the manufacturing facility. The cost of water transportation is small compared to hauling so the storage area need not be immediately adjacent to the manufacturing facility.

4.1.4 Water Currents

The research of wet storage indicates that leaching from the logs occurs. It is appropriate therefore to seek out lake storage locations where there is some element of current to provide a dilution effect and minimize risks of toxicity. Larger lakes typically have a number of large rivers that move water into and out of the main body of water. Depending on the shape and hydrology of the watersheds, currents may be present that can mitigate the impact of leachate from the logs. If not, then the feasibility for log storage may be limited by environmental concerns.

4.2 Economic Feasibility of Storage

The economic feasibility of the water storage of logs depends upon the answer to a fairly simple question. Is it profitable to make investments today in the storage of timber in order to increase the supply of merchantable timber in the future? However, answering this question involves a myriad of estimates and assumptions. Estimating the costs of the investment is tractable, because these costs largely involve expenditures for harvesting and placing the wood into storage. Estimating the future value of the stored timber is much less straightforward.

The financial aspects of log storage were evaluated in 2001 on behalf of the Ministry of Forests.[96] The results of the analysis at that time led to the conclusion that water storage of logs may allow for positive operating earnings although not for an adequate return on capital employed. Several factors have changed since the report was completed. Improved milling technology has led to an increase in the average lumber recovery factor,[97,98] the price of lumber has increased from US$295[99] to US$397,[100] and the cost to convert logs to lumber has dropped from $150[101] per mfbm to $110 per mfbm.[102] Canfor's new 'super' mill at Houston, B.C. is expected to achieve a $73 per m3 conversion once it is fully operational.[103] These positive factors have been countered by an appreciation in the value of the Canadian dollar against the U.S. dollar. B.C. lumber is priced in U.S. dollars when sold into the U.S. Therefore, an appreciation of the Canadian dollar vis a vis the U.S. dollar, yields lower revenues in Canadian currency.

Table 4 describes the estimated logging costs used in the analysis shown in Table 7 through Table 9. Data from the Interior appraisal manual have been added where it is available. It should be noted that sawmills that are located on lakes where booming already takes place

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[96] Rogers, 38.

[97] The Lumber Recovery Factor (LRF) represents the ratio of the volume of merchantable lumber that can be derived from a cubic meter of wood. The ratio is expressed in terms of 1,000 board feet (mfbm) of lumber produced per m3 of logs used. For example, an LRF of 0.263 would represent 263 board feet of lumber per m3 of timber consumed. The LRF is dependent on log quality and milling technology.

[98] John Allan reports that the average LRF is now 0.283, up from the 0.263 that was used in 2001 by Rogers, 40:
John Allan, "The Forest Industry in BC – Putting it in Context," *Presentation to Prince George Community Meeting*, (Prince George: Council of Forest Industries, 2004), 13.

[99] Rogers, 40.

[100] Random Lengths Woodwire, Random Lengths Publications, Inc. Online. 2005.

[101] Rogers, 40.

[102] Canadian Forest Products reported its average conversion in Quarter 1 of 2004 as $110 per mfbm. Also, the target conversion cost for Canfor's Houston sawmill is $73 per mfbm. Source: "Canfor Corporation Announces First Quarter Results," *Globe and Mail,* April 29, 2003. Q1 Data are also available from URL accessed July 19, 2005: < http://www.canfor.com/_resources/investors/ir1q04.pdf>

[103] Ibid.

would have an advantage because they would not need to incur the cost of dewatering, reloading and hauling to mill.

Table 4. Estimated Cost of Logging and Water Storage of Logs[104]

Cost Category	Cost ($/m3)
Logging Costs[105]	
Tree to truck	18.23
Hauling	9.23
Scaling	0.25
Camp Costs	0.21
Other Direct	0.89
Roads	6.14
Silviculture. & Reforestation	3.95
Planning & Administration	5.45
Depreciation	0.52
Corporate Overhead	0.19
Other Indirect	0.42
Subtotal	**45.48**
Costs to place timber into water storage[106]	
Dump and Boom	1.86
Tow & put in place	1.01
Total	**48.35**
Costs to retrieve timber from water storage	
Tow	1.01
Dewater & Reload	2.38
Haul to Mill	4.50
Road Maintenance	0.75
Total	**8.64**

Adapted from: Rogers, with permission.

[104] Stumpage is excluded from this table.

[105] Rogers, 2001, 39. The data refer to 1999. According to industry sources the 1999 data are similar to 2001 costs.

[106] Ministry of Forests and Range, Interior Appraisal Manual, April, 2005, 4-39.

The data used to convert lumber prices are shown in Table 5. The current price and the May, 2005 futures price of lumber are converted to Canadian currency. The Canadian dollar has appreciated against the American currency in recent years and is currently trading at $0.8155 per $US. It is assumed that this rate will remain stable for the purpose of this analysis.

Table 5. Conversion of US Lumber Prices to Canadian Currency

	Lumber Prices June 28, 2005[107]	**Lumber Futures for delivery May, 2006**[108]
Price (US$/mfbm)	$397.00	$330.00
Currency Conversion CAD/USD[109]	1.2263	1.2263
Price (C$/mfbm)	$486.84	$404.68

Source: Compiled by author, with data from sources shown in footnotes.

The estimated operating earnings are shown using log costs adjusted for the cost of capital, excluding stumpage costs. Since the costs of harvesting and placing the logs into storage are incurred at the outset, but the benefits are obtained in the future, the cost of the logs must be adjusted for 'carrying' or 'inventorying' costs. Interest rates of 10 and 4 percent are used in the estimates. It is expected that log quality will degrade during storage in the water. There is limited quantitative information on the impact of water storage on LRF. The rates of decline in the lumber recovery factor are assumed to be between 2 and 6 percent. Lumber markets are cyclical. The current price of lumber is used for the calculations in Table 7. Table 8 and Table 9 are based on the price of lumber being sold on the futures market for delivery in May, 2006. The following table summarizes the factors that have been used to evaluate the economic feasibility.

[107] Random Lengths Woodwire, Random Lengths Publications, Inc. Online. 2005.

[108] *Globe and Mail*, Lumber Futures, June 23, 2005.

[109] Bank of Canada. Online. 2005

Table 6 Matrix of Factors Evaluated

	Interest Rate	Rate of LRF Decline	Lumber Selling Price CAD/mfbm	Indicated Number of Years of Economically Viable Storage
Table 7	10%	2%	$486.84	7
Table 8	10%	6%	$454.68	3
Table 9	4%	6%	$454.68	5

Assuming the current price remains stable, and timber stored in water will degrade by 2 percent per year, water storage could be viable for up to Year 7, at a 10 percent carrying charge as shown in Table 7.

Using the same 10 percent carrying charge, but a more pessimistic rate of LRF decline and a lower lumber price, Table 8 suggests that log storage would not be economically viable beyond the Year 3. Under these assumptions water storage may not be economic except for companies that are already using water storage as part of their log inventory system. For reference, the elimination of the cost to dewater and re-haul the logs would add an additional year to the length of viable storage for the pessimistic scenario shown in Table 8.

Table 9 utilizes the same parameters as Table 8 except that carrying charges are assumed to be 4 percent, which was the global industry average return on capital employed in 2002. Under these assumptions storage may be economically viable up to year 5.

Companies are expected to increase shareholder value over time. With the competition of the marketplace, firms must focus their investments on the best investment options available, taking into account economic returns and business risk. Canadian Forest Products' return on capital employed increased from 6.5 percent in 2003 to 16.2 percent in 2004.[110] With the timber supply in the B.C. Interior no longer being constrained, because of abundant salvage timber, opportunities to earn 16 percent on investments such as mill expansion and upgrades appear to be more attractive than investments in long term log storage.

The implementation of the water storage of logs will depend on its operational and economic viability and the perception of risk by individual forest companies. The prospect of a sawmill 'running out of wood' weighs on the minds of most industry woodland managers. It is possible that a preference to secure a supply of timber for future use may become a consideration for some companies.

The interests of the Province may diverge from the interests of a company with respect to the acceptable interest rate used. If log storage were to be implemented by B.C. Timber Sales on behalf of the government, a carrying charge of 4 percent could be considered acceptable. This would serve to secure the Province's financial interest in the timber that would not otherwise be salvaged and this could provide communities with a longer period to adjust to reductions in the timber supply. According to the agency's brochure, "The **Mission** of B.C. Timber Sales is to market Crown timber to establish market price and capture the value of the asset for the public."[111] It would be in the interest of the government, through the B.C Timber Sales agency, to initiate a program to build an inventory of logs using water storage.

There are changes to the cost structure that may occur as the value of salvage logs decline and the harvest of green timber is adjusted to lower, more sustainable levels for the long term. The development of large scale water storage of logs and dewatering systems may create efficiencies that will lower the cost of the generic estimates that have been used in this analysis.

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[110] Michael Kane, "World's Most Profitable Forest Firms From B.C.," *Vancouver Sun*, July 14, 2005, D1.

[111] Ministry of Forests and Range, B.C. Timber Sales Brochure, 3.

Later, as the level of salvage harvesting drops, excess hauling capacity may result in lower hauling costs where wood is dewatered and hauled to a mill-site.

It is possible that temporary sawmills could be located adjacent to water storage areas to eliminate the need to dewater and re-haul the water soaked timber. Finally, it is likely that conversion costs will continue to drop as processing technology evolves and labour costs are reduced.

The results of the analysis are not conclusive. Nonetheless, if given an opportunity to implement the water storage of logs, individual companies may be able to orient their operations to create the necessary efficiencies to take advantage of the water storage option. Some operations may utilize water storage as a form of hedge against future increases in log costs. It would be ideal if the option to store logs in water were made available for companies to implement to the level they consider economically appropriate.

Table 7. Predicted Impact of Log Storage with a Carrying Charge of 10% on Operating Earnings at Current Lumber Price and 2% LRF Decline

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Capitalized Log Cost (@ 10% p.a.)	48.35	53.19	58.50	64.35	70.79	77.87	85.65	94.22	103.64
Recover logs and deliver to Mill	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64
Total	56.99	61.83	67.14	72.99	79.43	86.51	94.29	102.86	112.28
Conversion Costs ($/mfbm)	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00
LRF (declining @ 2% p.a.)	0.283	0.277	0.272	0.266	0.261	0.256	0.251	0.246	0.241
Wood Cost ($/mfbm)($/m3 x 1/LRF)	201.38	222.92	247.04	274.04	304.29	338.17	376.14	418.68	466.36
Total wood & conversion costs ($/mfbm)	311.38	332.92	357.04	384.04	414.29	448.17	486.14	528.68	576.36
Sales (C$/mfbm)	486.84	486.84	486.84	486.84	486.84	486.84	486.84	486.84	486.84
Chips and Hog Fuel Sales	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Total sales ($/mfbm)	536.84	536.84	536.84	536.84	536.84	536.84	536.84	536.84	536.84
Operating Earnings ($/mfbm)	225.46	203.92	179.80	152.80	122.55	88.67	50.70	8.16	(39.51)

Adapted from: Rogers, page 40. With permission.

Table 8. Predicted Impact of Log Storage with a Carrying Charge of 10% on Operating Earnings at Lower Market Pricing and 6% LRF Decline

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Capitalized Log Cost (@ 10% p.a.)	48.35	53.19	58.50	64.35	70.79	77.87	85.65	94.22	103.64
Recover logs and deliver to Mill	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64
Total	56.99	61.83	67.14	72.99	79.43	86.51	94.29	102.86	112.28
Conversion Costs ($/mfbm)	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00
LRF (declining @ 6% p.a.)	0.283	0.266	0.250	0.235	0.221	0.208	0.195	0.184	0.173
Wood Cost ($/mfbm)($/m3 x 1/LRF)	201.38	232.41	268.51	310.54	359.49	416.52	482.99	560.49	650.88
Total wood & conversion costs ($/mfbm)	311.38	342.41	378.51	420.54	469.49	526.52	592.99	670.49	760.88
Sales (C$/mfbm)	404.68	404.68	404.68	404.68	404.68	404.68	404.68	404.68	404.68
Chips and Hog Fuel Sales	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Total sales ($/mfbm)	454.68	454.68	454.68	454.68	454.68	454.68	454.68	454.68	454.68
Operating Earnings ($/mfbm)	143.30	112.27	76.17	34.14	(14.81)	(71.84)	(138.31)	(215.81)	(306.20)

Adapted from: Rogers, page 40. With permission.

Table 9. Predicted Impact of Log Storage with a Carrying Charge of 4% on Operating Earnings at Lower Market Pricing and 6% LRF Decline

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Capitalized Log Cost (@4% p.a.)	48.35	50.28	52.30	54.39	56.56	58.83	61.18	63.63	66.17
Recover logs and deliver to Mill	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64
Total	56.99	58.92	60.94	63.03	65.20	67.47	69.82	72.27	74.81
Conversion Costs ($/mfbm)	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00	110.00
LRF (declining @ 6% p.a.)	0.283	0.266	0.250	0.235	0.221	0.208	0.195	0.184	0.173
Wood Cost ($/mfbm)($/m3 x 1/LRF)	201.38	221.50	243.68	268.14	295.10	324.83	357.61	393.78	433.66
Total wood & conversion costs ($/mfbm)	311.38	331.50	353.68	378.14	405.10	434.83	467.61	503.78	543.66
Sales (C$/mfbm)	404.68	404.68	404.68	404.68	404.68	404.68	404.68	404.68	404.68
Chips and Hog Fuel Sales	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Total sales ($/mfbm)	454.68	454.68	454.68	454.68	454.68	454.68	454.68	454.68	454.68
Operating Earnings ($/mfbm)	143.30	123.18	100.99	76.54	49.58	19.85	(12.94)	(49.10)	(88.98)

Adapted from: Rogers, page 40. With permission.

4.3 Policy Option for Analysis

The use of the water storage option is not likely to be implemented without a policy incentive to do so. Some firms are earning more on their current investments than they would with a system of storing logs in water. The nominal returns shown in Table 7 that can be provided by storage do not include the cost of stumpage payments. It is in the interest of the timber owner, in this case the Crown, to minimize the economic loss of the resource to mountain pine beetle. Implementation of a policy that encourages the water storage of logs would require the Province to authorize a deferral of stumpage payments for the timber being stored. It would also be appropriate for the Province to recognize the degradation of the timber that is being stored in stumpage rate adjustment that reflects the reduction in grade over time. In other words, stumpage should be charged when the timber is retrieved from storage, and not when it is harvested, and it should be at a rate consistent with the quality of wood when retrieved as opposed to its quality when harvested.

A storage policy must also recognize the fact that many of the stands that will be harvested will not consist of pure pine. Instead, timber of other species will be harvested as incidental 'by-catch' and surplus timber in this category will require storage as well. One estimate suggests that the 'by-catch' ratio could be as high as 1.3 m3 of non-pine species for every 1 m3 of pine that is salvaged.[112]

The following section will explore this policy option in more detail.

[112] Eng, Year 2, 6.

4.3.1 Deferral of Stumpage Payments

Stumpage is normally billed when the load is hauled across truck weigh scales or when it is lifted off the truck and lowered into the water, where water storage is used. The weight and grade are reported to the Ministry and an invoice for the stumpage payable is sent to the licensee.

Healthy timber is often interspersed with dead timber. The low salvage stumpage rates only apply to the various grades of dead timber. Where practical for silvicultural purposes, healthy timber can be reserved from harvesting. In most cases however, clearcutting is the preferred silviculture option because single trees are subject to windthrow or because the stand is predominately pine and apparently healthy trees are at a very high risk of being lost to insect attack later. As a result, both sawlog quality timber and Grade 3 timber would be inventoried under a water storage program.

To enable the water storage option to be viable therefore, it is important that the cost of building the inventory is not exacerbated by stumpage costs. If the mill were required to pay stumpage at the time of harvest, this would increase the carrying costs of the stored inventory. The cost of this 'up-front cost' could be quite high for sawlog quality timber. This could be alleviated by extending the deferral of stumpage payment to all timber held in water storage. To derive the greatest benefit, a stumpage deferral policy would need to be limited to stands that are comprised substantially of pine. When the sawlog bundle is moved to the sawmill, the timber would be evaluated for quality and the stumpage invoice would become payable based on log grades at the time of utilization. Inventory management systems using bar coding or radio frequency identification[113] could provide opportunities to track storage, utilization and stumpage payments for the log bundles. There are two impacts of this policy:

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[113] Rob Brewin, "Radio Frequency Identification," *Computerworld,* December 16, 2002. Online. 2002.

a) The Crown would forgo charges on the increase in volume attributable to growth between the date of harvest and the date of milling.[114] While this is a negative effect it would not be substantial because mature stands experience lower growth rates.

b) There will also be some quality impacts. On the one hand, healthy sawlogs will deteriorate somewhat as a result of storage. On the other hand, the storage programme will allow the harvest and eventual use of sawlog grade pine logs before they are completely lost to the mountain pine beetle. The overall quality impact is likely to have a very positive effect on Crown stumpages.

On balance between these factors, it is in the financial interest of the Province to defer stumpage on sawlog grade timber where it is placed in water storage inventory because the value of sawlog grade stumpage is significantly greater than salvage grade stumpage. Section 6 will expand the analysis of this option.

4.3.2 Other Options

With time being of the essence, the Province must create an innovative environment where proposals such as log storage in water can be expedited. Instead of relying solely on centrally planned solutions, which in their own right will be very effective, the creation of a policy to encourage new solutions could leverage the operational talent that is located throughout the Interior of the Province, or elsewhere. Concepts could include partnerships with industry where flexible public policy provides incentives for private funds to be invested in solutions to mitigate losses to mountain pine beetle.

Ideally, the Province should assign a senior manager to oversee the mitigation of the economic impact of the mountain pine beetle. This 'facilitator of innovation' should be given the opportunity to work across the Ministries of Forests and Range, Environment, Agriculture and Lands and Economic Development to ensure that alignment exists between these agencies and the goals of the government, with respect to the epidemic. Implementation of effective mitigation

[114] Growth will not be absent for long, as the stand will be replaced and growth will continue on the new stand. The difference is that this period of growth on the older trees could increase the quality and value of the stands by a greater margin than on a younger stand on a site of the same growth potential.

strategies will require tradeoffs between the goals of ministries. It would be important to identify the tradeoffs and place them in the hands of Cabinet for review and resolution.

4.4 Summary

The foregoing is a review of the feasibility of the water storage of logs. Stumpage deferral is identified as a possible approach to encourage industry to utilize the storage option. B.C. Timber Sales could also implement a log storage system and it would appear to be in the interest of government to do so.

There are other possible options to mitigate losses in the value of pine. An overall approach to encourage innovative solutions to the mountain pine beetle epidemic would facilitate implementation of the storage option and the development of other options that are not yet identified. Given the extraordinary size of the epidemic, all opportunities to mitigate the losses deserve consideration. The identification of a senior manager to oversee the establishment of an innovative mechanism may be necessary to expedite the review and implementation of new options.

5 REVIEW OF FACTORS THAT INFLUENCE WATER STORAGE OF TIMBER

5.1 Regulatory Issues

Storage of logs in lakes and reservoirs is under the jurisdiction Land and Water B.C., a department of the Ministry of Agriculture and Lands.[115] The authority to grant tenure for log storage is provided to the Minister under Section 11 of the *Land Act (RSBC, 1996).* Land and Water B.C. has a Log Handling Policy,[116] which identifies two forms of tenure that would be of importance to water storage of timber. The Licence of Occupation offers a term of up to 10 years and can be overlapped with other licences if necessary. Leases provide longer term tenure, up to 30 years according to the policy, and confer exclusive use of the tenure area. The fees for each tenure are comparable at 7.5 percent and 8.0 percent of assessed area value respectively. The area value for the Northern Interior is $1,964 per hectare and for the Southern Interior $2,409 per hectare. A 100 hectare area of foreshore lease in the Northern Interior would therefore cost approximately $19,000 annually or in the order of $0.03 per m3 annually.[117]

Land and Water B.C. reviews each application for foreshore tenure with respect to Provincial government policy and First Nation's interests. Tenure holders must operate in conformity with a variety of Provincial and Federal regulations.

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[115] Land and Water BC (LWBC) was administered by the Ministry of Sustainable Resource Management until this agency was moved to the Ministry of Agriculture and Lands.

[116] Ministry of Agriculture and Lands, Land and Water BC. "Land and Water BC Log Handling Policy." Online. 2005.

[117] One hundred hectares of bundled logs is estimated to hold roughly 800,000 m3. These are coarse estimates and are only intended to provide the order of magnitude that the LWBC fees would represent.

The most significant legislation that a log storage tenure holder must address is the *Federal Fisheries Act*. Section 34 of the *Act* defines fish habitat as "the spawning grounds, nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes." Many of the lakes that are large enough to be used for log storage are used for the spawning and rearing of salmonids during phases of their life cycles. Section 35 of the *Act* prohibits harmful alteration, disruption or destruction of fish habitat (known by the acronym 'HADD') unless authorized by the Minister or under regulations. For example, it is possible that bark could slough off during storage and impact the fish habitat.

Another section of the *Fisheries Act* that pertains to log storage is Section 36 (3) which reads:

> Subject to subsection (4), no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water.

Subsection (4) describes the provisions where substances may be permitted and it is possible that a new application to do so would require the completion of an environmental assessment under the Federal *Canadian Environmental Assessment Act* (CEAA). The CEAA assigns the responsibility of environmental assessments to the government where a regulatory agency of the government has a decision making authority to grant an approval of a permit. Assessments are normally done by proponents, on behalf of the government.

Another Federal act that could apply to water storage of logs is the *Navigable Waters Protection Act*. This act may restrict log storage activities where navigation could be impacted. Given the size of most lakes where log storage occurs, impacts on navigation are not likely to be significant.

A report prepared for Fisheries and Oceans Canada[118] describes the current 'best management practices' for the location and management of water storage facilities in British Columbia. The approach includes consideration of the interests of the Federal and Provincial governments and First Nations groups. The application process describes a six-step process beginning with:

1. Identification of habitat and other environmental issues,
2. Identification of proposed activities and potential negative impacts,
3. Identification of requirements for approval, regulatory authorities and relevant issues,
4. Completion of initial habitat assessment and project review,
5. Preparation of the application and,
6. Submission of the application to Land and Water B.C.

The establishment of a log storage facility on a lake where this activity has not historically occurred would appear to be a daunting task. Therefore, initiation of this activity on an undeveloped lake would require the conceptual support by the Federal and Provincial governments beforehand. Both governments would appear to have a vested interest in doing so and it is unlikely that a company would embark on such a project without such support. Both governments could cooperatively identify a 'regulatory pathway' to help expedite the necessary approvals that would be required.

5.2 Stumpage Issues

The Ministry of Forests and Range has a fiduciary responsibility to manage the Crown forests for the benefit of the Province. The *Ministry of Forests Act (RSBC, 1996)* sets out the following Ministry responsibilities:

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[118] G3 Consulting Ltd., "Guidebook: Environmentally Sustainable Log Handling Facilities in British Columbia, April 2003" *Report prepared for Fisheries and Oceans Canada, Pacific and Yukon Region, Habitat and Enhancement Branch,* 13.

(a) Encourage maximum productivity of the forest and range resources in British Columbia;

(b) Manage, protect and conserve the forest and range resources of the government, having regard to the immediate and long term economic and social benefits they may confer on British Columbia;

(c) Plan the use of the forest and range resources of the government, so that the production of timber and forage, the harvesting of timber, the grazing of livestock and the realization of fisheries, wildlife, water, outdoor recreation and other natural resource values are coordinated and integrated, in consultation and cooperation with other ministries and agencies of the government and with the private sector;

(d) Encourage a vigorous, efficient and world competitive timber processing industry in British Columbia;

(e) Assert the financial interest of the government in its forest and range resources in a systematic and equitable manner.

In the context of the mountain pine beetle epidemic, the Ministry has a duty to ensure that forests killed by mountain pine beetle are promptly restocked. The Ministry must also manage the economic and social benefits in the immediate and long term, which requires an element of optimization. The Ministry of Forests must also apply a systematic and equitable approach to collecting revenues from the industry.

Given the duties of the Ministry of Forests and Range described above, it is within the agency's mandate to set discounted fees for timber salvage and recognize the additional costs that water storage of timber would entail. By providing an economic incentive for industry to salvage timber, the Ministry ensures the forests are restocked and returned to maximum productivity. In doing so, the Ministry also minimizes the government's potential losses over the immediate and long term because it could otherwise be faced with no timber revenue, suboptimal rates of growth and the full burden of restocking costs.

5.2.1 Salvage Stumpage Rates

The rate charged for salvage Grades 3, 4, 5 and 6 is \$0.25/m3 as outlined in Section 2.3.2 and presented in Appendix A. This is a prescribed rate, which captures the nominal value of the

Crown's financial interest in the timber. In the context of the costs of harvesting, hauling and storage, which amount to \$50 per m3, the nominal rate is unlikely to represent an impediment to the harvest of the salvage grades of timber for storage. Stumpage rates are based on grade and forests often contain mixtures of species and timber of all grades. This means that salvage harvesting also creates stumpage billings at market rates of \$20 to \$30 per m3 for timber of sawlog grade. This timber is most likely to hold its value while stored in water with the least degradation in LRF.

5.3 Eligibility Issues to Implement Water Storage of Logs

Changes to stumpage policy that encourage the water storage of timber will favour licencees that are already using water storage as part of their inventory management system. It is conceivable that a temporary sawmill could be located adjacent to a lake to take advantage of water storage under a deferred stumpage policy. The savings from the costs shown in Table 4 could be as much as \$8.64 per m3 because a sawmill located adjacent to a water storage area would not need to dewater, haul and unload the timber, which as noted earlier, would be much heavier with the absorbed water. This could be considered an unfair advantage for operations that are already established with log storage systems on lakes.[119] Nonetheless, if implemented, the policy could encourage operations that are not located on water to invest in wet storage systems. As a result, the location of existing operations could be considered either an advantage or disadvantage depending on the circumstances. By providing the option to store logs, using a deferred stumpage policy, the Ministry could offer a neutral policy that can be selected by individual operations.

[119] It should be noted that operations that have log storage in water have already incurred the cost of establishing them. Personal communication, Paul MacNamara, July 25, 2005.

6 REVIEW OF COSTS AND BENEFITS

The Province has ownership interest in the timber that is being affected by mountain pine beetle. The implementation of a policy that facilitates water storage must consider the costs and benefits that would arise as a result of such a policy. The Province would incur costs related to the deferral of stumpage revenues and the environmental impacts of clearing large areas and storing logs in lakes. The benefits to the Province of a policy favouring the water storage of logs include the additional stumpage revenues that would be collected because of larger volumes salvaged and preservation of higher timber grades.

6.1 Costs of a Log Storage Policy

6.1.1 Hard Costs of the Water Storage of Logs

The storage of logs in water will not arrest degradation. It can only reduce the rate of degradation. Research has confirmed that the biological processes that cause degradation are less active in water of colder temperatures. The extent of degradation while in water storage is difficult to quantify or predict. As some of the logs in the floating bundles will remain above the water line and exposed to the effects of dry air and insects, and as the submerged logs will be affected by bacterial growth, some reduction in quality is unavoidable. There is also the possibility that entire log bundles could sink, although this is more characteristic of species that have high levels of decay, such as Interior hemlock.

The supply of timber for storage purposes would have to be generated by an increase in the harvest rate. This increase in current harvest costs in order to build inventory would be borne by industry and this is the single greatest cost of a log storage system. Companies currently have a choice of investments that have returns on capital employed that likely are greater than an investment in log storage would provide. Depending on the perception of risk, some companies could choose log storage as an investment option as returns for alternate investments decline and as timber supply becomes constrained.

Timber of species other than pine that is harvested as 'by-catch' is most likely to retain its value on the stump through the epidemic and would be available in the post epidemic scarcity era to receive higher prices in stumpage. If this 'by-catch' is stored it will degrade. The stumpage that will be invoiced when it is milled, will be at a lower grade. This reduction in the value of non-pine species during storage would represent an opportunity cost to the Province.

6.1.2 Soft Costs of the Water Storage of Logs

Some costs of the water storage of logs are difficult to quantify. These are costs that result from the environmental impact of harvesting additional area, the environmental effects of storing logs in the water and the social costs of a rapid expansion and contraction in harvesting capacity.

6.1.2.1 Impacts on Wildlife Habitat

An accelerated harvest program to make timber available for storage would increase the area of habitat that would be modified by harvesting. In the absence of water storage, the unsalvaged stands will represent 2.5 million hectares of area where harvesting is delayed or permanently deferred.[120] The qualitative value of these stands for habitat is more difficult to determine than the quantitative value of these stands for timber harvesting. It is the role of

[120] Calculation, with data from Section 1.3.2: (960 million m3 less 329 million m3 salvaged leaves 631million m3, which at an estimated volume per hectare of 250 m3 per hectare, represents 2.5 million hectares of area.)

government to determine whether all or a part of the value from salvaging the timber, has greater or lesser value than leaving the stands for habitat values.

6.1.2.2 Impacts on Water Quality

There will be potential impacts to water quality in the lakes where storage is implemented. Most of the research on the impacts of log storage on water quality relates to wet storage systems or log storage in a marine environment. Wet storage involves water that is sprayed over log decks and this can lead to toxic concentrations of dissolved organic chemicals in the water. The impact of log storage on water in a marine environment has received considerable attention. It is believed that:

> ...The opportunity for dilution available in most log-handling areas usually prevents accumulation of hydrogen sulphide or wood leachates in the water column. It is possible that in the absence of circulation or sufficient volumes of water, that insufficient dilution could result in concentration of leachate and create toxic effects in the environment.[121]

The most significant negative impacts of the water storage of logs in ocean environments have been identified as destruction of habitat, crushing of benthic[122] organisms in inter-tidal log-storage sites, and alteration of benthic infauna habitat[123] as a result of wood debris and bark accumulation.[124] Wood and bark debris is most likely to sink to the bottom in the vicinity of log dump sites. For this reason, modern log dumps typically lift the tied bundle of logs off the truck, swing it onto skids and lower it into the water without a significant splash. In addition, Interior

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[121] Sedell and Duval, 32.

[122] Definition of benthic: Pertaining to areas of water (and organisms) at the bottom of a water body, like the bottom of a lake. Biology-Online. 2005

[123] Definition of infauna: Aquatic animals living within the matrix of bottom sediment. Biology-Online. 2005.

[124] Sedell and Duval, 34.

lakes do not have the tidal fluctuation in water level and therefore, there is limited benthic habitat to be impacted by debris sinkage.

Section 3.1.3 identifies at least ten lakes or reservoirs where log transportation and storage have been in use for multiple decades in the Interior of British Columbia. It is reasonable to conclude that the effects of log storage on these water bodies over this period of time provide a reference point for the degree of environmental costs of log storage. Therefore, while there is likely some impact to the environment by water storage of logs, and given that storage will be for a finite period of time, the implementation of a new or an expansion of an existing facility is not likely to pose an unacceptable environmental cost.

6.1.2.3 Impacts on Social Structure

The harvesting levels have already been increased beyond a sustainable level to enable salvage of the timber mortality. This has required an increase in the harvesting capacity and in some cases, milling capacity. The increase in harvest that would be required to place timber into storage would increase the harvesting capacity even further beyond sustainable levels. When the level of harvest is reduced following the completion of salvage, the inclusion of the 'storage harvest' will add to the adjustment that will be necessary for communities and workers. Contractors can protect themselves by amortizing equipment over an appropriate time period but the reduction in labour capacity is likely to have significant impact on individual families. To provide some scale, an operation producing 100,000 m3 per year would require a crew that can produce 20 loads per day.[125] This would typically employ 7 to 10 people, depending on the level of mechanization and support services required. For each 1 million m3 stored, the 'storage harvest' would add an additional 70 to 100 people to the labour surplus when harvest reductions

[125] Calculation: (100,000 m3 per year divided by 200 days per year divided by 25 m3 per load)

are required. This would be partially offset by the employment of people to dewater and haul the timber, if the storage area is not adjacent to a mill site.

While labour is assumed to be mobile, as compared to manufacturing infrastructure, reductions in employment are likely to create social costs. On balance however, the capture of the economic value of the 'storage harvest' is likely to provide sufficient benefits that will offset the social costs that might be incurred.

6.2 Benefits of a Water Storage Policy

6.2.1 Hard Benefits of Water Storage

The benefits of water storage are greatest where logs can be harvested as live sawlogs and placed in water to preserve them. To quantify the magnitude of this benefit requires some assumptions to be made. If there are ten lakes where 2 million m3 could be stored in each lake, over and above current manufacturing requirements, the volume that would be protected would be 20 million m3. If this volume were to be left standing until killed by mountain pine beetles, the stumpage revenues the Province would receive would be $5 million.[126] Alternately, the deferred stumpage revenues from storing the logs could be in the order of $300 million if the stumpage rate charged were $15 per m3 at the time of milling. A stumpage rate of $15 per m3 would be half of the average stumpage rate that existed in the Northern Interior before the

[126] Calculation: (20 million m3 x $0.25 per m3 = $5 million for Grade 3 logs)

epidemic began, assuming some degradation in log grades would occur during storage.[127] The fees from the foreshore storage tenures are not significant as they would be in the order of $50,000 per year.[128]

This stored volume would provide additional time for communities to adjust to lower harvest volumes following the epidemic. The duration of this effect depends on the type of mill that would be serviced by the stored logs. In the case of Canfor's 'super' mill at Houston, B.C., where the mill capacity is 600 million fbm per year and employment is estimated at 0.5 jobs per million fbm,[129] 2 million m3 of stored logs would maintain employment for 300 people for almost a year.[130]

Using the same data source as above, communities with more labour intensive manufacturing facilities that have lower production, such as the Cheslatta/Carrier mill at Ootsa Lake would be sustained for a much longer period. The mill capacity there is 62 million fbm annually with employment of 1 person per million fbm. This suggests that the mill could

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[127] Calculation: (20 million m3 x stumpage (see below) of $30 per m3 = $600 million in deferred stumpage revenues.)
The stumpage rate for appraised timber (non-B.C.T.S timber sales) in 2000 in the Prince George Forest Region was $31.28 per m3. Reference: Ministry of Forests and Range, Revenue Branch. URL accessed July 15, 2005: <http://www.for.gov.bc.ca/hva/timberp/volumesrates/volumes_rates2000.pdf>
The stumpage rate for appraised timber in 2002 in the Prince George Forest Region was $21.55 per m3. Reference: Ministry of Forests and Range, Revenue Branch. URL accessed July 15, 2005: <http://www.for.gov.bc.ca/hva/timberp/volumesrates/volumes_rates2002.pdf>
The average stumpage rate for appraised timber for the Northern Interior Forest Region for the three month period ending December 31, 2003 was $14.52 per m3.
This data indicates a downward trend, likely due to increased volume of non-sawlog grade wood being harvested at the stumpage rate of $0.25 per m3. Reference: Ministry of Forests and Range, Revenue Branch. URL accessed July 15, 2005: <http://www.for.gov.bc.ca/hva/timberp/stumpagebillings/4thquarter2003.pdf>

[128] The calculations in Section 5.1 have been extrapolated here. The storing of 800,000 m3 at a fee cost of $20,000 has been translated to a cost of $50,000 for 2 million m3.

[129] Max Blouw, "Perspective on Future Forestry – What Do We Need to Succeed?" *Presentation given to the Association of BC Forest Professionals Annual General Meeting in Prince George, BC, February, 2005*, 10.

[130] Calculation: ((2 million m3 x LRF 0.270)/capacity 600 million fbm per year = 0.9 years.)

continue to employ 60 people for 8.7 years.[131] It is unfortunate that the opportunity for this sawmill to utilize the log storage option may have already passed in this instance, as most of the timber in the vicinity is already dead.[132] Still, there are similar sawmills near the expanding front of the epidemic where the log storage option may be available.

6.2.2 Soft Benefits of Water Storage

It has been estimated that forestry related employment makes up 12 percent of overall employment for the Prince George TSA.[133] In contrast, in the Nadina Forest District, which is a smaller community area to the west of Prince George, the forestry sector accounts for 24.5 percent of total employment.[134] Given that forestry is a rural industry and given the dependence on forestry as the primary source of employment, water storage of logs provides additional time for rural communities to adjust to lower levels of employment in this sector. Depending on the scale of lumber manufacturing currently in place, the transition period could be 7 years. The benefit this would convey to a local economy is difficult to quantify. It would however, provide an opportunity to utilize downsizing strategies such as career retraining or attrition through retirement, resulting in less dislocation to families and the communities they live in.

Another benefit of log storage is that it provides an opportunity to manage the impact of the mountain pine beetle epidemic in a controlled manner, particularly with respect to the impact on habitat. In the absence of harvesting, there is uncertainty concerning the rate at which the areas of mortality will be restocked with new trees. There is also the risk that large areas of dead timber may be subject to wildfire, which could result in the catastrophic elimination of whatever transitional habitat had developed. Some of the 631 million m3 of pine that is not currently

[131] Calculation: ((2 million m3 x LRF 0.270)/capacity 62 million fbm per year = 8.7 years.)

[132] Personal communication with Jamie McLennan, Burns Lake, May 5, 2005.

[133] Patriquin, 34.

[134] Ibid, 19.

scheduled for harvest is likely to be burned in wildfires at some time over the next several decades. The managed harvest of a portion of this volume could instead provide for timber reserve areas that would result in a fire of a lesser intensity and across a smaller geographic area. A managed harvest could also reduce the magnitude of a forest fire, and this would be an obvious benefit if a fire were to occur in the vicinity of a community. Wildfires in areas of high fuel intensity due to mountain pine beetle mortality can have unpredictable consequences, as demonstrated by the Okanagan Mountain Fire near Kelowna in 2003.

One of the constraints that affects the management of the mountain pine beetle epidemic described in Section 1.5 is that there is a limited amount of time to respond with mitigative measures. Water storage of logs offsets this constraint by maintaining the value of the logs longer into the future. While this report has reviewed the financial feasibility of this option with respect to milling of timber into lumber, there may be other industries that may also benefit by preserving the quality of the timber salvaged.

6.3 Summary of Costs and Benefits

The most significant cost of a log storage system is the logging cost that must be carried until the timber is manufactured into products and sold. In the case of a smaller company, a 1 million m3 inventory would tie up $50 million in capital until it was manufactured and sold.

One of the primary concerns will be the impact on water quality. Given that water storage of logs has been and continues to be widely utilized in the Province already, a temporary increase in this practice would appear to represent a limited and temporary cost. Soft costs of water storage of logs will also include impacts on fish and wildlife habitat due to the increased area that would be harvested.

A log storage policy would provide significant benefits to the Province. The value in stumpage payments could exceed $300 million if 20 million m3 of logs were stored and utilized during the period of reduced harvests. Accelerated harvest would also reduce the potential for catastrophic wildfires and uncontrolled impacts on fish and wildlife habitat.

7 RECOMMENDATIONS

The impending losses to the Province of B.C. are significant and imminent. While considerable research to control the epidemic is underway through the Mountain Pine Beetle Initiative, large areas of pine forest are being killed. Based on projections of current salvage rates, only one-third of the affected timber is likely to be salvaged.

Urgent action is required. The Ministry of Forests and Range has increased the amount of affected timber that can be harvested through uplifts. Manufacturing facilities are running at or near capacity. Log storage in water is a feasible option to reduce the loss in the value of timber. To facilitate the opportunity to store logs in water, there are several policy issues that require attention.

Firstly, the timber pricing structure should recognize the oversupply of affected timber. To address the opportunity to store logs in water, the Ministry of Forests and Range should consider the deferral of stumpage on timber stored, and provide allowances for degradation during storage. Private firms have alternate investments that provide attractive returns with less risk than would occur by storing the timber. Therefore, in the absence of an economic incentive to do so, the outcome is likely to be a very significant loss to the Province in the form of lost stumpage revenues.

Secondly, the Federal and Provincial governments should cooperatively identify a 'regulatory pathway' for the water storage of logs. This would help expedite the necessary approvals that would be required to expand the use of this option. Given the alternate investment choices, and given the risks and difficulties in negotiating competing objectives of government, industry is unlikely to store timber without public policy that supports it. This report has identified that 631 million m3 may not be salvaged, if the current rate of harvest continues. If additional salvage is a priority, then it will be important to develop policies to facilitate the implementation of a water storage system for logs.

Thirdly, the Province should consider implementation of a log storage system through the B.C. Timber Sales agency. The Province has a fiduciary responsibility to obtain the best value for the timber resource. According to the B.C.T.S. brochure, "The **Mission** of B.C. Timber Sales is to market Crown timber to establish market price and capture the value of the asset for the public."[135] The government has the means and the B.C. Timber Sales agency has the mandate to implement a log storage system to secure the economic value of the timber being affected by the mountain pine beetle epidemic.

Finally, the Provincial government should identify a 'Facilitator of Innovation.' This senior manager, reporting to Cabinet, could help identify and expedite the implementation of potential mitigative options, such as the water storage of logs. Time is of the essence, and the extraordinary circumstances require an adaptable approach to identify and implement innovative solutions.

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[135] B.C. Timber Sales Brochure, 3.

APPENDIX

APPENDIX A

SCHEDULE OF INTERIOR TIMBER GRADES[136]

All Species

1. Firmwood Reject, Grade Code Z

(a) A log where

(i) heart rot or hole runs the entire length of the log and the residual collar of the firmwood constitutes less than 50% of the gross scale of the log,

(ii) rot is in the log and the scaler estimates the net length of the log to be less than 1.2 m, or

(iii) sap rot or charred wood exists and the residual firmwood is less than 10 cm in diameter at the butt end of the log.

(b) That portion of a log that is less than 10 cm in diameter or that portion of a slab that is less than 10 cm in thickness.

2. Sawlog

A log or slab 2.5 m or more in length and 5 cm or more in radius where

(a) for a hemlock log, at least 75% of the gross scale can be manufactured into lumber,

(b) for a cedar log

(i) up to and including 25 cm in radius at the midpoint, at least 75% of the gross scale can be manufactured into lumber, or

(ii) greater than 25 cm in radius at the midpoint, at least 50% of the gross scale can be manufactured into lumber,

(c) for a balsam log, at least 67% of the gross scale can be manufactured into lumber, and

(d) for a log of a species other than hemlock, cedar or balsam, at least 50% of the gross scale can be manufactured into lumber, and

at least 50% of the lumber will be merchantable.

3. Dead and Dry Sawlog, Grade Code 3

A log or slab graded as sawlog cut from trees which were dead and dry when harvested.

4. Lumber Reject, Grade Code 4

A log or slab lower in grade than sawlog and higher in grade than firmwood reject.

5. Dead and Dry Lumber Reject, Grade Code 5

A log or slab graded as lumber reject cut from trees which are dead and dry when harvested.

6. Undersized Log Grade, Grade Code 6

A log or slab higher in grade than firmwood reject and cut from a tree which was below the minimum diameter, including the bark, at stump height.

NOTE: This regulation replaces B.C. Reg. 563/78.

[Provisions of the *Forest Act*, R.S.B.C 1996, c. 157, relevant to the enactment of this regulation: section 151 (2) (n) and (4)]

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[136] Queens Printer, Scaling Regulation. B.C. Reg. 446/94, - O.C. 1451/94. Consolidated to February 27, 2004. URL accessed June 28, 2005: <http://www.for.gov.bc.ca/tasb/legsregs/forest/faregs/scalreg/sr.htm>

The schedule of Miscellaneous Stumpage Rates can be found in Table 6-4 of the Interior Appraisal Manual. All species of Grades 3, 4, 5, and 6 have a reserved stumpage rate of $0.25 per m3. This manual is available at URL accessed June 15, 2005: http://www.for.gov.bc.ca/hva/manuals/interior/index.htm

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