

Kootenay Lake Forest District Forest Health Strategy – 2005

**Submitted to
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D) Introduction

This Forest Health strategy is intended to guide the forest health program in Kootenay Lake Forest District. The report consists of several sections and includes an assessment of the overall trends for the key forest health factors currently of note in the District. The Strategy is intended to be a living document, which will be regularly updated as the situation or the District's knowledge base changes.

As of 2004, approximately 11,115 hectares of mountain pine beetle infested pine existed in the District. This equates to 200,000m³ of red attack, and reflects an average District expansion of a 5-fold increase from 2003. While currently of a lesser concern, strategies for the Spruce Bark Beetle and the Douglas-fir beetle are also laid out.

Because the mountain pine beetle is at outbreak levels in the District, much of this report is a strategy for managing the beetle. Provincial direction, guidelines, and recommendations for managing the mountain pine beetle are outlined, as are landscape level plans. Research germane to the bark beetle issue is presented, including information on wildfire, and hydrologic impacts. This then culminates in harvesting strategies recommended for the District, and an assessment of the location of lodgepole pine within the District. Finally, there is an assessment for each Beetle Management Unit for mountain pine beetle, Douglas-fir beetle, and Spruce Bark beetle.

Objective:

To guide forest health strategies and, budgets for the Kootenay Lake District -especially for the 'big three' – bark beetles (mountain pine beetle, spruce bark beetle, Douglas-fir beetle)

Although spruce bark beetle, and Douglas-fir beetle will be discussed to a certain degree, they are currently at low levels. Consequently, this report focuses on mountain pine beetle.

Conventions used in this report

Throughout this report, the following conventions are used, IBM or MPB = Mountain pine beetle. IBD, or DFB = Douglas-fir beetle, and IBS, or SBB = Spruce bark beetle. Beetle management unit (BMU) boundaries correspond to Landscape Unit boundaries.

Assumptions – reader knowledge

This report assumes that the reader has a reasonably robust understanding of all of the following:

- 1) bark beetle biology for spruce bark beetle (IBS), mountain pine beetle (IBM), and Douglas-fir beetle (IBD),
- 2) the bark beetle management 'cycle' of aerial mapping, ground probes, and fall and burn,
- 3) the bark beetle management strategies such as single tree treatments, harvesting etc.
- 4) the Shore –Safranyik rating system ,

- 5) the silvicultural characteristics of lodgepole pine and the species dependence on fire and the mountain pine beetle cycle,
- 6) the reports written by Marvin Eng, and the Forest Practices board regarding bark beetle populations, and bark beetle management strategies,
- 7) the topography of the Kootenay Lake Forest District.

Such a level of knowledge is necessary to understanding the implications of the data. Thus, generally this report will not reiterate basic bark beetle management strategies. If readers are not familiar with this information, it is suggested that they review the information referred to in the Appendices and references prior to reading this report.

Data limitations

Readers are asked to acknowledge that much of the data in this report has limitations. Rather, the information reflects trends and the limitations of trying to identify forest health factors while flying over the ground at speeds of 90+ m/hr, or processing thousands of bytes of information reflecting the locations of hundreds of trees that are showing as red. The report is a synthesis of millions of bytes of information for timber types, and beetle points. In particular, some of the summaries of timber types by hazard class, and beetle populations should be viewed with some latitude. Certainly the forest health officer will endeavour to review these problems in the coming year, but dealing with the data as an inexact entity is part of the inherent nature of dealing with large amounts of changing information.

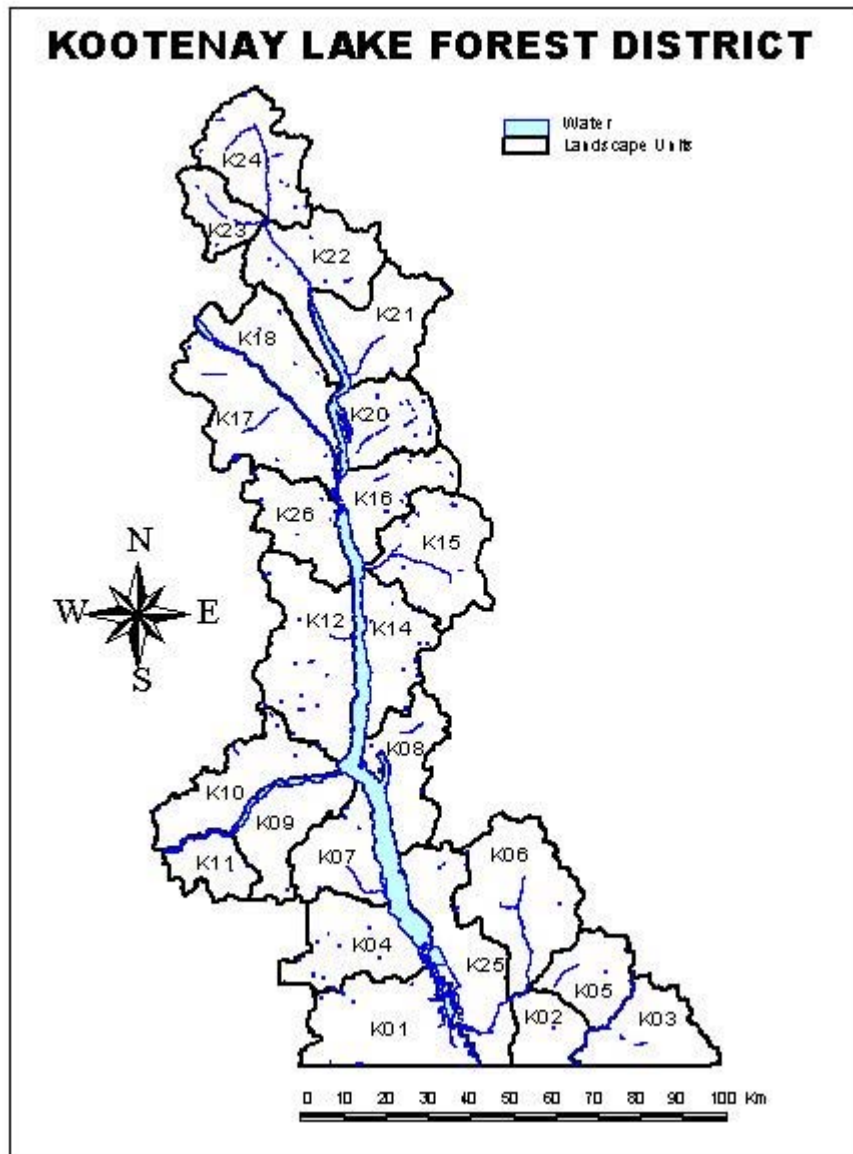
Beetle Management Units

The Kootenay Lake forest district has been divided into 24 Beetle Management Units (BMU). BMU boundaries are equivalent to Landscape Unit boundaries. The table below shows the BMU names and associated numbers and the following figure shows a map of the entire district with its associated BMU boundaries.

Table 1. Kootenay Lake Forest District Beetle Management Units and Associated Numbers.

BMU Name	BMU #	BMU Name	BMU #
Summit Creek	K01	Riondel	K14
Moyie River	K02	Fry Creek	K15
Hawkins Creek	K03	Hamill Creek	K16
Darkwoods	K04	Goat Range	K17
Kid Creek	K05	Lardeau River	K18
Goat River	K06	Glacier Creek	K20
Midge Creek	K07	Howser Creek	K21
Gray Creek	K08	East Creek	K22
Lasca Creek	K09	Westfall River	K23
West Arm	K10	Duncan River	K24
Fortynine Creek	K11	Duck Lake	K25
Kaslo River	K12	McKian-Schroeder	K26

Map of Beetle Management Units-Kootenay Lake Forest District



II) Overall Trends for Forest Health Factors in DKL in 2004.

The following section briefly discusses some of the key forest health factors found in the Kootenay Lake District.

Western Balsam Bark Beetle (IBB)

Although western balsam bark beetle is not dealt with specifically by BMU in this report, the total amount of area infested is significant. The overview surveys show that the amount infested had dropped from 3,625 ha in 2003, to 2,364 ha in 2004. My hunch is that this may be suspect as it would be very difficult to map; Western balsam bark beetle is ubiquitous throughout most, if not all balsam fir stands in the District. Although most of the infestation occurs as single trees dispersed throughout the range of balsam fir, in dry, rocky areas, or locations with shallow soils over bedrock, more trees have been attacked. Likely this is also a factor of drought. In any case, although there are limited timber volume concerns, it may be problematic for other values (e.g. caribou) and the implications should likely be further explored over the next year.

Fir Engraver Beetle

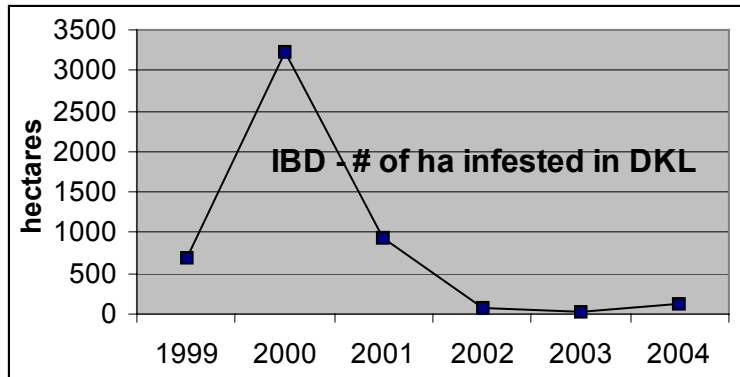
Although the overview survey notes three small infestations in much of the southern portion of the district including Balfour, Arrow Creek, and Kamma Creek areas, fir engraver beetle has been noted over much of the southern third of the District. Most infestations have happened in the Creston area, particularly in Canyon/ Lister, and the Creston Valley Forest Community (CVFC) areas. Although the beetle is causing some economic concern for CVFC, and some of the woodlot owners, the beetle is generally of limited commercial concern.

Western Blackheaded Budworm

The total hectares defoliated decreased slightly to 106 hectares with the small infestation in Gray creek continuing. A small new infestation was noted in the Arrow Creek area.

Douglas-Fir Beetle

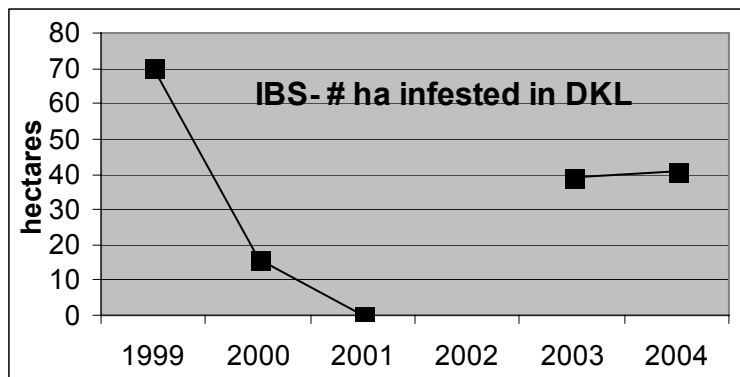
The number of hectares infested increased from 18 ha in 2003 to 123 in 2004. However, spot infestations have continued to decline from 33 (495 trees) to 10 (150 trees). Most of the activity was found in the Arrow Creek/Goat River area. Other areas of concern are the Loki-Tam O'Shanter drainages (site of large-scale blowdown in 2002). At this time Douglas-fir is highly sought after by both licensees and salvage operators, meaning that any infested trees are usually harvested.



Spruce Bark Beetle.

Approximately 41 ha of spruce bark beetle were noted scattered throughout the district. Most of the infestations exist as single trees, in inaccessible areas, and are centred on the Meadow creek and 5 mile creek areas. At this point they will be monitored carefully.

Note that in the following chart there is no data available for 2002.



Young Plantations:

Snowmobilers/ skiers in young plantations.

Leader damage to plantations continues to be a concern. Although the actual number of hectares that are affected has not been totalled, increasing reports of damage are coming in from various locations. While damage from heli-ski operations bears further investigation, much of the damage appears to be concentrated around snowmobile cabins and access routes in the Crawford, 6mile, and Gold/Giveout creeks areas.

Lodgepole pine

Many of the lodgepole pine in plantations 14-20+ years old, that are in the wet ICH and ESSF subzones (e.g. stands that have been declared as free growing) are demonstrating extremely poor growth and form; they are characterized either by “lions tails” (only the current years’ growth of needles remains on the branch), broken tops, or various needle blights. This problem needs to be assessed and quantified.

III) Mountain pine beetle – Provincial context and guidelines

Provincial Context and Rate of Spread

Scope of the Mountain pine beetle infestation

While mountain pine beetle epidemics are natural events in BC, several consecutive mild winters and abundant stands of mature lodgepole pine have led to an outbreak unprecedented in the province's recorded history (BC Ministry of Forests. 2004). As of 2004, approximately 7.1 million hectares were infested. Of that, roughly 59%, or 4.2 million hectares were in the Southern Interior Region. (MacLauchlan et al. 2004).

The current infestation is different from previous outbreaks in that it is more widespread. Additionally, this outbreak has expanded far beyond the mountain pine beetle's historical range (Logan and Powell, 2003).

Forecast

Projections indicate that approximately 50% of the mature pine in BC's interior will be dead by 2008, and 80% by 2013. Significant volumes will continue to be killed until at least 2015 (Eng. *et al.* 2004). About 25-30% of the province's timber harvesting land base is pine (Mountain Pine Beetle Action Plan 2005-2010).

The current outbreak will continue largely unabated until the majority of the susceptible host stands are infected (Eng et. al. 2004). The current outbreak is now so widely distributed that there is not a high probability that the province will experience a severe enough cold weather event of sufficient scope to effect a significant proportion of the population. (Eng et. al. 2004)

Unknowns

It is unknown exactly how fast the mountain pine beetle infestation will spread across the land. However all indicators are that it will occur faster than anticipated. Second, it is not fully understood how management actions undertaken now will have an effect on the future wood supply, socio-economic, wildfire, wildlife, and streamflow.

Mountain pine beetle and climate change

Research indicates that warmer weather has expanded the beetle's range into previously unsuitable areas – in the West Kootenays this particularly means higher elevation stands. The average winter minimum temperatures have increased by 2.2. to 2.6°C in the central interior over the last century (WLAP report, Indicators of Change for BC 2002). Furthermore, the report notes that the climate is projected to continue to increase by 1-4°C over the next century. Both summer and winter mean temperatures have increased, resulting in more successful brood production and reduced over-winter mortality in the beetle population. Bradley et al. (1995) indicate that intense summer warming at high elevation (greater than 3000m) and latitudes between 35° and 55° N has occurred. Logan and Powell (2003) cite the following factors as changes of evidence of this;

- Intensification of impact within the range of historic distribution; outbreaks of increased frequency and intensity are to be expected across the current distribution of mountain pine beetle. Increasing mean annual temperature by 3°C can transform thermally mal-adapted areas into ecosystems that are thermally positive for the mountain pine beetle. (this is relevant to the higher elevation Pli stands located in the West Kootenays)
- General northerly shift in population distribution.
- Invasion of high elevation pine ecosystems. Range expansion into high-elevation, five-needle pines with subsequent loss of biodiversity. E.g. whitebark pine (*Pinus albicaulis* Engelmann).

Provincial Guidelines

The crux of the challenge is to address the epidemic in a manner that captures the best economic value of beetle-killed forests while managing for the other values and resource objectives identified in land use plans. Dealing with the situation is complex, dynamic, and involves many competing interests.

The following points are some highlights from a few of the key objectives and corresponding actions from British Columbia's Mountain Pine Beetle Action Plan 2005-2010.

Recover the greatest value from dead timber before it burns or decays, while respecting other forest values:

- Determine the best rate of harvest to capture the economic value from timber to be salvaged over the term of the strategy while considering other forest values.
- Chief Forester will continue to review the timber supply in affected areas and make further adjustments to the Allowable Annual Cut (AAC) to recognize new circumstances or information.
- Price damaged timber in a manner that recognizes its value, and maintains revenue to the Crown and industry viability during the term of the salvage program.
- Use small scale salvage opportunities where they are the most appropriate to achieve mitigation strategies.

Small scale salvage opportunities are designed to recover small timber volumes that might not otherwise be economically viable. The program has limited application in a widespread salvage operation and is not suitable for most areas of the epidemic, but is expected to be appropriate in special circumstances. It is particularly prudent in areas of 'leading edge' harvest where control objectives for bark beetle are in place.

Conserve the long-term forest values identified in land use plans

- Identify and monitor critical water supplies that may be impacted by the infestation or forestry mitigation activities.

- Identify and monitor areas of unstable terrain that may be impacted by the infestation or mitigation activities.
- Ensure parks and protected areas management incorporates an assessment of the impacts of the epidemic on conservation values.
- Infestations inside parks and protected areas will need to be managed in a manner that complements actions taken to mitigate effects and reduce the risk to values in adjacent areas. In areas where the values in parks are seriously impacted, mitigation plans will be necessary. These plans may include the use of prescribed fire or removal of infested or dead trees.
- Examine the opportunities and costs, including possible funding sources and new research, for techniques to restore non-timber values (e.g. wildlife habitat, hydrological function). Harvesting and reforestation treatments should be planned and conducted to maintain and improve non-timber values, especially where these have been compromised by the beetle infestation. Where harvesting activities are not a priority, restoration treatments might contribute to meeting timber and non-timber objectives.

Prevent or reduce damage to forests in areas that are susceptible but not yet experiencing epidemic infestations.

- Continue to establish Emergency Management Units, as needed, according to science-based criteria and the appropriate forest management strategies applied.
- Continue to conduct timely and appropriate detection and assessment surveys to monitor the level of infestation and mitigation actions.
- Update the inventory of susceptible timber stands.

Restore the forest resources in areas affected by the epidemic

- Restore forest ecosystem productivity.
- Improve forest resource inventory information.
- Identify the policy issues or constraints to implementation of longer-term objective and address them.

Maintain a project management structure that ensures co-ordinated and effective planning and implementation of mitigation measures.

- Apply timber administration and pricing consistently in areas with similar circumstances. The Government will closely monitor Forest Act licenses and stumpage rates and ensure mitigation strategies are implemented equitably.

Landscape level objectives

One of the key questions when managing bark beetles at the landscape level (30000 to 100,000 hectares), is, ‘what dead wood should be salvaged and what should be left behind?’ To help answer that question, Marvin Eng (2004) prepared a report for the Chief Forester. That report makes the following suggestions;

The harvesting “footprint”

At the very least, leave what was originally planned under the existing landscape level plan. There are two reasons for this suggestion. First, targets were set for landscape-level objectives and are the result of agreements among environmental, economic, and social concerns. Second, current harvest levels are well below those required to salvage all the existing dead pine, and all the dead pine cannot possibly be utilized, therefore increased salvaged activities should be designed to be similar to originally planned activities.

Unharvested legacies

Unharvested legacies must remain.

As a general rule it is recommend that salvage harvesting should be minimized in the productive non-contributing land base. These areas include

- environmentally sensitive areas (particularly steep and/or unstable slopes)
- class A lakeshore
- inoperable areas
- unmerchantable forest types
- cultural heritage areas; and
- area specific netdowns, such as riparian, wildlife habitat, wildlife tree, and old-growth management areas.

Retention Levels

The creation of larger openings are within the range of natural disturbance levels, provided that they are designed to respect existing land use planning objectives and that the legacies left increase in proportion to the increasing size of the opening. Although there is provision for small blocks, this should not encourage the development of small blocks in the context of large-scale salvage operations.

Proposed proportion of unharvested legacies (retention levels) left, based on opening size. (Eng 2004)

Opening size	Percentage of opening unharvested
<50ha	10%
50-250ha	10-15%
250-1000ha	15-25%
>1000ha	>25%

Additionally, the spatial distribution of the legacies can be as important as the relative amount remaining.

Recommendations about stand level retention must be implemented with a full understanding of the implications at the landscape level. It is possible that stand level management that ‘aggressively’ attempts to slow the impact of the outbreak in one area could result in a reduction of landscape level requirements in some other area. At present it is unknown as to how easy or difficult it will be to maintain these targets under large-scale salvage operations.

Prioritization for harvest / salvage

It will not be possible, nor desirable to harvest all affected pine forests; any further increases beyond current levels of harvest must carefully consider stewardship values. Additionally, it should be noted that poorly planned and poorly executed large-scale salvage operations have the potential to cause significant negative effects on a variety of forest values (Lindenmayer _____). Large-scale salvage operations will result in conditions that differ from those that would be created by the outbreak alone and the combined effects may be outside the range of natural variability.

Stands should be prioritized considering the following principles

- recover the greatest value from dead timber before it burns or decays, while respecting other forest values
- conserve the long term forest values identified in land use plans
- prevent or reduce damage to forest in areas that are susceptible but not yet experiencing epidemic infestations.
- try to conserve forest values, to the extent possible, while mitigating timber losses.
- consider the shelf life of a dead tree – 5-18 years depending on local conditions (British Columbia’s Mountain pine beetle Action Plan 2005-2010).

Old Growth management areas (OGMA’s)

OGMA’s with considerable dead pine may still have value to biodiversity and should be retained if no suitable replacement OGMA’s are available. Also, it may be useful to select ‘recruitment’ areas that have advanced regeneration of species other than pine (e.g. Spruce, Douglas-fir, and Balsam).

It is desirable, although possibly difficult to maintain mature plus old targets in jurisdictions that have such targets. Mixed species stands should be used wherever possible to contribute to the mature requirement; however stands with some dead pine still provide biodiversity values.

Riparian Areas

There should be no changes to the provisions made for riparian management areas (RMAs) and riparian reserve zones (RRZs). Also see the recommendations from Winkler in the ‘Environmental Values, Hydrologic concerns section in this document.

Ungulate winter range

In areas where ungulate winter range is, or should be, Douglas-fir dominated, selective salvage of dead pine may be allowed provided that there is minimal impact on the Douglas-fir component, nor on long term stocking /growth and yield issues.

Caribou habitat

The following information is taken from the KBHLP-04 Variance. In section 5, the variance states that timber harvesting to deal with mountain pine beetles is permitted, under certain circumstances. The application of this variance needs to be reviewed

within the Kootenay Lake District as to what specific geographic locations it might be applicable (ie. do areas above the operability line qualify).

Visuals

The following is guidance from KLFD staff and the Landscape Forester for the Southern Interior Region regarding management of visual quality and mountain pine beetle

The current Operational and Site Planning Regulation states that licensees are exempted from completing a Visual Impact Assessment (VIA) in situations of: 1) minor salvage 2) expedited major salvage and 3) emergency harvest. (If it is not salvage then regular VIA requirements apply.). This is inferred to mean that licensees are not required to meet the VQO in the short term.

This is inferred to mean that the standard VQO definitions and levels of forest cover removal may be exceeded in the short term. However, the Visual Quality **Objective** remains the same, as the intent is to meet it in the mid- and long-term. If the openings are well-designed the original VQO can still be achieved over time, which may not be the case in the event of no management intervention (ie. due to stand deterioration and/or wildfire). We do not favour changing VQO's – in our view, the objective is unchanged, even if it cannot be fully met in the short term.

However, at all times (even in exempted situations), licensees should apply visual design principles to all larger openings. Visual Impact Assessments can be a valuable tool, both for exploring options to minimize visual impact, and to help inform the public. Not knowing the final spread of beetle kill makes things more difficult, but natural appearing boundaries are critical to minimizing visual impact in the mid- to long-term. Here are a few suggestions:

- Avoid long, straight boundaries and square corners. Maintain irregular boundaries.
- Work to natural boundaries wherever possible, and use or imitate natural features such as rock outcrops, distinct stand types, draws and ridges, etc.
- When in doubt, follow the pattern of beetle attack, as this will generally result in natural-appearing shapes.
- Retain scattered green trees where possible (even 10 to 20 sph makes a difference in providing some texture) and include leave patches where possible to reduce the scale of openings.
- Roads can be the largest source of visual impact. Minimize visible soil disturbances and rehab where necessary (e.g. fully rehab in-block roads) following harvest, seed exposed cut/fill slopes, and use in-block retention as screening.
- Consider the use of foreground screening where ecologically feasible to do so, with the intent of softening visual impact rather than attempting to hide it completely.

Following these simple design strategies will avoid a "worst-case" scenario" and will probably result in a fairly acceptable design.

Access management

A large number of temporary access structures may be created over a very short period of time. Development of those roads should adhere to all existing regulations and they should be de-activated as soon as possible after operations have finished.

From a conservation perspective, the public will gain access to previously inaccessible or poorly accessed areas. They will develop an expectation for continued levels of access. However, because increased human access can have a detrimental affect on wildlife, access management plans should be developed up front along with salvage operations to mitigate this impact. KLFD will be exploring this issue further with MSRM.

Future susceptibility to mountain pine beetle outbreaks

Wherever possible and ecologically suitable, plant species other than lodgepole pine to lessen future problems.

Silviculture considerations

Stands shall be left in a condition where either there is enough merchantable timber to go back to and economically harvest. Or, stands shall have residual basal areas with a maximum of 8-10m²/ha and shall be re-stocked to using the DKL default even aged stocking standard guidelines.

Environmental Values

Harvesting aside, large-scale mountain pine beetle epidemics will still have an impact on the environment. These impacts must also be recognized. In order to decide how to best manage the mountain pine beetle, an assessment must be made of the possible impacts on assorted values. There are 3 key factors that are most relevant in the Kootenay Lake District. They are hydrologic effects, the threat of possible wildfires, and impacts on wildlife species. This section is represented as a literature review of the research on the respective topics, with recommendations where applicable.

Hydrologic concerns –water

“Large scale (watershed level) infestations will affect watershed hydrological processes such as canopy interception, transpiration, soil moisture storage, groundwater levels and recharge, snowfall, snow melt, runoff and peak flows, flood estimation, stream and bank stability, erosion, and sedimentation.” (Rita Winkler – “recommended operational procedures).

Hydrological concerns and responses are sub-divided into the following 5 key areas:

1. Peak flows
2. Riparian
3. Fish
4. Surface Erosion
5. Water Temperature.

1. Peak Flows

Peak flow refers to the maximum flow rate that occurs within a specified period of time, usually on an annual or event basis. In the interior it usually occurs between May and June and occurs due to spring snow-melt (Winkler). The Watershed Assessment Procedure (WAP), lists the two primary factors considered in an evaluation of the potential effects of past or proposed forest harvesting on peak flows. These are equivalent clear cut area (ECA) or the area considered to be in (equivalent to) a clear cut state, and road density.

Snow accumulation and rate of snow melt control peak flows in the interior. (Winkler). The elevation, above which 60% of the watershed occurs, also referred to as the H60 line, is considered to be the source area for the major snowmelt peak flows. When peak flow occurs, the creeks are usually near the bank level and snowmelt from the area above the H60 line is contributing directly to peak runoff. In the southern interior, research has found that a H20 line (Winkler) might control peak flow.

“Based on MSRM research, a 30% increase in daily peak flows would mean that peak flow events experienced every 10 years would now have a magnitude exceeding those experienced once every 100 years. Therefore, pre-harvest peak flow events that have a return period of >10 years would now, post harvest, have a magnitude that exceeds the 100 year return period magnitude.” (Winkler).

Based on the fact that a 75% ECA can increase the magnitude of daily peak flows by 22% or more, and this increase can be equivalent to or greater than that of a 100 year event, Winkler, suggests considering a reduced ECA. In comparison, a 50% ECA will increase the magnitude of a 10 year daily peak flow event 14%.

Research in the West Kootenays indicates that watersheds with greater elevation gradients have greater sensitivity to harvesting. However, the presence of a large sub-alpine area can substantially mitigate peak flow changes.

Recommendations (from Winkler):

1. Recommend licensees use MSRM streamflow data or regional unit area runoff estimates to calculate peak flows in proposed salvage watersheds to plan drainage structures.
2. Recommend licensees perform watershed assessments in salvage watersheds to monitor/assess hydrologic change and have a record for future comparison.
3. Recommend prompt re-forestation of logged sites.
4. Recommend leaving logging slash on site. The slash will slow snow melt, reduce wind speeds (and thus sublimation), maintain soil moisture, and aid in site regeneration.
5. Recommend, where possible, minimizing forest harvesting on south facing slopes.
6. Recommend licensees plan harvesting on a watershed or landscape scale to minimize road construction and road density. No incremental harvesting as this leads to ad hoc road systems and drainage networks. Where possible, winter log.

2. Riparian

Depending on the amount of riparian that is Pli, licensees may want to consider leaving wider riparian management areas to help mitigate any potential future impacts.

Recommendations:

7. Where possible, retain all green vegetation (under-story and over-story) both in and outside the riparian area. IF ECA's are high, consider doubling current buffer widths and make them reserves. Evidence indicates dead trees can stand for 30-40 years – if the water table is lower than the root mat. If the riparian area has a larger percentage of live wood to dead wood, it is better to leave the dead than to disturb the whole site by removing the dead ones. By 30-40 years after disturbance, the regeneration will take care of any issue regarding sediment sources due to blowdown. If the sites are primarily dead pine (>60%), licensees should consider discussing with local DFO staff the benefits of harvesting the site and replanting a new forest.

3. Surface Erosion

Most surface erosion issues associated with harvesting are linked to road and drainage structures – their construction, maintenance, and de-activation.

Recommendation:

8. Recommend development of erosion control plans by a qualified specialist to minimize erosion and movement of sediment from areas of exposed mineral and organic soils, the management of overland and channelized drainage water, and the maintenance of drainage systems/structures. (Winkler)

Additional recommendations (from Beaudry 1997) :

1. For areas with high IWAP indices, limit future forest development plants to very stable sites not adjacent to stream channels until there is further green-up.
2. For areas with a high riparian buffer score, limit harvesting on unstable alluvial fans, and conduct intensive reforestation.
3. For areas with a high peak flow index, recommend special road construction techniques to maintain drainage networks and minimize erosion and sedimentation.
4. Areas with high erosion hazard should be assigned a high priority for future road surveys, road de-activation programs and slope stabilization activities.
5. Areas with medium to high riparian and landslide index scores should be targeted as a priority for more detailed hydrological analysis and watershed restoration activities.

Summary of other research

Potts, D. F. 1984. Hydrologic Impacts of a Large-Scale mountain pine beetle Epidemic. *Water Resources Bulletin*, 20 (3) 373-377.

A mountain pine beetle outbreak in 1975-1977 killed an estimated 35% of total timber in a 133km² drainage in south-western Montana. Analysis of data for 4 years prior to and 5 years after mortality indicated a 15% post-epidemic increase in water yield, a 2-3 week advance in the hydrography, and a 10% increase in low flows, but little increase in peak flows. The data indicated that, in the absence of major site degradation by soil compaction, timber-harvesting spread uniformly throughout a drainage might not increase peak flows. However, caution must be used before drawing absolute conclusions about impacts on peak discharges.

Bethlahamy, Nedavia. 1975. A Colorado Episode: Beetle Epidemic, Ghost Forests, More Streamflow. *Northwest Science*. 49(2), 95-105.

In 1939 a severe windstorm in the high plateaux of Colorado created ideal conditions for Spruce Bark Beetle. By 1946, the beetle had killed trees covering hundreds of square miles. When the epidemic finally ran its course, it killed up to 80% of the forest trees in the affected area. Before the outbreak, the stand had basal areas of 34m²/ha and volumes of 343m³/ha. Twenty-five years later, dead trees are still standing and the basal area has dropped to 10m²/ha, and volumes to 60m³/ha.

Average water yields increase for a 15 year post epidemic period were 22% for one drainage, and 14% for another.

Wildfire

The following information is taken from unpublished data supplied by Brad Hawkes, CFS, Pacific Forestry Centre, July 2001.

Impact of mountain pine beetle on fire behavior and probability of ignition

Fire risk and probability of ignition depends on 1) frequency of lightning and person caused ignitions, 2) past fire regimes and stand history (e.g. large areas of even-aged stands, multi-storey stands), 3) time since attack and fuel loading.

Specifically, IBM infested lodgepole pine is affected in the following ways;

- 1) Red needle stage – probability of crown fire is higher
- 2) Needle drop (1-5 years but generally 1-3 years). Needles stay on longer in wetter climates versus drier areas. This equates to an increase in; surface fine fuels, within stands wind speeds, and solar radiation will increase the probability of ignition. Probability of crowning drops down to pre-attack levels depending on proportion of pine in the stand and the level of attack.
- 3) Dead and down stage where the killed pine trees fall over – 1-20+ years. The increase in woody surface fuel loading would increase surface fire intensity and therefore increase the probability of crowning of the remaining trees depending on the

level of attack and surviving tree size, density and structure. There would be a probability for increase in spotting distance because of loose bark on the dead trees.

- 4) Decomposition stage. Decomposition of dead trees on the forest floor surface after they fall (10-30+ years) would likely lead to a reduced surface fire intensity and reduced potential for crowning depending on the density, size, and structure of the remaining stand.

More recent information from Brad Hawkes includes observations from the 2004 fire near the Kennedy Dam in the area south of Vanderhoof.

1. Spotting occurred directly in the red needled crowns.
2. Wider cat fireguards were built because the red needled tree crowns were igniting from the radiant energy before green needled pine ignited.
3. Some comments on more rapid fire spread but this was not measured quantitatively.
4. Higher crown consumption (needles and most branchwood) leaving tree spikes.

Wildlife

This section will be updated at a future date, in consultation with MWLAP staff.

IV) Mountain pine beetle in Kootenay Lake District

Outbreak phases

In order to understand the mountain pine beetle populations present in Kootenay Lake, it is necessary to have a rudimentary understanding of the beetle indicators that characterize endemic, incipient, and outbreak levels. The section offers an abbreviated description of those terms (from Safranyik 2003), for a more detailed description, refer to the Appendix..

Characteristics of Endemic populations

- IBM infest weakened and decadent trees, e.g. Beetles exist primarily in susceptible “predisposed trees”
- frequently found in trees co-attacked by secondary beetle species such as Ips.
- currently attacked trees seldom located near original brood trees.
- attacked trees are scattered singly or in small groups –numerically this might roughly equate to one infested tree per 40.5 ha.
- IBM pitch tubes are often not apparent.

Characteristics of Incipient infestations

- incipient populations are those with beetle numbers that exceed a minimum level necessary to overcome the resistance of the average large diameter apparently healthy tree in a stand.
- populations grow, but slowly, on average, population and infestation levels may not even double in successive years.
- populations tend to escape detection and concern.**
- most of the infested trees are in large diameter classes.
- infestations are scattered and confined to individual stands,
- clumps of infested trees grow in size and number over time.

The incipient phase of IBM population development is the most accessible and vulnerable to aggressive management action.

Characteristics of outbreak populations

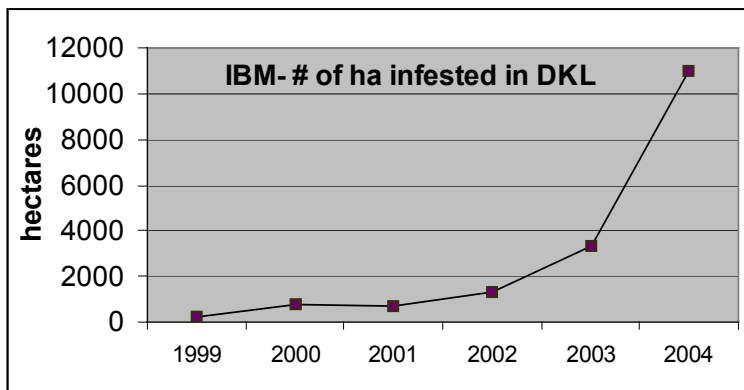
- require sustained favourable climate for beetle survival, such as a series of mild winters and good weather during the dispersal and attack periods.
- widespread with large annual increases in infested areas. Incipient infestations develop into landscape level outbreaks as groups of infested trees coalesce into larger patches and new infestations develop annually through within-stand and long range dispersal.
- populations are resilient to normal mortality and can easily rebound following large-scale mortality.

Trends in DKL

Populations/ Rate of spread

Mountain pine beetle populations have been increasing at an exponential rate over the last 3 years to the point that as of summer 2004, there were 11,115 hectares showing as

red attack in the Kootenay Lake District. This represents an approximately 5-fold increase from 2003.



However, this rate of increase is a District *average* and the rate of increase is much higher in several BMU's, and is significantly different for the BMU's located in the northern half of the District vs. the southern half. Goat River, West Arm, Fry, Lasca, and Duck, and Kid creek BMU's all showed increases of 2-4 times. Moyie river, and Summit, Fortynine, and Midge creeks all experienced increases of 10-16 times between 2003 and 2004. Hawkins creek and Riondel showed increases of an incredible 21 and 28 times. And finally, Gray creek, Darkwoods, and Kaslo River all increased by a phenomenal 60+ fold. Although aerial overview surveys tend to overestimate the amount of infestation, even if one tempers these assessments, the rate of increase is still unprecedented. And the rate of increase for the BMU's in the District with a component of pine, may be more in the range of 17 times. This accounts for the fact that 6 of the District's BMU's have negligible amounts of lodgepole pine and registered very little or no mountain pine beetle.

Green: red ratios

Green to red ratios collected during fall 2004 ground surveys ranged from 3:1 to 25:1 and averaged approximately 6:1. Cruise data collected during the winter of 2004/2005 also reflected these ratios.

Winter mortality rates

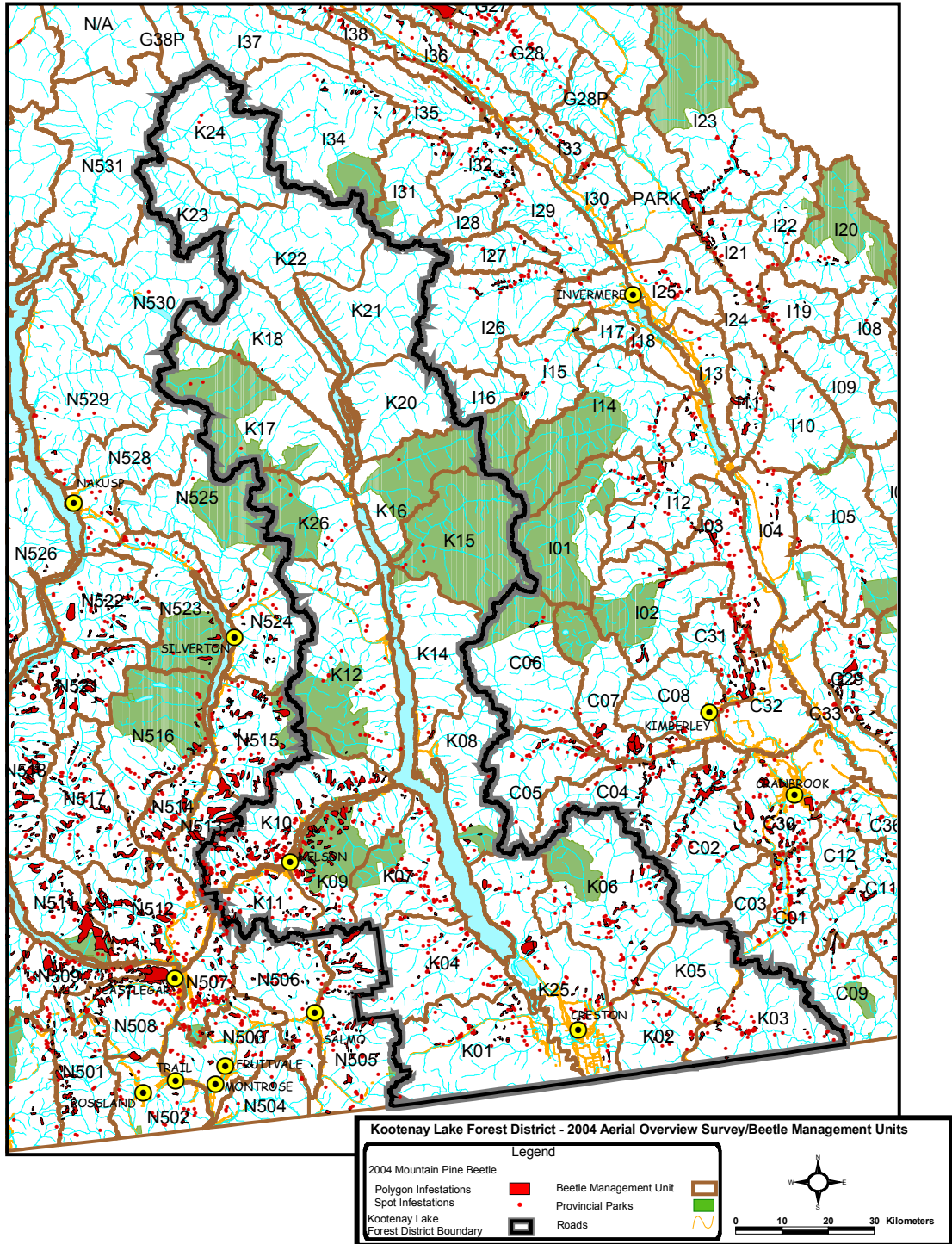
Winter mortality surveys were completed in March 2005 in 10 locations in the District. Mortality samples were collected in 4 locations in the Hawkins drainage, in West Kokanee, Busk, Sproule and Smallwood creeks, at a cross section of elevations and aspects. These surveys are done to determine winter mortality and to estimate beetle population trends for the coming year based on brood success. The R value is the ratio of successful beetle progeny to initial attack and is a reliable indicator of population trends.

Note that R values greater than 4 indicate increasing populations. Additionally, it was previously thought that R-values greater than 10 were biologically impossible. Now, however, R-values more than 10 are frequently reported throughout the southern interior.

In the winter of 2003/04, winter mortality rates of 81%, an average R value of 6, and 8.9 live larvae/15cm² corresponded to a 5-fold increase across Kootenay Lake. Results for the winter mortality surveys in 2005 indicate a whopping 20-25 live larvae/15cm², an average R value of 11.5, and mortality rates of only 45% (MacLauchlan, Rankin, and Buxton 2005). Thus, with few exceptions it is highly probable that beetle populations will again be increasing to a significant degree again in the District. The main question is to what degree the expansion will happen.

Geographic area	"R"	Ave. % mortality	Ave % brood mortality by District
Hawkins Creek	1.82	90.0%	45%
Hawkins Site 5	7.05	54.0%	
Hawkins Site 6	1.64	65.3%	
Hawkins Site 7	6.83	53.0%	
Kokanee Crk	18.25	36.9%	
Kokanee Site 8	9.85	25.6%	
Redfish	13.23	41.8%	
Redfish Site 9	15.88	13.2%	
Busk Crk	10.51	39.1%	
Site 3 Sproule Crk	23.06	16.2%	
Smallwood Site 10	7.24	59.9%	

2004 – Mountain pine beetle infestations in Kootenay Lake District



Intensity of attack

Kootenay Lake showed the following levels of red attack in 2004:

Category	% of trees infested	Number of ha infested 2004
Trace	<1%	0
Light	1-10%	5200
Moderate	11-29%	4343
Severe	30-50%	1571
Very severe	>50%	0

Mountain pine beetle populations are increasing both in the level of dispersed attack (more hectares infested) and in intensity of infestation (ie. more trees killed within a previously attacked polygon) within the District.

The outbreak has now progressed so far that most pine forest in the province is quite close to infested areas (Eng, 2004). This is consistent with DKL where most Pli stands from the 49th parallel all the way to Trout Lake are infested to some degree.

The suggestion from beetle researches is that beetles rarely kill more than 90% of the volume in a stand. Researchers at CFS suggest that in pure pine stands subject to heavy beetle pressure, 70% of the stems and 90% of the standing volume might be killed. Over the whole landscape, they suggest the average is probably closer to 50-60% of the stems and 60% of the volume (Eng, 2004). For a visual benchmark, compare this to the fact that in 2003 Arrow TSA was showing 10% attack of 10-20% intensity, and 3% with 21-50% cumulative kill (Eng 2004).

Comparison to the Marvin Eng Model Projections

As of 2004, approximately 220,000m³ have been killed in Kootenay Lake District, or 1.8% of the merchantable Pli in the TSA. (Eng pers. comm. 2005). When the 1999 to 2003 data is used to predict the percent kill for 2004, the model slightly over estimates the kill rate at 2.1%. Therefore, empirically, the beetle populations in Kootenay Lake are currently close to what the model is predicting. However, the incidence of red attack *mapped* in Kootenay Lake shows less red attack than is *actually* found. This is particularly true for the northern half of the District where detailed mapping was not done. Thus, in fact, the model may be closer still to predicting the actual kill rate.

Note that using the 220,000 m³ of infested compared to a District calculated 7 million m³ of Pli in the THLB suggests a slightly higher infestation rate of 3.3% red attack as of 2004.

Emergency Beetle Management Status

As of February 15, 2005, the entire Kootenay Lake District has been designated as part of the Emergency Bark Beetle Management Area (EBBMA). Bob Clark, the Provincial Beetle Co-ordinator assigned this classification in recognition of IBM conditions within the District.

Assistant Deputy Minister Tim Sheldon's March 22, 2005 memorandum noted that "for the purposes of emergency bark beetle harvesting, district managers may approve the use of blanket salvage permits only in areas designated as aggressive, or sanitation pursuant to Section 109(2) of the Bark Beetle Regulation. Region has since provided further clarification denoting that this basically applies to all BMU's that are designated as Suppression and Holding. Because all of Kootenay Lake is either Holding or Suppression, the BBR can apply to all appropriate areas within the District.

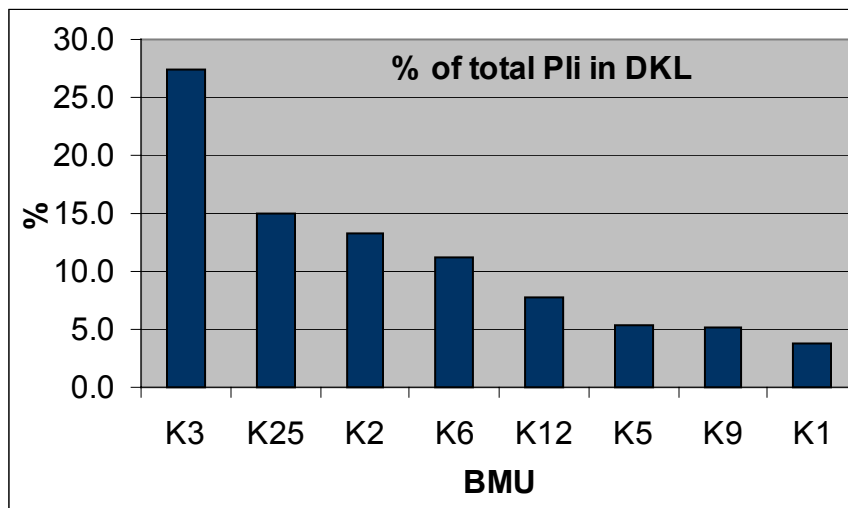
Distribution of lodgepole pine leading stands in the District

When an assessment of the lodgepole pine leading stands is done for the District, it becomes even more apparent that most of the Pli is mostly located in 8 of the District's 26 BMU's. Note that for the purposes of the graph, BMU's showing less than 3% of the District's Pli leading types were deleted.

Not surprisingly, most of the lodgepole pine is located in K3-Hawkins Creek with 1,948,222 m³ or 27.5% of the District's total pine. The BMU's in descending order with the next most lodgepole pine are K25-Duck Lake with 1,064,690m³ or 15%, K2-Little Moyie with 935,412m³ or 13.2%, K6-Goat River with 793,447m³ or 11.2%, K12-Kaslo River – 553,902m³ or 7.8%, K5-Kid Creek –374,989m³ or 5.3%, and K9-Lasca Creek with 365,471m³ or 5.2%. (K1-Summit creek shows 263,832 or 3.7%). Other BMU's each with less than 5% of the District's lodgepole pine were omitted for the purposes of this graph but are found within the Appendix.

This graph helps to assess where the mature pine is located within the District. It is interesting to note that the Duck Lake BMU contains more mature Pli than does the Little Moyie or Goat River areas. Equally of interest is the fact that there is as much Pli in the Lasca creek BMU as there is in the Kid Creek BMU. Also, although most (88.9 %) of the lodgepole pine is found within 8 BMU's, another 11% is scattered across another 11 BMU's.

Pending further data, which will show the number of hectares in the moderate and high hazard categories in the THLB by each BMU, the District will be able to more closely align it's forest health program compared to timber values at risk and the mountain pine beetle populations.



District role- the forest health program

Guiding principles

The intent is that the Kootenay Lake District Forest Health program will operate under the following principles;

- remain abreast of the most current research and it's implications.
- manage to biological principles.
- use empirical data to monitor trends and performance.
- try to minimize losses due to the beetle while still preserving biodiversity and other values.
- work with all agencies (Licensees, Woodlot owners, Community Forests, WLAP, and Parks) to achieve the highest degree of beetle management possible.
- strive to push the boundaries such that administrative constraints are not limiting.
- remain in contact with the Regional Entomologist on a weekly or bi-weekly basis, and undertake joint field reviews with same.

The program

In the last 3 years the forest health program has experienced numerous changes, including the rise and fall of the DFAM concept, personnel changes, and the eruption of the bark beetle epidemic. As of 2005, guidance is that the program will be moving back under the umbrella of the District Stewardship staff. That said, it will take the participation of licensees, ministry staff, and contractors to carry out a solid forest health program. This section represents a concept of how this transition year might unfold.

Aerial overview surveys

As per usual, Region (Southern Interior) will undertake the aerial overview surveys in July-August.

Detailed aerial surveys / "measle maps"

To a certain degree, the aerial overview surveys will help to guide where the detailed aerial surveys will be done. However, the detailed surveys are not dependent upon the timing of the overview flights.

In 2004, WLAP undertook a province wide detailed program where aerial photos were taken and then photo interpretation and digitizing was done on the resultant photos. Ultimately this culminated in extremely accurate 'measle maps'. However, as accurate as those maps were, they were not produced in a timely fashion for all areas of the province. It has been concluded that such a program is not a viable option to continue with.

In 2005, the detailed aerial surveys will be done at the District level. However, the 2004 mapping project suggested new ways of doing the detailed aerial work - i.e. taking current air photos as a base vs. the previous method of using someone fly around in a helicopter and map the infestations. Given the learning of 2004, and the sheer number of infestations, it will likely be impractical to continue with the traditional rotary wing

flights. The District intends to explore new procedures, resulting in a product at least somewhat similar to the maps of 2004. A budget submission was made for some of the mapsheets covering most of the “Suppression” BMU’s in the District. However, if licensees are interested in contributing funds, perhaps more area could be done.

Timing

In the bark beetle management cycle, the timely completion of the detailed aerial overview surveys, map production and digital data distribution is critical to the success of rest of the cycle –including ground probes, fall and burn, and harvesting. Thus, every effort will be made to produce sound maps by mid September.

Locations

The 2005 budget submission was done on the assumption that a minimum of 23 mapsheets in the Suppression BMU’s would be flown. This figure may be juggled up or down depending how the bark beetle levels unfold. However, the focus will be on Hawkins, Kid, Little Moyie, Kaslo River, Riondel, Summit, Duck creek, and Gray Creek BMU’s. Second priority would include the Goat River BMU.

Pinch points

The District does not currently have the capability to prepare maps and distribute them to all the necessary users in a short time period. This is potentially a serious pinch point or bottleneck. The District has applied for funds to allow for the prompt processing of the digitized measles data.

Fall Map reviews

The District and the licensees will sit down with the measles maps and do a preliminary review of where harvesting is likely to take place, which areas are deemed to be licensee responsibility for fall and burn, and where recce’s will be needed prior to doing full ground probes and fall and burn. The identified infestations will be assigned reference numbers to allow tracking of management activities and/or decisions.

Following the field recce’s by the respective licensees, the District and the licensees will again sit down and jointly decide where to do fall and burn and probes etc.

*** Note that this will be an iterative ongoing process occurring throughout the fall and winter.

Fall and burn

Fall and burn will not normally be done for licensees in areas where they plan to harvest e.g. normally considered to be ‘areas under the plan’ or areas usually within 400m of a cutblock, or road. However, the intent is that the District and Licensees will sit down together and jointly come up with a plan on where to best focus these treatments.

It is intended that the fall and burn program will focus on areas very similar to that of the 2004/05 season; the 2005/06 fall and burn program will focus on the Suppression BMU’s, particularly in the areas where fall and burn will be effective. Thus the intent is

to focus on Hawkins, and Kid BMU's. Secondary areas would include possibly Duck creek, and Little Moyie,

If the licensees are amenable, the District fall and burn program will likely be run in concert with the two key licensees (Tembec and BCTS) in the Hawkins, Kid, and Little Moyie BMU's. As the season progresses, the involved parties will explore this option. Once again, speedy delivery of the program is essential to its success.

Budget

The District will prepare (with review by Licensees) and submit a budget on an annual basis to the Regional Entomologist.

Forest Health Strategy

The District will prepare (with review by Licensees,) and submit a budget on an annual basis to the Regional Entomologist. This will include the BMU strategies for the 3 key bark beetles and will be jointly reviewed on a biannual basis (minimum) with the Regional Entomologist.

Matrix showing responsibilities by agency:

Item	Responsibility	Comments
Winter mortality surveys	MOF – Region	
Aerial overview surveys	MOF - Region	
Forest Health Strategy	MOF - District	
Detailed Aerial survey	MOF – District(or Branch)	Suppression BMU's only
Fall and Burn	MOF- District	Suppression BMU's only, and only for areas not under Licensee responsibility
Ground Probes	Licensee's	For areas that are licensee responsibility
Ground Probes	MOF	For areas not licensee responsibility
Recce's	Licensee's (+ MOF for areas not licensee responsibility)	To determine where to fall and burn, where to harvest etc.
Review BMU strategy	All (MOF Region, MOF District, + Licensee's)	
Apply for EMU status	MOF District	
Public relations	All.	

Survey data.

In order to support management of the bark beetle program, it is necessary to know green to red ratios, population status etc. in the respective areas. As they have done previously, licensees should continue to submit bark beetle information in a timely manner, preferably using a format similar to the table below.

Although bark beetle infested areas may initially be identified via a variety of methods including aerial surveys, in order to rationalize harvesting (either salvage or full stand), the following information should be collected:

Recommended basic components of a 'forest health assessment' are;

1. The identification of major forest health factors, if applicable, including factors that are contributing to the problem being assessed (i.e. interaction of Armillaria Ostoyae and Douglas-fir bark beetle)
2. Incidence and severity of the forest health factor; (ie. Number of red and green attack, green:red ratios)
3. Stand susceptibility and risk assessments of the affected and adjacent stands. (ie. Shore-Safranyik) rating. (note that free software is available from the Pacific Forestry Centre website. This software is a simple one screen program that uses age of the stand, basal area, density, latitude, longitude, elevation, distance to nearest infestation and number of infested trees to calculate Stand susceptibility, Beetle Pressure Index, Pine susceptibility Index, Pine Risk rating, and the Stand Risk Rating. http://www.pfc.forestry.ca/entomology/mpb/tools/DSS/software_e.html#downloads)
4. Percentage of the susceptible stand type that is infested, and percent of the stand that is vulnerable.
5. Maps showing the location, boundary, and distribution of the forest health factor; (note that survey intensity should be guided by the Bark Beetle Management Guidebook as well as by Professional expertise.)
6. Type and date of assessment procedures used (i.e. survey or ground probe location, survey intensity)
7. Description of the measures that will be undertaken to reduce identified risks.
Note: If harvesting is proposed vs. fall and burn treatments, then information should show that the number of infested stems is beyond the scale of fall and burn.

Bark Beetle Ground surveys - Timing

Guidelines for planning ground survey activities:

Bark Beetle species	Start date of survey	Target Completion date
Mountain Pine Beetle Priority 1.* Priority 2.**	September 1. October 1	September 30 November 30
Douglas-fir beetle	August 1	September 30
Spruce bark beetle	August 1	August 31.

Survey priorities should reflect the susceptibility rating of stands, with the highest hazard, accessible stands surveyed first as follows:

*Priority 1 – harvestable in terms of access and merchantability

**Priority 2 – inaccessible or suitable for small scale treatments.

Mountain Pine Beetle Assessment – Sample Summary Table.

LU	Map/Poly	Area (ha)	Timber type	Age	Vol m3/ha All spp	Vol m3/ha Pli ≥12.5 cm	Infestation %	Green to Red Ratio	Survey type	Suscept & Risk rating	CP / Blk	Treatment & Schedule

30	82K095-099	23	PI(Fdi)	118	256.9	95.3	10	2:1	Grid	Mod/Mod.	76/2	Monitor, possible salvage
1	82F009-001	47	Pli	100	189.2	66.4	26	3:1	Walkth rough	High/High	NA	Bait spring 200x, Harvest fall 200xy

When seeking emergency approval for harvest, submit assessment results as supporting rationale.

Pheromone baiting guidelines

To be inserted as soon as possible (although guidelines are available separately from the District).

Hauling Restrictions/ Guidelines

To be inserted..

Winter Mortality Surveys

The Region will continue to administer and contract. However the District will assist in identifying the actual locations from which samples will be taken.

XX

Decision points

-to be added:

(notes):

-as pass each forest health management goalpost (e.g. 80% = Suppression), will consider altering management strategies.

-possibilities:

-move licensees –increase harvest amount in a given BMU (but keep AAC for the District same)

-apply for uplift.

Timber Harvesting Strategies for Kootenay Lake District

Biological Principles

It is the intent that the harvest and salvage strategies in Kootenay Lake should follow the principles in line with bark beetle epidemiology, and the recent modelling work done by Eng (2004) and Fall, Shore, et. al (2003) that compared the effects of different harvesting strategies..

Rule of thumb for determining number of infested trees requiring treatment

A key precept in managing mountain pine beetle is that $\frac{1}{2}$ to $\frac{3}{4}$'s of the infested trees have to be removed just to keep the infestation from *growing*. If we want to *suppress* the infestation, a still higher proportion of trees must be removed. (Shore and Safranyik, 2003). Thus, if the average yearly rate of increase is 3, more than $\frac{2}{3}$ of the infested trees need to be treated each year in order to suppress the infestation. Bearing this concept in mind, with large annual expansions, it quickly becomes apparent that it does not take long before a bark beetle population cannot be suppressed by either single tree treatments or by focusing on the leading edge and harvesting the green attack trees.

The “Suppression” strategy rests on the premise that 80% of the brood (ie. Green attack trees) can be destroyed or removed prior to bark beetle flight.

1 to 512 trees in 10 years rule

The other key concept to recognize is that single tree treatments done early in the incipient phase can have significant effects years later. A single infested tree in year 1 can result in 512 infested trees in year 10 if the population doubles every year. Thus especially early on, even partial treatment of infested trees can have some effect in the longer term (Shore and Safranyik 2003). Although this may only be a delaying tactic (as opposed to a suppression strategy), it may provide additional time in which a negative weather event will affect the population. At the very least, it will allow for more time to mobilize against the epidemic. This would then help to reduce unsalvaged losses and possible socio-economic concerns. The longer time frame that the infestation can be spread out over, the better.

The combination of the two concepts leads to the precept that there is a threshold of attack, below which small scale treatments (fell and burn, harvesting small patches, etc.), are warranted and above which, overall focus on mitigating impacts may be better (Fall, Shore, et.al. 2003). Thus beetle management can be effective to manage the outbreak provided the outbreak is below a critical threshold. Above this threshold, the potential for the outbreak to expand exceeds resource capacity. The key message is that early attack is a key approach in reducing the risk of an outbreak growing beyond containment resources.

Overall principles to guide harvesting

- Adhere to landscape level guidelines suggested earlier.

- Draw down the susceptible Pli inventory concurrent with infested Pli stands e.g. As the rate of spread increases, plan for more harvest of moderate and higher susceptible types. (District will need to monitor this closely.)
- Maintain other values, where possible, especially riparian, water, and soil
- Aggressively manage the mountain pine beetle.
- All harvesting must withstand the scrutiny of sound forest management practices
- Harvest beetle infested wood, or wood about to be infested or trees of moderate or high susceptibility (as per Shore-Safranyik hazard rating)
- Provide information about bark beetle levels on a stand level basis in an open and transparent manner.
- Focus on stands with more than 30% Pli.
- Silviculture and long term TSR will not be compromised (e.g. No high-grading). Stay out of stands with understory with a pole layer.
- Give consideration to harvesting white pine, particularly if it is infested with mountain pine beetle or if it is proximate to infested Pli stands.
- Focus on certain drainages (e.g. be strategic).

Harvest Strategies

Another question people also wanted answered in a quantitative way was the debate as to whether or not bark beetle management strategies affect mountain pine beetle populations. The same scientists assessed this question.

At a provincial level, beetle management does not slow the outbreak. However, at the periphery of the outbreak (e.g. Kootenay Lake District), beetle management appears to have the desired effect; the peak in annual kill occurs later as beetle management is implemented and single tree treatments depress the amount of kill throughout the outbreak. (Eng 2004).

Not surprisingly, no management (no harvesting) and no beetle management scenarios have the highest cumulative kills. By concentrating harvest on pine, there appears to be a positive impact on the volume of pine killed

Harvesting green attack trees (Leading edge strategy)

Those strategies suggest that when the outbreak lies within harvest capacity, the preferred harvest option is to first harvest the leading edge of the attack, and then to focus on salvage. Alternatively, it is suggested that the focus could continue on the leading edge, but to increase the cut to keep pace with the levels of bark beetle infestation. This leading edge strategy is likely currently a viable option for Hawkins, Kid Creek, Gray Creek, and the Kaslo River BMU's.

Salvage-focus harvesting (Trailing edge strategy)

The salvage focus harvesting or trailing edge of an outbreak has high levels of salvage and also has high levels of mountain pine beetle. This strategy appears to be relatively effective from both a salvage recovery and a MPB population suppression perspective. In addition, a trailing edge MPB management strategy may have reduced operational

costs (e.g. fewer ground probes would be required.). Note that this strategy differs from a grey salvage focus. The ‘salvage focus harvesting’ or ‘trailing edge’ strategy targets stands with high merchantability salvage and implies recently killed and a high likelihood of relatively high beetle populations as well as some living hosts. In contrast, the ‘grey salvage’ strategy targets stands with a high level of any age of salvage meaning that there may be very few beetles remaining in the stand.

In areas where the rate of beetle infestation has reached epidemic levels, a ‘trailing edge’ strategy is generally more effective in reducing beetle populations and maximizing the recovery of salvageable timber (Eng 2004). This strategy is more appropriate for the West Arm, Duck Lake, and Fortynine Creek BMU’s.

Stand level harvesting priorities

The following table provides a matrix of stand characteristics to set priorities for salvage among stands. This matrix provides a sliding scale of the possible outcome (percentage of volume that is pine) and the current state (percentage of pine volume killed).

Priority for Salvage based on stand characteristics and level of beetle kill (modified from McLennan 2003).

<i>Priority for salvage based on stand characteristics and level of beetle kill (modified from McLennan 2003)</i>				
	Percentage of pine volume killed			
Percentage of stand volume that is pine	<30%	30-50%	51-70%	>70%
<30%	No	No	No	No
30-50%	Low	Low	Low	Low
51-70%	Low	Moderate	Moderate	High
>70%	Low	Moderate	High	High

An additional consideration should be that stands that are well stocked with pole-sized regeneration of species other than pine should have a low priority for salvage because these stand will develop old-growth features commercial value faster than ones without an understory.

From technical report #19

-At the landscape level, there should be little, to no, salvage harvesting in the non-contributing land base and, at the very least, what was originally planned under existing landscape-level plans should be left.

-at the stand level, there should be no changes to the provisions made for riparian management areas and riparian reserve zones. As well, there should be no changes to the management of wildlife tree patches, wildlife habitat areas, and other fine-filter measures. Legacies of coarse woody debris should be left throughout the blocks.

-to the extent possible, the area chosen for salvage should have the highest level of infestation and the highest proportion of pine.

Timber Supply Implications

Scope of the Issue

The Chief Forester indicates that the problem is, "an epidemic of catastrophic proportions" (Pederson 2003). Because of those beliefs he posed the question, "How serious is the mountain pine beetle problem from a Timber Supply Perspective?" To that end Marvin Eng and several entomologists from the MOF and CFS modelled prospective impacts. They suggest that by 2020, the mountain pine beetle will kill virtually all of the susceptible mature pine. Additionally, the suggestion is that there is no reason to expect that less than 80% of the pine will be killed.

Given the cost of harvesting in the West Kootenays it is doubtful that companies will be able afford to harvest stands that have 50% mortality? Thus, it is incumbent upon all involved to manage the mountain pine beetle problem as aggressively as possible. With a higher percentage of mortality, there will be proportionately more severe timber supply impacts.

Rate of spread

The other factor noted by the Chief Forester is that, "we continue to be astonished by its rate of progression over such a vast area as the interior." (Pedersen 2003). This seems to bear out amongst all entomologists and forest health officers. From 1994 to 2000 the beetle spread at an average annual rate of 44% (Pedersen 2003)

In Quesnel , the mountain pine beetle is projected to increase yearly by 40% until all hectares of the high risk pine stands became infected at varying intensity levels. Analysts were surprised to note that this occurred as early as 2004. Therefore, they believe that 40% expansion rate is conservative for Quesnel; the rate of spread over the last four years in that area was actually likely much higher than 40%.

Intensity of attack (

The other key point of debate is what % of the pine will be killed. The suggestion seems to range from 40-80% of the Pli of the high risk.

Age classes affected

All indications are that all mature – 80 years or older (possibly 60 years and older) will be affected. Locally, in areas of high beetle pressure (e.g. Grohman), the beetles appear to have moved into the younger stands that are about 60 years old.

Adjacent jurisdictions

Given that bark beetles can feasibly fly one to several kilometres means that beetle populations in areas adjacent to Kootenay Lake District become pertinent to managing the beetle within the District.

Rocky Mountain District

The old Cranbrook District portion of the Rocky Mountain District is experiencing similar increases in mountain pine beetle populations as Kootenay Lake, having sustained a 350% increase between 2003 and 2004. Nearly three quarters of their 29, 834 ha of red attack was classed as either moderate or severe. However, for the most part much of this infestation does not particularly impact beetle populations in Kootenay Lake. In Cranbrook heavy infestations occur in the Perry Creek area, but also corresponds to intense levels of attack in the Kamma creek area on the Kootenay Lake side. Kid Creek and Hawkins creek are the other key BMU's that share borders with Cranbrook. For the most part BMU's in both Districts in those areas area fairly clean. Given that prevailing wind patterns are from west to east means that beetle populations in Cranbrook District are not especially likely to influence mountain pine beetle levels in DKL.

Arrow/Boundary District

These same winds that are sheltering Kootenay Lake from Rocky Mountain District beetle populations, are providing an influx of beetles from the Arrow/Boundary District. In particular, it appears that bark beetles emerging from Winlaw, Pedro, and Trozzo creeks are overflowing into the Sproule and Smallwood creeks in the Kootenay Lake District. Additionally, beetles from Ymir, Porcupine, and Sheep creeks look to be moving from west to east in the Darkwoods and Summit Creek BMU's. Thus, the activities in each District can have far reaching effects spilling over to other Districts.

United States

At this point in time communications have not been made with forest health professionals the United States. However, over the next year the Forest Health officer in DKL intends to initiate a working relationship with our counterparts to the south, particularly for the area south of the Summit Creek, Little Moyie, and Hawkins Creek BMU's.

Parks

Mountain pine beetle populations have been a concern in the West Arm Provincial Park for a number of years (Phero Tech In. 1993). As evidenced on the overview map, there are now approximately 25 polygons existing either wholly or partially within the Park. As of 2004 beetle populations in the entire West Arm area both within and outside the Park have increased substantially. With the exception of Harrop Creek, most lodgepole pine stands outside the park have been infested to a significant degree. Additionally, beetle populations within the park are beyond any suppression efforts. The IBM status in other parks in the District is discussed by BMU.

Constraints

There are a number of factors that make management of IBM in the Kootenay Lake District a challenging enterprise. Many of these constrain the operable land base, making it ever more critical that the District manage its timber supplies in the most prudent fashion possible.

Terrain

Excepting the Hawkins and Kid Creek BMU's, most of the rest of the District is characterized by steep valleys. Most of the easier terrain has already been harvested meaning that a majority of the remaining Pli is challenging to access, and is frequently at higher elevations.

Timber Harvesting Land Base (THLB)

Although the District comprises 1.29million hectares (including water, private land etc.), only approximately 20%, or 257,000 hectares of that is categorized as part of the Timber Harvesting Land Base. Furthermore, about 266,000 hectares of the area consists of Parks.

Community & District watersheds

The District has 50 community watersheds and approximately 40% of the THLB is in either community or domestic watersheds. There are several thousand water licenses registered over this landbase.

Grazing Tenures

Much of the land in the Creston/Yahk area (Hawkins BMU in particular) is important to ranchers for cattle grazing.

Ungulate Winter Range

Ungulate Winter Range covers a large proportion of the district. Fortunately, most of this area is low elevation, and lodgepole pine is of limited value as a wildlife species. For the most part concerns for UWR appear to be resolvable at the landscape level.

Visual Quality Objectives (VQO's)

Approximately 30% of the District has constraining VQO's. This is because populated corridors transect much of the District, and Kootenay Lake and scenic concerns are a key part of the landbase.

Species at Risk

Although there are several species at risk found within the borders of the District, there are three in particular that must be addressed when considering the mountain pine beetle. The Mountain Caribou (much of the area), the Tailed Frog (Hawkins creek), and the Cour d'Alene Salamander (Duck Lake). Any harvesting will certainly recognize and manage for these species.

Also, consideration should be made to working with Water, Land, Air Protection (WLAP) to access some of the Federal Funds allocated for the mountain pine beetle initiative in order to rehabilitate some of the pine stands specifically for caribou.

Administrative guidelines - salvage rates

The current salvage rates appear to be oriented towards salvage in the central interior thus they do not recognize the additional costs of harvesting in areas such as the Kootenays. Nor do the rates work for helicopter salvage. Both are key concerns to addressing the bark beetle in the West Kootenays.

Roads/access management

Road development should be managed on a proactive basis to address hydrologic concerns (discussed in the Hydrology section), safety, wildlife management, and public access issues.

Number of Tenure holders

There are numerous tenure holders of different types within the district, this means that managing for the mountain pine beetle will necessarily involve numerous players. The district has eight -major licensees, three community forests, and fourteen woodlots.

Perceptions Knowledge/ Human nature

A large component in managing any natural event entails not just addressing the issue, but also involves managing the human element. Managing such situations requires co-operation and active participation by numerous parties. In the case of the mountain pine beetle epidemic, this is particularly so, and bears some consideration. While we spend time assessing bark beetle levels we rarely understand the human reaction to the epidemic and this response needs to be acknowledged in order to deal with the beetle.

With regard to the mountain pine beetle situation, people's perceptions have been affected by several factors;

- 1) People are used to seeing the level of infestation in the Central Interior e.g. "red to the horizon". Because the pine forests in the Kootenay Lake area are not as widespread, and hence the amount of red attack is not as contiguous, there is a perception that the level of infestation here isn't that high.
- 2) Due to our mountainous terrain, people can only see limited portions of the landscape from the routes generally travelled; people cannot see the total amount of infestation until one gets in the air.
- 3) There is a widespread lack of understanding of the characteristics that represent endemic vs. incipient vs. outbreak beetle populations.
- 4) The mountain pine beetle populations have increased at such a rate that people's perception, knowledge, and understanding of the situation is behind the actual situation.

- 5) The mountain pine beetle epidemiology is somewhat complex, and challenging to understand in relation to lodgepole pine silvics, and the management strategies linking to both.
- 6) Much of the literature regarding the management of catastrophic or large scale events, notes that people tend to respond with disbelief and scepticism; people often don't believe something is going to happen until it has happened. Note that people often over react to some events that while catastrophic, are localized and the risk of them happening again is low. Meanwhile it is difficult to convince people that large scale, less flamboyant, on going events are of concern. Ie. There is some scepticism that the bark beetle epidemic will happen in the West Kootenays, when in fact it already *is* happening.
- 7) There is a perception that there is not very much lodgepole pine in the Kootenay Lake District. In fact, because it is generally somewhat of a lesser preferred species compared to Spruce, or Douglas-fir, as a species it has not been focussed on for harvesting to the degree that the other more valuable species have. Thus, a significant component of pine remains in the district.

Resources

Previously, the District had one full time Forest Health Officer to manage the program. At the height of the Douglas-fir bark beetle epidemic in 2001, the District had 677 hectares infested with Douglas-fir beetle, and 943 hectares of mountain pine beetle. Contrast that to 2004 when the District had 11,115 hectares infested with mountain pine beetle, and 123 hectares of Douglas-fir beetle to manage with 0.5 of an FTE. Using these comparisons and recognizing the scope of the IBM epidemic shows that it will be less than ideal to manage the epidemic with current resource levels.

V) Detailed BMU Summary

K1- Summit Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	656	388	1044	12	6	661	60	Suppression
IBS	11	0	11	0	0	0	Negligible	Suppression
IBD	102	14	116	0	0	0	Negligible	Suppression

IBM status

In the last year MPB populations have picked up considerably, from a sprinkling in 2003 (60 ha), to 661 ha in 2004, a 10 fold increase. Most of the remaining Pli stands exists at higher elevations in the Topaz and Summit Creek areas.

Management status

J.H. Huscroft has recently put in a development to harvest some of the Pli in these areas including 5-6 blocks, about ½ cable harvesting and a good portion of it Pli. However, for the most part, the bulk of this area is in caribou habitat and so would take some work to proceed with harvesting.

K01	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	133	47,938
Pli	1206	263,832

Limitations: much of the remaining Pli in this BMU exists on steep, difficult terrain. Thus, most Suppression efforts in this BMU will be directed at harvesting and protecting the Pli on a stand level basis. It would be unrealistic to try and stop the beetle in most of the rest of the area as much of the remaining pli is problematic from a harvesting point of view.

IBD

Most of the Fdi in this BMU is situated along the lower elevations of the mountains facing the Creston Valley (e.g. Adjacent to the Creston Valley Wildlife Mgt. area). Currently IBD populations are low, but will be monitored accordingly.

IBS.

The number of hectares of moderate and high hazard spruce types only show 11 ha. This seems unrealistically low given that this BMU is mostly an ESSF type. (This figure needs to be checked into prior to the 2006 FH strategy). However, IBS populations are currently at very low levels. Given that the area is designated as caribou habitat means that the BMU needs to be monitored for IBS as a high priority.

K2- Moyie River

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations ⁵ =	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	2240	689	2929	5	15	143	15	Suppression
IBS	0	0	0?	0	0	0	0.25	Suppression
IBD	78	36	114	0	0	0	0	Suppression

IBM- status

IBM increased almost 10 fold in this BMU from 15 ha in 2003, to 143 ha in 2004. There are reports of field surveyors counting 100 green attack in an OGMA (Old Growth Mgt. Area) before they quit counting. Beetles in this BMU are moving into the outbreak phase.

The beetles are nearly beyond control here. Projecting ahead, if the beetles continue to increase 5 fold 15 hectares will become 143 hectares by summer 2005 and then 3573 hectares by summer 2006. Thus it becomes critical to destroy as much of the brood (80%), as possible this year.

Management status

During the winter of 2004/05, 345 ha of ground probe surveys were done, and 119 trees were felled and burned.

Tembec's operating area:

- For 2005, Tembec plans to harvest approximately 375 ha.
- Tembec's field crews suggest that the infestations around Tally creek are likely beyond fall and burn strategies.
- several areas that were noted as red attack in 2004 were unable to be addressed through the winter of 2005.
- ground surveys will be done in spring/summer of 2005 on an unnamed creek in the Little Moyie drainage.
- the largest polygon in Banman creek is mostly contained by CP 125. However, there are several WTP that will contain IBM infestations (note that while this may compromise the 'Suppression' category, leaving the WT Patches is in keeping with management for biodiversity.)
- the polygon below CP 32-2 is within CP 125. Consider pheromone baiting.
- review the blocks in CP 113 and CP 142 in the winter of 2005 for harvest priority and for IBM activity.
- consider pheromone baiting all blocks in CP 125 and CP 113.

Limitations

This BMU consists of some challenging ground; in some areas there are bands of inoperable (rocky, dry) at mid slope.

-Ungulate winter range.

K02	Mature THLB (ha) -netted down	Mature THLB (m3) - netted down
Pine	46	16,807
Pli	4,253	935, 412

Recommendations

1. This unit represents 935,000m3 out of approximately 7 million m3 in DKL; therefore it is critical to aggressively manage beetle within the unit.
2. Depending on harvesting and fall and burn levels, this may be the last year that this BMU is designated as ‘Suppression’.
3. Tembec crew’s are working flat out to lay out pli. However, based on the amount of susceptible types, and IBM populations, increased harvesting levels should be considered over the coming year.
4. Practice a leading edge harvesting strategy in this BMU.
5. Need to be as aggressive as possible in this BMU over the coming year.
6. Consider doing fall and burn on inoperable timber types. Assess infested trees for capability to produce brood.

IBS.

Data shows no moderate or high susceptible spruce stands. Continue to monitor

IBD

The unit shows 114ha, of moderate and high susceptible types; most are in low elevation types, key to winter ungulate habitat.

-Monitor for suppression on an aggressive basis

K3- Hawkins Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	6777	1357	8134	14	39	429	20	Suppression
IBS	10	0	10	0	0	0	0	Suppression
IBD	0	0	0	0	0	0	0	Suppression

IBM

This BMU is still designated as a ‘Suppression’ BMU meaning that 80% of the brood needs to be destroyed or removed. This equates to 0.8 x 429 hectares, = 343 hectares.

The rate of increase from 2003 to 2004 was 21 times. Again, many of the beetles are initiating in stands of marginal operability, usually these are south and west facing aspects at low elevations. Much of this increase occurred in the front part of the Hawkins drainage and the slopes facing the highway to Kingsgate. The number of spot infestations has increased and a few polygons have appeared along the low elevation south/west facing slopes (e.g. Elmer, Elmira, King, and Mahon areas).

Management Status

During the winter of 2004/05, 1968 ha were ground probed, and 384 trees were felled and burned.

BCTS and Tembec are the two principle licensees operating in this BMU.

BCTS

In the last 8 months BCTS has embarked on an aggressive bark beetle management strategy for the Hawkins drainage. They have hired a forest health consultant who reviewed the hazard rating for each stand within their area. Each stand has been prioritized for treatment, and BCTS is aggressively laying out roads, harvesting, and baiting in much of these areas.

BCTS is selling 629 ha of Pli in 2005. Plans for 2006 are in the works.

Tembec

Tembec is doing layout, harvesting, and baiting, particularly in the Mahon creek areas. It is anticipated that they will harvest approximately 75 hectares in this BMU in 2005.

If rough projections are made that there will be a 5 fold increase (conservative given that the increase from 2003 to 2004 was 21 times), then 429ha x 5 = 2145ha infested by 2005, x 5 = 10,725 ha in 2006. Granted, these are broad projections but the numbers involved should seriously be considered given 1) the increase that happened in the last year, 2) early indications of good survival in the brood this last winter, 3) and the number of infested trees in the inoperable and private land areas that are not being treated.

K03	Mature THLB (ha) -netted down	Mature THLB (m3) - netted down
Pine	55	20,415
Pli	8,528	1,948,221

Limitations

- range permits
- water (Hawkins creek)
- number of infested trees on the inoperable land base and on private land (all along the highway south to Kingsgate)
- However, there are fewer limitations here compared to elsewhere.

Recommendations

1. The treatments done in the next year in the Hawkins BMU are pivotal to keeping the area in a Suppression strategy. This BMU (and the Kid creek BMU) should be the top two priorities in the District.
2. Confirm status of large polygon in the Mahon area (slated for harvest?).
3. Harvest polygons of infested pine as a high priority.
4. Consider fall and burn even in 'inoperable' areas; assess all stands for their capability to produce brood, and not necessarily on the same parameters as for harvesting.
5. Be as aggressive as possible with the beetle in this BMU.
6. Update the forest health database; monitor the status and action taken for each infestation point.
7. Treat the area as a high priority for detailed aerial survey work.

IBS

No ha in moderate or high hazard.

IBD

No ha in moderate or high hazard.

K4- Darkwoods

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	306	59	368	17	46	328	5	Suppression
IBS	11	0	0	0	0	0	0	Suppression
IBD	332	386	718	0	0	0	0	Suppression

This BMU consists of an area of private property held by Darkwoods Forestry. The land was part of a grant to the Nelson and Fort Sheppard Railway in 1897. Over the years it passed through the hands of many owners, although most of the owners were American. In 1967 a German family purchased the area and has owned it since then. More than 85% of the area is situated on terrain higher than 1400m elevation.

IBM – Status

The Darkwoods Foresters are reporting many, many green attack in stands where in 2003 there were no beetles at all. This is consistent with the change in red attack (328 ha) in 2004, from a mere 5 hectares in 2003, an increase of **66** times the amount of area infested.

IBM - Management

This BMU has minimal impact on surrounding crown land BMU's (except K1- Summit creek to the south and K25- Duck Lake to east where beetles could spread).

Darkwoods is pursuing an aggressive approach and they have hired J.S. Thrower to do a forest health/bark beetle strategy based on an outline suggested by Lorraine MacLauchlan, Ph.D., and forwarded by the Kootenay Lake Forest District. Darkwoods Forestry has applied for funding from the Federal government (Mountain Pine Beetle Initiative). They plan to pursue a Suppression strategy at this time.

Recommendations

The MOF has no jurisdiction over this land but strives to work co-operatively with the landowner on bark beetle management by sharing data and information.

K5- Kid Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	1817	475	2292	0	15/ 225 trees	137	31.9	Suppression
IBS	0	0	0	0	0	0	0	Suppression
IBD	91	23	115	0	2	30 trees	0	Suppression

IBM - Status

Mountain pine beetle levels in this BMU are still generally very low, especially compared to the rest of the District. Even though this BMU is showing a 4-fold increase, it is still somewhat beetle clean and all efforts should be made to keep it that way. Thus, this BMU and K3- Hawkins are the two highest priorities as Suppression units in the Kootenay Lake District. Much of the increase has occurred in the Hazel Creek area.

Compared to the rest of the District, it appears to be the only BMU with no significant increase in pine beetle populations over the last year. However, I speculate that beetle populations will increase.

Mountain pine beetle populations in K6- Goat River, the BMU to the west of Kid Creek, are beyond suppression. Because the prevailing winds in the area are from west to east it is probable that beetles from the Leadville creek area will start to move eastwards into the Kid creek area.

K05	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	218	48,733
Pli	1,682	374,989

Management status

Approximately 78 trees felled and burned in the winter of 2004/05, and Tembec will harvest an estimated 75 hectares in 2005.

Tembec's plans for their operating area (as of March 2005):

82F020

-the upper areas of Hazel creek have scattered current attack around existing blocks.

These areas will be surveyed further and all current attack will be included in the fall and burn program in the winter of 2005.

-the few scattered trees in the lower area of Hazel creek will be investigated further and included in the fall and burn program in winter 2005.

- several stands in Hazel creek will be looked at in spring/summer 2005 for layout potential.
- an infestation has been located at the end of Christopher creek road. This area will be assessed further and including in the fall and burn program for winter 2005.

Limitations

This area has fewer limitations for treatment than the rest of Kootenay Lake District. Road access is good, and the terrain is comparatively benign.

Recommendations:

- 1) Ensure that all woodlot owners in the area are aggressively managing both the mountain pine beetle, and their lodgepole pine types.
- 2) Be extremely aggressive about under taking fall and burn in this BMU, even if it means doing so in areas that are traditionally not considered for this treatment , e.g. Area that is 'Inoperable' from a harvesting point of view, but is capable of producing substantial beetle populations.
- 3) Practice leading edge harvest strategy.
- 4) Try to keep most of the beetles out of the Kid creek main drainage by confining beetles to the Goat BMU to the west. (this could be problematic given the number of beetles in the Goat BMU and the fact that the prevailing winds are from the west).
- 5) Given the amount of moderate and high hazard pli types (2292 ha), and the fact that this unit contains approximately 375,000m³ of the District's 7.1 million m³, means that The District should carefully monitor the anticipated rate of spread vs. harvest capabilities in the area over the next 3 years.

IBD

Large potential for problems here given the timber types and the low elevation south facing slopes. Monitor. Encourage trap tree program in conjunction with harvesting as a standard practice, particularly for woodlot owners.

IBS

No concerns at this time. Monitor.

K6- Goat River

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	2875	572	3447	20	58/ 870	1022	515	Holding
IBS	33	0	33	0	2/30	2	0	Suppression
IBD	54	107	161	3	0	122????	0	Suppression

IBM- Status

Not surprisingly, the mountain pine beetle populations doubled in the Goat River BMU over the last year. Given the amount of lodgepole pine in the area, and the existing beetle populations it would have been surprising if the beetles hadn't increased. This BMU, is, for the most part, beyond suppression. To keep the BMU in Suppression, a minimum of $1022 \times 0.8 \text{ ha} = 817$ hectares would have to be treated (note that this simple calculation does not factor in the expected expansion for 2005).

Certainly, the beetles are out of control in the Kamma, Cameron, and Mount Cowley areas. In Kamma creek it is interesting to note that the beetles are working their way through all the riparian leave strips, and any and all remaining pine that exists above the operability line on the south facing slopes above Kamma creek. Kamma creek represents where the beetle populations in Kootenay Lake District are likely to go in the next few years. It just happens that Kamma creek is ahead of the curve.

If the rate of spread occurs at roughly at least 2 fold per year, (discounting the fact that beetles are now expanding at an exponential rate,) and 1022ha of a possible (minimum) of 3447 ha are already infested, then one could project that a possible 2044 ha could be infested by 2005. Sobering thought. If the rate of harvest is 200ha per year then it would take 17 years to harvest the wood. If the shelf life for harvesting lodgepole pine is 3-4 years then under current harvest levels approximately 600 hectares might be harvested, leaving 2800 ha unsalvaged.

K06	Mature THLB (ha) -netted down	Mature THLB (m3) - netted down
Pine	167	53,151
Pli	3,516	793,446

Management Status

At this point all management activities are centred on harvesting or salvage harvesting. The licensee J.H. Huscroft harvested 83 hectares in the Kamma creek area in 2004. Tembec harvested 100 ha in 2004, although at least some of that was salvage from the 2003 fires.

Tembec's plans (as of March 2005)

82F029

- two infested polygons on the west side of Leadville creek will be surveyed in the spring/summer of 2005.
- two polygons in O'Brien need data for ground surveys in the spring/summer of 2005.
- North Anchor polygon beside CP108-251 needs ground survey data in spring/summer 2005.
- polygon west of CP 90-107 needs ground survey data in spring/summer 2005-05-05.
- polygons in Cowley bowl needs ground survey data in spring/summer 2005.

82F030

- polygon goes onto the next development plan. Layout in summer 2005.

82F038

- two polygons in Skelly and Dampy creeks need data collected in summer 2005.

Limitations:

Much of the area is inaccessible due to rocky inoperable ground. Woodland caribou are of concern in the area.

Recommendations

1. Review respective licensee development plans for Hall, Bohan, Leadville, Anchor, Cowley, Skelley etc.
2. Aggressively pursue the bark beetles in the area adjacent to K5- Kid Creek BMU (e.g. Leadville, and Anchor creeks). Try to keep the beetles from spreading out of this BMU. (apply for funds for that area as the Goat River BMU strategy is 'Holding')
3. Undertake a total chance plan looking at moderate and high hazard lodgepole pine stands in the area. Assess rate of spread vs. harvest capability.
4. Seriously consider applying for federal funding regarding rehabilitation of caribou habitat areas. Review with Mike Knapik @ WLAP.
5. Consider extensive salvage permits in the area.
6. Practice trailing edge harvest strategy in this BMU.
7. Review harvest levels for the area compared to the potential unsalvaged losses.
8. Update the Forest Health database and monitor the actions and status taken for each beetle point and polygon.

IBD

Some Douglas-fir beetle was noted at the mouth of the Goat River. The licensee is aware of the situation and is assessing for development. The summary table only shows 161 hectares of moderate and high hazard Douglas-fir. This seems low given the topography and preponderance of Fdi in the area. In any case, Douglas- fir will be monitored throughout the area for bark beetle infestation and salvaged.

IBS

The 2004 aerial overview survey noted a small infestation in the back of Kianuko Provincial Park.

Recommendation: ensure that Parks is aware of this infestation.

K7- Midge Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	657	31	688	12	63/ 945 trees	364	22	Suppression
IBS	20	0	20	0	0	0	0	Suppression
IBD	957	199	1156	0	1/ 15 trees	0.25	0	Suppression

IBM--Status

Most of this BMU (14,757 hectares) is comprised of the Midge Creek Wildlife Management Area and the south eastern section of the West Arm Provincial Park. Therefore, a comparatively small portion of the BMU is within the Timber Harvesting Land Base of the Kootenay Lake Forest District.

Mountain pine beetles are increasing in the area at a rapid rate (16 fold increase between 2003 and 2004). Most of this infestation is centred on the Midge creek area. However, a March 2005 flight also revealed many red attacks, and several ‘faders’ along the slopes west of Kootenay Lake within the wildlife management area.

K07	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	0.9	314
Pli	357	76,900

Management status

At this time only minimal plans exist for treating lodgepole pine in the area. Currently J.H. Huscroft is considering doing some development in the area

Limitations:

For the most part, access to this BMU is extremely limited, as there are no roads up Midge creek, nor along the shores of Kootenay Lake south east of Procter; to gain access one must obtain permission from Darkwoods Forestry and travel on their roads into the area..

Recommendations

1. Monitor this BMU – especially the portion at the top end of Midge creek.
2. Consult with the licensee and the MOF timber tenures section to determine merchantability chance for the Pli in the area. Given that beetles are rapidly increasing in the area, and the fact that a lot of beetles exist in the adjacent West Arm Provincial Park, means that any Pli in the area should be treated as high priority.

3. Ensure that appropriate WLAP or MSRM staff are aware of the increasing MPB populations in the Midge Creek Wildlife Management area.

IBD

No concerns at this time. Monitor.

IBS

No concerns at this time. Monitor.

K8- Gray Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	559	222	781	4	9/ 135 trees	133	2	Suppression
IBS	0	0	0	0	0	0	0	Suppression
IBD	356	400	756	0	0	0	0	Suppression

IBM – Status

Once again, mountain pine beetle populations here have increased at a significant rate, somewhere in the neighbourhood of 60 fold, from a small sprinkling to approximately 135 trees. Although the largest infestations are found as polygons in the Lockhart Creek Provincial Park area, red attack is showing up sprinkled throughout all the pine stands in the Crawford, and Gray creek areas.

K0	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	7.3	3,019
Pli	67.9	18,336

Limitations:

For the most part, these beetles are going to be difficult (impossible?) to get to as many of the Pli stands exist in the upper reaches of the west facing slopes adjacent to Kootenay Lake and there are no roads to these areas. Additionally, visuals and terrain stability may limit treatment options.

Recommendations

1. At the landscape level, merchantability of the lodgepole pine on the upper slopes above Kootenay Lake should be explored.
2. Encourage assessment of the Pli in Crawford creek. Discuss the concept of allocating the area as part of a NRFL (or similar) with BCTS.
3. Review the 2-5 year plans for the area with respective licensees and the DKL Timber tenures officer.
4. Consider fall and burn in the Crawford Creek area. Review with BCTS.
5. Ensure that Parks is aware of the mountain pine beetle infestation in Lockhart Creek Provincial Park.
6. Practice a leading edge harvesting strategy.

IBD

Significant potential for a Douglas-fir beetle in the area, especially the lower slopes along Kootenay Lake. Monitor and treat aggressively.

IBS

No concerns at this time. Monitor.

K9- Lasca Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	2768	723	3491	38	47/ 705 trees	2529	666	Holding
IBS	17	0	17	1	0	14	0	Suppression
IBD	437	112	549	0	3/ 45 trees	1.25	1.25	Suppression

IBM – Status

Mountain pine beetles are still on the increase in this BMU having infested almost 4 times the amount of area in 2004 from 2003. People seem to keep comparing the bark beetle infestation in the Kootenays to those of the Caribou where trees are red to the horizon. Thus, there appears to be a perception that the bark beetle infestation has not yet hit the Nelson area. However, when one realizes that a full 72% of the Moderate and High hazard types are now infested in the Lasca Creek BMU, it must be recognized that the infestation is already ‘here’.

Several polygons of red attack exist within the West Arm Provincial Park. The polygon # has increased from 16 polygons in 2003, to 38 polygons in 2004 (indicating that some spot infestations increased to the point of polygon infestations.) In addition, the number of spot infestations increased from 35 in 2003, to 47 in 2004. Significant mountain pine beetle populations are situated in the Selous, Anderson, 5 mile, and Lasca creek drainages. At this point, the only drainage without very many spot or polygon infestations, exists in the Harrop creek area.

K09	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	169	68,773
Pli	1,077	365,471

Management status

At this point to the knowledge of the District, Parks is not currently undertaking any beetle management strategies within the West Arm Provincial Park.

Harrop Procter Community Forest is currently endeavouring to embark on a bark beetle strategy for the lodgepole pine within their management unit.

Limitations

Most of the area is 1) beyond any Suppression efforts, 2) situated within the West Arm Provincial Park.

Recommendations

- 1) Continue to encourage Parks branch to assess the West Arm Provincial Park for I) ecosystem restoration II) possible wildfire impact or liability issues regarding the City of Nelson's watershed.
- 2) Encourage Harrop Procter Community Forest to undertake bark beetle management strategy tactics within their management area.
- 3) Consider working with Protection Branch to assess wildfire hazard, and possible mitigation strategies at the landscape level.
- 4) Ensure that the City of Nelson is aware of the situation and possible implications (e.g. increased streamflow).
- 5) Practice a trailing edge strategy in the Kalesnikoff management unit and a leading edge strategy in the Harrop Procter Community Forest where feasible.

IBD

Douglas-fir beetle remained about the same levels over the last year however predictions are that they will increase in 2005.

Monitor and treat aggressively.

IBS

None noted at this time. However, downed wood on a couple of heli-pads built during the 2003 wildfire in the 5 mile drainage were heavily infested in year one (2004). Normally spruce bark beetle operates on a 2 year cycle so for the logs to be heavily attacked in year one suggests that there were already significant spruce bark beetle populations in the stand at the time. Additionally, in 2004 there was a small outbreak in the Apex creek area (close to the Whitewater ski area), where Kalesnikoff Lumber Co. baited and harvested the trees that were infested.

K10- West Arm

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	887	247	1134	56	87/ 1305 trees	3333	1129	Holding
IBS	50	0	50	0	0	0	0	Suppression
IBD	1452	835	2287	0	1/ 15 trees	0.25	????	Suppression

IBM-Status

IBM populations are, for the most part, at outbreak levels in this BMU. In the last year the beetles have increased 3 fold at the landscape level. Most, if not all of the pine stands in the area show some level of beetle infestation. Most of the moderate and high hazard types have been infested to a significant degree, including pli stands in the Redfish, Kokanee, Busk, and Bradley drainages. Essentially most of the higher elevation, Pli leading stands on south and or west facing slopes have been attacked.

Sproule, Rixen, and Smallwood creeks, located in the south-west portion of the BMU are the latest hotspots. Although they seem to have been infested a few years after drainages in the actual West Arm area (e.g. Kokanee, Busk, and Bradley), the huge mountain pine beetle populations to the west in the Arrow/Boundary District (e.g. Pedro, Winlaw, and Trozzo creeks) appear to be spreading south and west into Sproule, Rixen and Smallwood. Much of the Pli in these areas consists as mixed stands with other species. BCTS is currently assessing the area. There may be more opportunity here for further work.

The number of hectares infested in 2004 (3333 ha) exceeds the number of hectares in high and moderate hazard types (1134ha. This suggests that the mountain pine beetle has moved into low hazard types. Note that low hazard types can be classified as such due to the fact that Pli might be a minor component in the stand (even though it is of an age to be susceptible to the mountain pine beetle), or it may be a younger age class. It appears that two things are happening; the beetles are seeking out mature Pli regardless of where the trees are, and the beetles are moving into smaller diameter Pli.

Status –management activities

BCTS are harvesting bark beetle infested Pli stands in the Kokanee, Busk, and Laird drainages.

As of 2004, the West Arm BMU was no longer deemed to be in a “Suppression” category, ie. Bark beetle populations within the BMU were deemed to be beyond the point where falling and burning could control them. And instead, salvage harvesting of lodgepole pine forest types became the focus. As of March 2005, BCTS has assessed

most of the moderate and high hazard Pli types within their operating area for feasibility of harvest.

K10	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	129	47,003
Pli	626	149,387

Limitations

Rough terrain, terrain stability issues, visual quality objectives, and administrative factors all combine to constrain management of the infested Pli types within the area. That said, BCTS has been particularly pro-active in seeking out ways to try to address the Pli. For example, they put up a helicopter sale of Pli in the Kokanee Creek area. Although it did not sell because of high stumpage rates (and the cost of helicopter logging), these issues should be further explored at a higher level.

Recommendations:

1. Continue to harvest and salvage harvest Pli leading types as appropriate with consideration to other non-timber values.
2. Continue to encourage Parks branch to assess the area above the highway in Kokanee Creek Provincial Park for possible ecosystem restoration.
3. Consider working with Protection Branch to assess wildfire hazard, and possible mitigation strategies at the landscape level.
4. Ensure the respective licensees have assessed all M & H hazard Pli types in the BMU for I) bark beetle status and II) feasibility of harvest.

IBD

Field recce's in early May 2005 noted heavy attack on Douglas-fir trees that had blown down in the Bradley face and Kokanee creek park areas in the fall and winter of 2004. This suggests that Douglas-fir beetle populations are likely on the increase.

Recommendations:

Notify Parks of the infested trees in Kokanee Creek Park (suggest removal by horse logging? Or peeling).

Monitor and treat aggressively if needed.

Monitor the 'Douglas-fir beetle proofing' cutblock at Queen's Bay (harvested by Meadow Creek Cedar)

IBS

No concerns at this time. Monitor.

K11- Fortynine Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	443	157	600	14	27/405	518	54	Holding
IBS	0	0	0	0	1/ 15 trees	0.25	39	Suppression
IBD	268	49	317	0	0	0	0	Suppression

IBM Status

There has been a 10 fold increase in the number of mountain pine beetles in the Fortynine Creek BMU in the last year. While fall and burn was undertaken in the BMU in winter 2003/04, in summer 2004 the area was deemed to be beyond Suppression and no additional fall and burn was done this past winter.

Note that the number of hectares infested exceeds the amount of moderate and high hazard types. This suggests (and has been verified by field reports), that the beetle is moving into low hazard types. In some instances the beetles have moved into smaller diameter Pli, and in other cases the low hazard class simply reflects a mixed stand, of which the Pli is a lesser component, but still vulnerable to the beetle.

Polygons and spots of mountain pine beetle currently exist in the Hall and Giveout creek areas. Additionally there are a significant number of infested trees located around the Morning Mountain ski hill.

K11	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	65	24,918
Pli	530	154,473

Status- management

The beetles are currently working their way through most of the Pli stands in the BMU, including mixed stands where Pli is a component. For the 49 creek, Rover and Connor creek areas, although MPB is present in the stands, it is not a great concern in these areas for a couple of reasons. First, most of the BMU is extremely well roaded, and second, only small patches of pure pine remain in the area. Kalesnikoff is pursuing Pli where it consists of greater than 30% of the stand. For Kalesnikoff Lumber Co. this will consist of two permits, each 40 ha in size, for a total of 80 hectares.

At this time it is not clear what plans Atco Lumber Ltd. has for harvesting infested Pli in their operating area.

Recommendations:

- 1) Continue to monitor licensee activities within the area. Ensure that Pli leading stands (M & H hazard types) have been addressed.
- 2) Assess remaining Pli for possible salvage. Target the infested polygons on the Giveout creek area, and Hall Creek in particular. Practice a trailing edge harvest strategy in this BMU.
- 3) Determine areas where mountain pine beetle has worked its way through most of the stand. Recommend for assessment to Prince George research student. (Student will be assessing stand level mortality by tree size etc. This will help to calibrate the bark beetle infestation models for mountainous areas.

IBD

No concerns at this time. Monitor.

IBS

No concerns at this time. Monitor.

K12- Kaslo River

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004- # Polygon infestations	2004 -# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	280	102	382	3	29/ 435 trees	34	0.5	Suppression
IBS	10	0	10	0	0	0	0	Suppression
IBD	1508	236	1744	1/ 15 trees	0	0	0.25	Suppression

IBM – Status

There has been a large increase of IBM populations in the Kaslo River BMU in the last year. Populations have increased from a couple of small patches in 2003 to 29 spots in 2004. In addition, 3 polygon infestations have popped up. Significant IBM populations exist on most Pli types in the Kaslo River area, particularly on the south and west facing slopes above the river e.g. in the Blue Ridge area (possibility that some beetles are situated within the Kaslo Community Forest). Additionally, there is a sprinkling of beetles found on the higher ridges to the north of Woodbury and Coffee creeks. The beetles outside Kokanee Glacier Park are on steep, rocky, inaccessible hillsides and are not proximate to any Pli stands. The beetles within the Park (Woodbury area), are located in a pure Pli stand to the east of the Silverspray Cabin. It is likely that the beetles will spread through this stand and Parks should be made of aware of this.

K0	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	55	16,896
Pli	192	55,302

Status – management

For the most part mountain pine beetle management activities have been focused in the southern part of the Kootenay Lake Forest District. However, licensees operating in this BMU need to be made aware of the rapid rate of spread of the beetles in this Kaslo River vicinity.

Limitations:

Visuals, high ECA's in the Blue Ridge area, and terrain.

Recommendations

1. Practice leading edge harvest strategies in this BMU.
2. Work with licensees to determine the applicability of fall and burn in the area.

3. Work with Kaslo Community Forest to address Pli types within their management area, specifically target Pli in the Blue ridge area (recent flight showed 80+ red trees in the area).
4. Work with other licensees in the area (BCTS) to confirm all Pli types have been assessed.
5. Notify Parks branch about the mountain pine beetle populations located to the east of Silverspray cabin.

IBD

No concerns at this time. Monitor.

IBS

No concerns at this time. Monitor.

K14 – Riondel

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	739	352	1091	1	6/ 90 trees	56	2	Suppression
IBS	0	0	0	0	0	0	0	Suppression
IBD	549	717	1266	0	0	0	0.25	Suppression

IBM – Status

Most of the mountain pine beetle found in the Riondel BMU exists as spot infestations scattered throughout the Pli types on the mid-upper, west facing slopes located all along Kootenay Lake. The beetle increased 28 fold between 2003 and 2004.

K0	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	0	0
Pli	518	123,137

Management status

Currently most of the infested trees are located a long, (long) ways from any road such that fall and burn is impractical. Most of the operable Pli is located on the slopes between Bernard and Campbell Creeks

Limitations

Visuals (area is located across the lake from Kaslo and adjacent to Kootenay Lake), and winter ungulate habitat may constrain management options for lodgepole pine in this BMU.

Recommendations

1. Encourage the licensee to do a ‘total pine plan’ for the moderate and high hazard types in the area.
2. Review the long term goals for Pli in this area with the licensee and the DKL Timber Tenures officer.

IBD

As seen from the summary table above, there are approximately 1266 hectares of moderate and high hazard stands regarding Douglas-fir beetle.

During late summer of 2002, a significant windstorm event happened, blowing down a large area (30+ hectares)of Douglas-fir between Bernard and Tam O’Shanter Creeks.

Salvage harvesting of a good component of this occurred during 2003 and 2004. However, many downed single trees remained scattered throughout much of the remaining moderate and high hazard types. It is anticipated that Douglas-fir bark beetle will continue to be of concern in this area and must be managed accordingly. The District may need to apply for funds for some of the area that is inaccessible for harvest.

Monitor the area from Bernard to Loki creeks for Douglas-fir beetle.

IBS -No concerns at this time. Monitor.

K15 – Fry Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	739	352	1091	0	4/ 60 trees	2	0.75	Monitor*
IBS	12	0	12	0	1/ 15 trees	0.25	0	Monitor*
IBD	946	46	992	0	0	0	0	Monitor*

*This BMU covers a Protected Area in the form of the Purcell Wilderness Conservancy. Thus bark beetle management would only be undertaken if it could be demonstrated that populations within the Conservancy were in jeopardy of threatening values outside the reserve.

IBM -Status

As in all other locations in the Kootenay Lake District mountain pine beetle populations are increasing. Three small spot infestations were found in the Fry Creek drainage. Due to the nature of the terrain, and the fact that bark beetles are increasing similarly outside the park, there are no current plans to deal with this infestation. It does not appear to be threatening any value outside the park.

K15	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	0	0
Pli	0	0

Recommendations:

Ensure that Parks branch is aware of these infestations.

IBS

One small spot infestation was noted on a tributary drainage of Fry creek.

Recommendations:

Again, ensure that Parks branch is aware of this infestation.

K16 – Hamill Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	537	73	610	0	1/ 15 trees	0.25	0	Suppression
IBS	0	0	0	0	0	0	0	Suppression
IBD	1669	523	2192	0	1/ 15 trees	0.25	0.75	Suppression

IBM - Status

The 2004 overview flight information only shows 1 spot infestation in the area. A flight done in March 2005 indicated many red trees sprinkled throughout the Pli types on the west facing slopes above Kootenay Lake. Without doing ground checks it is difficult to ascertain if these reds were in fact red last August, or if they had turned red this past fall. My hunch is that because there were no ‘faders’ showing in March, they were red last fall. Because they were individual reds scattered throughout the type, as opposed to being either a spot or an infestation, the overview flight did not pick them up. Additionally, because the area was not slated for detailed measles mapping, these reds were missed in 2004. In any case, indications are that mountain pine beetle populations are tipping into incipient levels in these stands.

K16	Mature THLB (ha) – netted down	Mature THLB (m3) – netted down
Pine	0	0
Pli	72	20,045

Management - status

Minimal management activities at this time.

Limitations.

Currently no access into these pli types, visuals (area borders Kootenay Lake).

Recommendations:

Review long term plans/ options for the pli types in this BMU with the DKL Timber Tenures Forester and the respective licensees.

K17 – Goat Range

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	228	18	246	0	3/ 45 trees	1.25	0	Suppression
IBS	86	0	86	1	0	26	0	Suppression
IBD	720	237	957	0	0	0	0	Suppression

Most of this BMU is located within the Goat Range Provincial Park. Additionally, a good portion of the area is a cool, wet, north/ east facing unit. Thus the area does not support very many hectares of Pli.

IBM-Status

Three small spot infestations were found within the Goat Range Provincial Park. They are remote and are not threatening any values outside the park (not much Pli outside the park in this BMU.).

K17	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	126	60,397
Pli	32	8,761

Limitations:

Park. No access.

Recommendations

Ensure that Parks Branch is aware of the infestations.

IBS

No beetles found. No concerns at this time.

IBD

The summary shows 957 ha of moderate and high hazard Fdi. Review maps to determine location of this Fdi, and whether it is accessible.

K18 – Lardeau River

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	279	10	280	1	1/ 15 trees	9	0.5	Suppression
IBS	6	0	6	0	0	0	0	Suppression
IBD	888	659	1547	0	0	0	0	Suppression

IBS - Status

A March 2005 flight revealed that mountain pine beetle now exists on most south/west facing slopes in all pli types along Lardeau River between Meadow Creek and Trout Lake.

I believe that the 2004 information under estimates the number of infested hectares in this BMU. It is likely that double the amount of area has been infested. Approximately 90% of these infestations do not appear to be noted on the 2004 information. I suspect that this reflects the fact that detailed mapping was not done for this area in 2004, as it is doubtful that all of these red attacks have popped up between fall 2004 and March 2005.

K18	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	17	7,991
Pli	445	150,849

Recommendations

Although it is likely going to be quite a shift for the Licensees in the area who are used to targeting the harvest of spruce, cedar, etc., tenure holders in the area should be encouraged to develop the pine types in the area. Alternatively, this wood could be put into some type of salvage permit.

IBD

No concerns at this time. Monitor.

IBS

No concerns at this time. Monitor.

K20 – Glacier Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	2004 - # Polygon infestations	2004 - # spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	300	60	360	0	0	0	0.25	Suppression
IBS	0	0	0	0	0	0	0	Suppression
IBD	1031	793	18240	0	1/ 15 trees	0.25	9	Suppression

IBM

Only a sprinkling of a very few infested trees exists in the area. Most of the Pli in the BMU exists in mixed stands. At this point, there are no concerns although mountain pine beetle populations will be monitored.

K20	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	0	0
Pli	239	57,883

IBD

Although there is a lot of Douglas fir situated along the slopes above the Duncan reservoir, licensees in the area have been actively managing for the beetle in an ongoing basis in the last several years. The only spot infestation noted in 2004 exists on a rocky, bedrock outcrop that is inaccessible. It would be unsafe to send fallers in the do fall and burn. For this reason, the area won't be treated but Douglas-fir beetle in the area should be monitored.

IBS

There are no concerns at this time. Monitor. Although the summary table shows that there are zero moderate or high spruce hazard types, I believe that this should be investigated.

K21 – Howser Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	9	79	88	0	0	0	0.25	Suppression
IBS	29	2	31	0	0	0	0	Suppression
IBD	221	85	306	0	0	0	12	Suppression

No issues at this time. Continue to monitor.

K21	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	0	0
Pli	46	13,068

K22 – East Creek

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	0	3	3	0	0	0	0	Monitor
IBS	0	0	0	0	0	0	0	Monitor
IBD	454	247	701	0	0	0	0	Monitor

There are no issues at this time. Monitor.

This drainage has been completely netted out of the THLB due to inaccessibility issues.

K23 – Westfall River

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	0	0	0	0	0	0	0	Monitor
IBS	215	0	0	0	0	0	0	Suppression
IBD		0	0	0	0	0	0	Suppression

Very few hectares of spruce, Douglas-fir, and lodgepole pine.
 No concerns at this time. Monitor and review for other forest health concerns (e.g. Hemlock looper).

K24 – Duncan River

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	0	0	0	0	2/ 30 trees	0.5	0	Suppression
IBS	22	0	22	0	0	0	0	Suppression
IBD	0	0	0	0	0	0	0	Suppression

Very few hectares of spruce, Douglas-fir, and lodgepole pine.
 No concerns at this time. Monitor and review for other forest health concerns (e.g. Hemlock looper).

K25 – Duck Lake

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	1723	752	2475	19	45/ 675 trees	1387	789	Suppression
IBS	9	0	9	0	0	0	0	Suppression
IBD	710	582	1292	0	0	0	1	Suppression

IBM status

Mountain pine beetle populations in the Duck Lake unit nearly doubled between 2003 and 2004. The number of spots increased from 7 to 45 (!) and, the number of polygons also increased from 16 to 19.

Although most of the infestations occur in the Sanca and Boulder creek areas, there are also beetles found all along the slopes facing Kootenay Lake.

K0	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	343	71,732
Pli	3,776	1,064,690

Management status

The Duck Lake BMU represents one of the biggest challenges in managing the mountain pine beetle within Kootenay Lake District. Approximately one seventh of the District's 7.1 million m³ of mature pine exists within the THLB in this BMU. However, because of the Kuskanook fire (2003), the associated landslide, previous harvesting, and recent designations for caribou habitat, under the current guidelines only minimal additional harvesting will likely be permitted within this BMU. Overlay the point that the area is highly visible Kootenay Lake, access difficulties, and the fact that there are numerous water licensees in the area, means that this is characteristic of managing the beetle in the District. In order to manage the beetle and its impacts in this BMU will certainly mean re-assessing current guidelines.

Wynndel Box and Lumber Co. has approximately 210 h (primarily Pli) slated for harvest in this BMU.

Recommendations

1. Work with the licensee to determine maximum amount that they feel they will be able to harvest under the current guidelines.
2. Determine by specific guideline, how much harvesting is limited (where there is overlap use the most constraining guidelines).
3. Ask for help from the Region and from the Research section to assess these guidelines (especially pertaining to caribou and hydrologic issues).
4. Consider applying for Funding (as per Federal and Provincial directives) and consider trying to do some rehabilitation work on this BMU.
5. Assess, as closely as possible, what the anticipated unsalvaged losses will be in this unit and the associated costs.
6. Consider exceeding the guidelines in the short term followed by extensive rehabilitation to preserve the long term values.
7. Review possible stand level fall and burn mitigation options with the licensee.

IBD

No issues at this time, however potential exists for a significant problem therefore IBD populations will be closely monitored.

IBS

No issues at this time. Monitor

K26 – McKian-Schroder

	Ha Mod. Hazard	Ha High Hazard	Total Ha Mod & High	# Polygon infestations	# spot infestations	Total ha infested 2004	Total ha infested 2003	Recommended BMU Strategy
IBM	372	33	405	1	8/ 120	20	28	Suppression
IBS	33	0	33	0	0	0	0	Suppression
IBD	668	321	989	0	0	0	0	Suppression

IBM – Status

Mountain pine beetle was found on several of the higher elevation ridges in Davis, South Cooper and McKian creeks (note that the infestations in South Cooper do not show up on the 2004 overview, but were noted as red attack on a March 2005 flight.) Although this does not impact recommended treatments for the area, it indicates that beetle populations are higher in the BMU than the 2004 flight suggests.

K26	Mature THLB (ha) –netted down	Mature THLB (m3) – netted down
Pine	25	10,373
Pli	58	12,758

Limitations

The Goat Range Provincial Park covers much of this BMU and most of the rest is inaccessible.

Recommendations

At this time, no active management is anticipated although the moderate and high hazard types of Douglas-Fir and lodgepole pine should be reviewed with Licensees and the Timber Tenure Officer.

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Appendix I – Summary Table by BMU

2005 DKL Strategies for Mountain Pine Beetle (IBM) by Beetle Management Unit (BMU)							
				Lodgepole pine leading stands			
BMU #	BMU Name	IBM Strategy	Harvesting strategy	Mature THLB (ha) before netdowns	Mature THLB (ha) netted down	Mature THLB (m3) (netted down)	% of District total
K1	Summit Creek	Suppression	Leading/trailing	1417	1206	263832	3.7
K2	Moyie River	Suppression	Leading	5004	4253	935412	13.2
K3	Hawkins Creek	Suppression	Leading/trailing	9205	8528	1948222	27.5
K4	Darkwoods	Suppression	Leading	0	0	0	0.0
K5	Kid Creek	Suppression	Leading	2697	1682	374,989	5.3
K6	Goat River	Holding	Trailing	4469	3516	793,447	11.2
K7	Midge Creek	Suppression	Leading	427	357	76,900	1.1
K8	Gray Creek	Suppression	Leading	105	68	18337	0.3
K9	Lasca Creek	Holding	Trailing	1573	1078	365471	5.2
K10	West Arm	Holding	Trailing	1176	627	149387	2.1
K11	Fortynine creek	Holding	Trailing	690	530	154434	2.2
K12	Kaslo river	Suppression	Leading	417	192	553902	7.8
K14	Riondel	Suppression	Leading	1067	518	123138	1.7
K15	Fry Creek	Monitor	NA	0	0	0	0.0
K16	Hamill Creek	Suppression	Leading	179	72	20045	0.3
K17	Goat Range	Suppression	Leading	47	32	8761	0.1
K18	Lardeau River	Suppression	Leading	649	446	150849	2.1
K20	Glacier Creek	Suppression	Leading	334	240	57883	0.8
K21	Howser Creek	Suppression	Leading	52	47	13069	0.2
K22	East Creek	Monitor	Leading	0	0	0	0.0
K23	Westfall River	Monitor	Leading	0	0	0	0.0
K24	Duncan River	Suppression	Leading	0	0	0	0.0
K25	Duck Lake	Suppression	Trailing	4393	3777	1064690	15.0
K26	McKian-Schroeder	Suppression	Leading	92	58	12759	0.2
	Total			33993	27227	7085527	100

Appendix 2 - Background information for readers

BC MOF Bark Beetle Management Guidebook October 1995

<http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/guidetoc.htm>

BC MOF Forest Health Surveys Guidebook

<http://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/guidetoc.htm>

Ministry of Forests mountain pine beetle website – information on strategies, latest overview information, action plans, Bark Beetle Recommendation

<http://www.for.gov.bc.ca/hre/bcmpb/>

Pacific Forestry Canada Website

Decision making tools, modelling of expansion rates.

http://www.pfc.forestry.ca/entomology/mpb/tools/DSS/introduction_e.html

Provincial level projections, (Marvin Eng's report).

http://www.for.gov.bc.ca/hfp/mountain_pine_beetle/

Appendix 3. Description of mountain pine beetle outbreak phases.

This information should be referenced as: Safranyik, L. 2003. Mountain pine beetle epidemiology in lodgepole pine. Pages 33-40 In: Mountain Pine Beetle Symposium: Challenges and Solutions. October 30-31, 2003, Kelowna, British Columbia. T.L. Shore, J.E. Brooks, and J.E. Stone (editors). Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-399, Victoria, BC. 298 p.

http://www.pfc.cfs.nrcan.gc.ca/entomology/mpb/outbreak/index_e.html

Recent synthesis on mountain pine beetle (IBM) population dynamics considers that beetle populations have identifiable developmental phases. The IBM population phase has a significant impact on appropriate strategy selection. What follows is adapted from presentations by and discussions with Les Safranyik and Al Carroll (Research Scientists, Canadian Forest Service, Pacific Forestry Centre):

IBM populations cycle through 3 “phases” which have markedly different characteristics. Outbreaks of IBM occur when climatic and host-tree factors combine to produce suitable conditions, usually at the landscape level.

Characteristics of Endemic populations

- Low level state between outbreaks. Endemic IBM populations are sometimes defined numerically, for example, as one infested tree per 40.5 ha. However, numeric thresholds are not strictly adequate to describe the character of endemic populations.
- IBM infest weakened and decadent trees. Endemic populations exist primarily in susceptible “predisposed trees” such as very old “veteran” mature trees, stressed trees in the understory or suppressed part of the canopy, lightning-struck trees, wind damaged trees, trees weakened by agents such as other scolytids, porcupines or stem diseases, or perhaps trees stressed by root disease or dwarf mistletoes.
- Frequently found in trees co-attacked by secondary beetle species, such as *Ips*. IBM in these trees is often associated with secondary bark beetles such as *Ips* or *Hylurgops* spp, which act as both facilitators and competition for IBM.
- Currently attacked trees are seldom located near original brood trees
- No obvious relationship between tree dbh and IBM attack.
- Yearly mortality is normally less than volume growth.
- Attacked trees are scattered singly or in small groups.
- IBM attack pitch tubes are often not apparent.

All of the above characteristics mean that endemic populations exist as widely scattered single tree infestations, occurring essentially at random. Consequently, currently infested trees are hard to find because of the difficulty in predicting their occurrence, and because they are often not located near parent brood trees. Pitch tubes, a characteristic “signature” of IBM attack, are not usually evident on IBM attacked trees in the endemic population phase. Factors such as host resistance, natural enemies, weather, and competition for food and space interact during endemic periods to keep reproduction and brood mortality in balance and restrain populations from increasing. A change that reduces the controlling effects of any one or a combination of these factors could theoretically result in the development of incipient populations.

Characteristics of Incipient infestations

- Incipient populations are those with beetle numbers that exceed a minimum level necessary to overcome the resistance of the average large diameter apparently healthy tree in a stand. Incipient infestations can develop either because tree resistance is reduced or because brood survival has increased as a result of favourable weather conditions.
- Populations grow, but slowly. Incipient infestations grow relatively slowly and, on average, population and infestation levels may not even double in successive years.
- Populations tend to escape detection and concern.
- Most of the trees are in larger diameter classes. Brood survival in large dbh trees is higher than in smaller trees for a number of nutritional and physical reasons such as thicker bark and phloem, and reduced mortality from drying of the bark or cold temperatures.
- Infestations are scattered and confined to individual stands,
- The number of infested trees *usually* increases annually, but unsuccessful attack (“pitchouts”) may occur in significant numbers within stands.
- Clumps of infested trees grow in size and number over time
- Incipient populations move to landscape and outbreak level in ~ 5(?) yrs or faster (2-3 generations?)
- Aggressive control may save trees over the long term, even if “suppression” is not 100 % effective.

The incipient phase of mountain pine beetle population development is the most accessible and vulnerable to aggressive management action.

Characteristics of outbreak populations

- Require sustained favourable climate for beetle survival, such as a series of mild winters and good weather during the dispersal and attack periods.
- Require pine of susceptible age and size. Susceptible landscapes contain an abundance of lodgepole pine greater than 20 cm in diameter and 80 years of age.
- Widespread with large annual increases in infested areas. Incipient infestations develop into landscape level outbreaks as groups of infested trees coalesce into larger patches and new infestations develop annually through within-stand and long range dispersal.
- Populations are resilient to normal mortality losses due to high numbers. Outbreak populations are very resilient to normal mortality and can easily rebound following large-scale mortality. Brood mortality is in the range of 80 to 95%, equivalent to a range of 5 to 20% survival, resulting in a 2 to 8 fold potential increase in population and damage levels (with a 2 to 4 fold increase being the norm).
- A strong relationship between dbh and tree mortality. Epidemic IBM populations select and kill large diameter apparently healthy trees, although new infestation spots may initially focus on predisposed trees. Consequently, trees in the dominant and co-dominant size classes will suffer the heaviest mortality.
- More than 80% of pines over 10 cm dbh may be killed over large areas, with perhaps 60% of volume and 40% of stems killed being the average.
- Outbreak populations within particular stands may last up to 6 years. At the landscape level outbreaks tend to last 10-15 years, and collapse when available food supply runs out, or a change in weather suitability (e.g. a cold weather event) occurs.
- Twenty to forty years may elapse between outbreaks. This pertains when an outbreak is allowed to run its full course. *Clearly this depends on the two essential factors, climate and food supply. The central interior of British Columbia experienced a large outbreak*

in the mid-1980's, which was stopped by a severe unseasonable cold weather event. The "next" outbreak in the central interior started in the mid-1990's, an interval of only 10 years. These events could perhaps be considered 2 chapters of the same outbreak.