100 Mile House Forest District
Forest Health Strategy
July 1, 2008 – March 31, 2009

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100 Mile House Forest District
Forest Health Strategy
2008-09

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100 Mile House Forest District
Forest Health Strategy
2008-09

Introduction

The 100 Mile House Forest District Forest Health Strategy is prepared by the 100 Mile House, Ministry of Forests and Range. The strategy is compiled under the guidance of the Provincial Forest Health Strategy, and Provincial Bark Beetle Strategy. The purpose of this strategy is to outline bark beetle management objectives, specific strategies and procedures, and the current status and extent of priority forest health agents. The main focus of this strategy will be the priority forest health agents of the district, with some comments on locally important pests**.** Also mentioned are comments related to issues that are hindering control efforts such as biodiversity. (i.e. old growth management areas)

The 100 Mile House Forest District (1.2 million hectares) encompasses a land base rich in resource values which provides substantial benefits to local communities. Resource users such as forestry, ranching, and tourism offer direct and indirect economic benefits to the local community. Other valuable resources including wildlife, water, and recreation provide significant social and economic benefits.

Bark beetle pests are posing a significant threat to management objectives for many of these resources. The mountain pine beetle, Douglas-fir beetle, and spruce beetle are classed as the priority forest health agents. Catastrophic infestations result in millions of dollars in reduced revenue due to timber losses, degraded lumber values, reduced stumpage values, degradation of non-timber resources, disruptions in forest planning, and long-term impacts on resource sustainability. Large scale tree mortality within the 100 Mile House Forest District could also have negative impacts on recreation, fire hazard, visual quality objectives, wildlife habitats, and other resource values.

Major Forest Health Agents
100 Mile House Forest District

Bark Beetles

- **Douglas-fir Beetle (Dendroctonus pseudotsugae)**
- **Spruce Beetle (Dendroctonus rufipennis)**
- Western Balsam Bark Beetle (Dryocoetes confuses)
- Mountain pine beetle (Dendroctonus ponderosae)

Defoliators

- Western spruce budworm
- 2 year cycle budworm
- Douglas-fir tussock moth
- Satin moth
- Western hemlock looper
- Forest tent caterpillar
- Black army cutworm
- Serpentine leaf miner

Root Disease

- Armillaria root disease
- Tomentosus root disease
- Laminated root disease

Stem and Branch Diseases

- Lodgepole pine dwarf mistletoe
- Western gall rust
- Stalactiform blister rust
- Atropellis canker
- Commandra blister rust

Weevils

- White pine weevil (Pissodes strobe)
- Lodgepole pine terminal weevil (Pissodes terminalis)
- Warren's root collar weevil (Hylobius warreni)

Foliage Diseases

- Lophodermella needle cast
- Elytroderma needle cast

Abiotic Injuries

- Blowdown
- Ice damage
- Animal damage

100 Mile House TSA Ranking of Forest Health Factors by Importance

Pest species are ranked according to:

- The collective knowledge of the Regional/District forest health specialists.
- Known or suspected impacts to forest resource values.
- Availability of operational detection and treatment methods.
- Costs and benefits of applying detailed detection and treatment activities.
- Distribution of pests and current incidence levels.
- Resources and funding required to implement the necessary management for the pests.

Note: abiotic injuries (i.e. blowdown, ice damage) are not ranked, as the severity can change with each event.
Also note that not all forest health factors are ranked, only the more significant pests within the 100 Mile House Forest District.

Table 1- Ranking of Pest Species by priority for Forest Management Activities

Very High	**High**	**Medium**	**Low**	**Very Low**
Douglas-fir beetle	Western spruce budworm	Western Balsam Bark beetle	Mountain Pine beetle	Atropellis canker
Spruce Beetle	Armillaria root disease	Laminated root disease	2 year cycle budworm	Elytroderma needle cast
		Dwarf mistletoe	Western hemlock looper	Satin moth
		Western gall rust	Douglas-fir tussock moth	Animal damage
		White pine weevil	Forest tent caterpillar	Black army cutworm
		Lodgepole pine terminal weevil	Commandra blister rust	Serpentine leaf miner
		Tomentosus root disease	Stalactiform blister rust	
			Lophodermella needle cast	
			Warren's root collar weevil	

Forest health treatment planning should target highest priority stands first. Douglas-fir bark beetle suppression is the highest priority followed by Spruce beetle suppression.

Status of Priority Forest Health Agents
100 Mile House Forest District
2008

Priority Ranking for Bark Beetles

- Douglas Fir Bark Beetle (IBD) – highest
- Spruce Bark Beetle (IBS) – highest
- Balsam Bark Beetle (IBB) – medium
- Mountain Pine Beetle (IBM) – low

Douglas-fir Beetle (highest priority)

Douglas-fir beetle throughout the district has been identified as *aggressive* for the purpose of the provincial established Emergency Bark Beetle Management Areas. ***(refer to pages 13-14 for definitions of BMU strategies)***

From the 2007 detailed aerial survey 1300 sites were located compared to 974 in 2006. Sites have become smaller in size, presumably due to the aggressive treatments over the past three years. The majority of the sites are 5-20 trees compared to the previous year were the majority of the sites were 5-40 current attack trees, however a few sites in the following locations were larger 200-500 current attack trees: refer to attached Douglas-fir beetle map for infestation locations.

Douglas-fir beetle activity increased significantly, and was mapped on 9,774 hectares up nearly 2.5 fold from 2006 levels of 4,112 hectares. The number of smaller spot infestations also increased dramatically, from just 26 (380 trees) to 226 (2,400 trees). Most activity was in the Fraser River, Big Bar Creek, Canoe Creek, Eagle Creek, Lac La Hache, Timothy lake, Canim Lake Clinton, Bonaparte lake and Young Lake areas.
(Provincial Overview Report)

<u>R - Values 2008</u>

Sheridan	R = 1
Loon 1	R=3.2
Loon 2	R = 2
Milk Ranch Clinton	R = 3.5
Ruth	R = 3.8
Pigeon	R = 0.4
Poison	R = 1.1
Lac La Hache	R= 2.3
Needa	R = 1.4

Winter Mortality Table

Year	Winter Mortality	R-Value
2008	72.8%	2.07
2007	61.28%	2.34
2006	57.92%	3.34
2005	86.8%	1.83

Note: R-value of over 1.3 means the population is increasing.

Timber Area (Ha) affected by Douglas-fir Beetle

	2001	2002	2003	2004	2005	2006	**2007**
100 Mile House F.D.	54	3,911	7,183	4,974	3,050	4112	**9774**

(Provincial Overview Report): These areas, in hectares, are all estimates of recorded trace, low, mod and high infestations collected during the provincial aerial overview survey. The survey records all red trees not new infestations. So as the reds turn into greys the infestation area decreases.

Spruce Bark Beetle (highest priority)

The status of the Spruce bark beetle remains the same as the previous year, for the purpose of the provincial Emergency Bark Beetle Management Area, it was updated to the following: Mckinley and Spanish BMUs are *salvage*, Deception and Hendrix BMUs are *containment*, and the other spruce type BMUs are *aggressive*. These BMU strategies were updated because of the infestation levels in these areas and the very limited to non-existent control efforts to date. *(refer to pages 13-14 for definitions of BMU strategies)*

Mortality levels fell from 15,280 hectares in 2006 to 8643 hectares in 2007. Most of the decline was in the Deception Creek, Spanish Creek, and Mckinley Cr areas. The proportion of attack classified as trace also increased to 70% This reflects the fact that much of the infested area is suffering ongoing, chronic, low-level mortality. (Provincial Overview Report)

Timber Area (Ha) affected by Spruce Beetle

	2001	2002	2003	2004	2005	2006	**2007**
100 Mile House F.D.	587	4355	20,935	17,250	13,724	15,279	**8643**

(Provincial Overview Report): These areas, in hectares , are all estimates of recorded trace, low, mod and high infestations collected during the provincial aerial overview survey. The survey records all red trees not new infestations. So as the reds turn into greys the infestation area decreases
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Balsam Bark Beetle (medium priority)

All mortality continued to be confined to higher elevations in the northeast part of the District. Trace and Light attack was mapped on 19,233 hectares, up from 12,488 hectares in 2006. Most of the increases were in the Mt. Hendrix and Deception Creek areas. *(Provincial Overview Report)*

The only effective control method for the extent of the balsam bark beetle infestation is large harvesting cutting permits. The majority of the balsam bark beetle infestations are located in spruce/balsam mixed stands. For this reason balsam bark beetle will not be treated unless in conjunction with spruce bark beetle treatment. These stands are very susceptible to blowdown if single tree extraction is conducted. Trap trees can be utilized to contain/concentrate balsam bark beetle.

Timber Area (Ha) affected by Balsam Bark Beetle

	2001	2002	2003	2004	2005	2006	**2007**
100 Mile House F.D.	3577	23,469	20,935	26,722	15,466	12,488	**19,233**

(Provincial Overview Report): These areas, in hectares, are all estimates of recorded trace, low, mod and high infestations collected during the provincial aerial overview survey. The survey records all red trees not new infestations. So as the reds turn into greys the infestation area decreases

Mountain pine beetle (low priority)

Overall infested area remained almost unchanged, at 725,136 hectares in 2007 versus 723,000 hectares in 2006. This demonstrates that mountain pine beetle is infesting virtually every pine stand in the District. However, the area of attack classified as moderate or higher fell from a high of 438,343 hectares in 2006, to 355,180 hectares in 2007, as severity levels began to drop throughout much of the northern and central areas of the District. This reduction in red attack levels is due to host depletion in areas previously sustaining high levels of attack. Severity levels increased substantially at higher elevations in the Deka Lake, Windy Mountain, and Hihium lake areas, where many areas have progressed from trace or light in the previous year to severe or very severe this year. This rapid expansion at higher elevations is a clear example of the lack of climatic barriers to bark beetle populations as well as the powerful wave of immigration into these zones. Infestations continue to be severe throughout the Marble Range, Bonaparte Lake, Eagan Lake, and North Bonaparte areas.
(Provincial Overview Report)

Because the epidemic has reached its peak, the infestation area has expanded into the districts younger stands (<40 years old). From the Young Lodgepole Pine stands surveys, the infestations levels in these stands varies from 10%-80% attack. Mortality of the larva in these small diameter trees is very high, and adult success is very low. Also, the district is seeing mortality of mature spruce because of the IBM. It is estimated that 5% of the spruce mixed in with the pine stands will be affected.

In 2005 the majority of the TSA had been identified as *salvage* for the purpose of the provincial established Emergency Bark Beetle Management Area. Although the prevalence of mountain pine beetle is in the epidemic stage, its status as a priority for management has been reduced to medium. Since there are no longer opportunities to effectively control the spread of the mountain pine beetle, emphasis (priority) for the management has been shifted to spruce beetle and Douglas-fir beetle where suppression activities may still be effective in controlling the spread, and impact of the beetle. *(refer to pages 13-14 for definitions of BMU strategies)*

Timber Area (Ha) affected by Mountain Pine Beetle (current attack**)**

	2001	2002	2003	2004	2005	2006	**2007**
100 Mile House F.D.	672	14,603	106,400	660,000	623,560	723,000	**725,136**

(Provincial Overview Report): These areas, in hectares, are all estimates of recorded trace, low, mod and high infestations collected during the provincial aerial overview survey. The survey records all red trees not new infestations. So as the reds turn into greys the infestation area decreases

Status of Locally Important Pests
2008

Defoliators

Western spruce budworm

Budworm defoliation expanded by 30%, from 128,373 hectares in 2006, to 165,994 hectares in 2007. At the same time, the proportion of the total area classified as moderate or severe fell from 35% to just 10%. This indicates that populations are expanding, but not yet intensifying. Egg mass sampling conducted in the fall of 2007 indicates that light to moderate defoliation can be expected again in 2008, in most areas.

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Management Objectives

For priority forest health factors the 100 Mile House Forest Health Strategy will follow the specific management objectives as per the Provincial Bark Beetle Strategy. The following are specific objectives:

- Minimize the loss of timber value
- Minimize the loss of Crown revenue
- Minimize the spread of bark beetles

Bark beetles are a natural component of forest ecosystems in British Columbia, and at most times are present at low or endemic levels. Presently the populations have expanded into large epidemic infestations in some portions of the district. In the epidemic areas only prolonged cold winter conditions, or depletion of appropriate host species will collapse their expansion. With adequate resources the endemic portions of the district are still manageable. This strategic plan provides direction to apply the limited resources we have available to where it is most appropriate to help mitigate the rate of spread. One impediment in achieving bark beetle management objectives includes biodiversity issues (i.e. OGMA and MDWR). This strategy proposes to address all species of priority bark beetles active in this district, which includes Douglas-fir beetle, and spruce beetle.

Specific Strategies

For priority forest health agents the 100 Mile House Forest Health Strategy will follow the specific strategies and tactics outlined in the Forest Practices Code Guidebooks, Provincial Bark Beetle Strategy, Regional Bark Beetle Plans, and focus on areas identified by the 100 Mile House Forest District Detailed Aerial Survey Maps.

Priority Forest Health Agents:

- Douglas-fir Beetle
- Spruce Beetle

Beetle Management Units

A Beetle Management Unit (BMU) is a planning and reporting unit for operational beetle management. Its purpose is to facilitate the implementation of beetle management activities. Resource management objectives will be consistent throughout the unit. Strategies will be evaluated for compatibility with adjacent BMUs. BMUs have been created within the district for prioritising each bark beetle species.

The BMU boundaries for the district will follow the boundaries of Landscape Units. The strategy and the recommended treatment options will be selected after consideration of the status of the outbreak in the BMU, funding allocations, and Provincial direction for bark beetle control strategies.

Beetle Management Unit Strategies

The following four strategies for each or portion of the 100 Mile House BMU's will be implemented. These strategies are selected based on the level of outbreak in an area and the estimated effectiveness of selected treatments in achieving stated objectives. The BMU's will be re-evaluated, usually yearly, as new aerial survey information is received. Revised strategies for each of the BMU's will be adjusted at that time.

1. **Suppression** (Aggressive): This is the most aggressive strategy. It is selected when the infestation status is such that aggressive direct control actions are expected to keep an area at low level of infestation. Areas are lightly infested, and resources for direct control or harvesting and milling capacities equal or exceed the amount of infestation. The intent of the strategy is to reduce or keep the outbreak to a size and distribution that can be managed within "normal resource capability".

2. **Holding** (Containment): The intent of this strategy is to maintain an existing outbreak at a static level. It is a delaying strategy until adequate resources are available, or access created that allow for a more aggressive approach, or to reduce overall loss while waiting for a killing climatic event. This is appropriate in areas with chronic beetle infestations that are too large to deal with using single tree treatments or where access is poorly developed for directed harvesting.

3. **Salvage**: Applied to areas where management efforts would be ineffective in substantially reducing the beetle populations and subsequent levels of damage. Such areas have extensive outbreaks covering a large proportion of susceptible stands. The objective in this case is to salvage affected stands and minimize value loss.

4. **Monitor**: This strategy is applied to areas where management efforts would be ineffective in substantially reducing the beetle population and subsequent levels of damage, or where there is no short term (less than 5 years) possibility of salvaging dead timber. This may be due to management constraints such as wilderness area, Park or ecological reserve, or because access cannot be put in place before substantial merchantable degradation of the dead material occurs.

Objectives for beetle population removal for BMU strategies:

Strategy	% of Current Infestation to Treat.	Comments
Suppression (Aggressive)	>80%	Address all current attack within **two** years. The intent is to "control" the outbreak in that area and stop spread
Holding (Containment)	50-79%	Address the largest proportion of the new infested material, at least close to the rate of expansion. The intent is to maintain beetle populations at a level that can be dealt with annually without huge expansion
Salvage	<50%	The priority is to salvage timber previously attacked to minimise value loss. Relevant in areas where suppression or holding actions are no longer appropriate or feasible.
Monitor	0	No action is required beyond monitoring and recording. This is most appropriate in Parks and Ecological Reserves and in inoperable areas where the outbreak has peaked, salvage is not possible, and there is no chance for any mitigation of further loss.

CONTROLS AND TACTICS

A number of tactics are available to achieve the forest health management strategies; these are described as follows:

Douglas-fir Bark Beetle Control Tactics

1. Use UTM coordinates from detailed aerial survey, locate red attack and perform detailed ground surveys collecting data on amount of current attack.

2. Prioritize control techniques by amount of current attack and location to access.

   General Guidelines:

   a. 1-10 current attack trees:
      - deploy MCH,
      - or consider heli/conventional trap trees,
      - if access is good harvesting may be considered.

   b. >10 current attack trees:
      - harvest current attack and access trees only,
      - or MCH deployment in remote locations and consider additional treatment with the use of heli trap trees outside the infestation area.

   c. >100 concentrated current attack ie in 1-2 ha area
      - clear-cut area encompassing current attack trees.
      - follow up with trap trees, outside boundary.

   The above mentioned control techniques will be deployed by the ministry's district forest health program and possibility in conjunction with the major licensee, BCTS or SSS.

3. Harvested bark beetle areas, should have a follow-up treatment such as MCH or trap trees before the next beetle flight to control residual beetles in stumps and slash.

4. Control efforts, in OGMA, must be done in accordance to the Integrated Land Management Bureau (ILMB), Regional Biodiversity Conservation Strategy.

5. Control efforts, in MDWR, must be done in accordance to the Ministry of environment, General Wildlife Measures (GAR).

6. Cutting authorities being planned by major licensees and BCTS in Douglas-fir beetle infested areas should incorporate pre-felling trees on roads and landings prior to beetle flight to concentrate beetle populations into harvest area.

7. Additional post harvest treatments are described in the Post Harvest Mop-Up, and Trap Trees sections.

Spruce Bark Beetle Control Tactics

1. Use information from detailed aerial survey to locate infestation centres and outer boundaries of infestations.

2. Where the BMU strategies are aggressive and containment the following control techniques can be utilized:

   General Guidelines:

   a. Small infestation site, less then 1 hectare in size and isolated:

      - The infested trees are to be removed by harvesting.

      - If infested trees cannot be removed before the beetle flight the following year because of harvesting conditions, a trap tree program is to be utilized.

      The above mentioned control techniques will be deployed by the ministry's district forest health program and possibility in conjunction with the major licensee BCTS or SSS.

   b. Larger infestation areas, greater than 1 hectare in size:

      - Harvested under a Forest Development plan or Stewardship plan.

      - Cutting authorities being planned by major licensees and BCTS in spruce bark beetle infestation areas should incorporate the use trap trees, by pre-felling roads and landings.

      - Or bait with attractant semiochemicals in a grid pattern to concentrate beetle populations. Areas grid baited must be assured of harvest within one year. Under the Forest and Range Practices Act (FRPA), FPPR Sec 41, it states that an agreement holder or a timber sales manager who uses trap trees or pheromones to concentrate insect populations must ensure that the insect brood is destroyed before the insects emerge.

Armillaria root disease control Tactics

1. Inoculum removal through the use of stumping and push over logging.

2. Use of less susceptible tree species to the armillaria root disease. Table 1. is a list the species susceptibility.

Table 1. Host susceptibility[1,2] to killing by DRA in 20-80-year-old trees by BEC zone and Species rated as Low, Medium and High.

Refer to Appendix for complete guide: Stand Establishment Decision Aid (Michelle Cleary July 2008)– Armillaria Root Disease – Southern Interior Forest Region

	BEC ZONES				
Species	**PP**	**IDF**	**MS**	**ICH**	**ESSF**
Fd	M	H	H	H	-
Bl	-	-	H	H	H
Bg	-	H	-	H	-
Hw	-	-	-	H	H
S	-	M-H	M-H	M-H	M-H
Py	M	M	-	M	-
Pw	-	-	-	M	-
Pl	-	M	M	M	M
Lw[3]	-	L	L	L	-
Cw[2]	-	L	-	L	L
Ep[4]	-	L	L	L	-
At[4]	-	L	L	L	L
Ac	-	L	L	L	L

[1] Susceptibility is not a good single index of damage. For example, in undisturbed stands in the IDF, Fd is as susceptible or more so than in the ICH, but is not exposed to inoculum as often as in the ICH. Hence DRA impact on Fd is much lower in the IDF than in the ICH. Ratings are only provided for species common in and suitable for the respective BEC zones

[2] **All conifer species are quite susceptible to killing when young (with the possible exception of Cw)**. The ratings here reflect the degree to which they become resistant with age, usually starting about age 15-20. Mortality rates for young cedar are significantly lower than other conifers in juvenile stands. Smaller trees exhibit high frequency of compartmentalization and callusing at the root collar and the rate of callusing increases with tree size. Hence, resistance in Cw appears to occur much earlier than other conifers.

[3] **Lw becomes increasingly resistant to *A. ostoyae* only after the age of 20-25 years. On good sites, rapid growth characteristics of Lw at early ages enable trees to contact inoculum sooner than other regenerating conifers which results in high mortality rates for Lw in younger stands, comparable to that of Fd.**

[4] Ep and At have low susceptibility to killing until about age 40 or until they are overtopped, then susceptibility increases.

Aerial and Ground Surveys

The provincial overview survey is carried out each year to determine the spread of the bark beetles within the district. In 2008-09 a detailed aerial survey was completed by the district forest health technician. This flight covered Douglas-fir beetle in the district and the outer edges of the spruce bark beetle attack in the northeast.

Prioritizing BMU's

A priority rating will be given to all beetle management units based on timber types, resource values, adjacent infestations, and past investments. This priority rating then needs to be further evaluated, to consider shelf life, species composition and amount of infestation to prioritizing harvesting.

Beetle Attack Analysis/Susceptibility Maps

This analysis reflects the susceptibility of forest stands to beetle infestation, based on factors such as tree age, elevation, species composition, landscape constraints, current infestation levels, and is calculated from information in the Ministry of Forests' digital inventory ("FIP") files

Small Patch Harvesting

Small patch harvesting is a viable control option for small scattered patch infestations of Douglas-fir and spruce bark beetle. All harvesting should be followed by a mop-up procedure. Small patch harvesting, utilizing Small Scale Salvage is no longer an effective tool in controlling the mountain pine beetle in this district because of the extent of the infestation.

Harvesting: Clearcutting

Harvesting is the main control for bark beetles, and wherever possible should be completed prior the next beetle flight. Forest development plans and Stewardship Plans should incorporate the sanitation of beetle infestations, where possible.

Minimizing Windthrow: where Douglas-fir and spruce are reserved in cutblocks or as wildlife tree patches, cutblocks should be laid out to ensure wind firmness. Reserve areas should have post-harvest inspecting conducted to ensure the wind firmness goals were met, and if there is blowdown these trees should be salvaged to prevent the concentration of bark beetles.

Post-Harvest Mop-Up

For Douglas-fir and Spruce bark beetle control, slash and felled trees which may be present after harvesting should be minimized, piled and burned or cut into lengths less than 1m, to prevent population build-up or survival in that material.

Conventional Trap Trees

This tactic is used against Douglas-fir and Spruce bark beetle, and takes advantage of the fact that this pest prefers downed material over standing trees; trees are removed between September and before beetle emergence. (For spruce bark beetle (IBS) this emergence date is just beyond May 15th and Douglas-fir beetle (IBD) Apr 15th.)

Access

Road deactivation should be delayed if future forest health activities are anticipated in an area.

All timber infested with bark beetles must be delivered to the mill and debarked between the following time periods:

Douglas-fir	Aug 15th to April 15th.
Spruce	Aug 15th to May 15th
Lodgepole Pine	no restrictions apply.

The mill must be advised of the beetle infested wood. Exemption maybe given to these restrictions if it is determined that these beetle have entered the tree in the present year and will not emerge until the following spring.

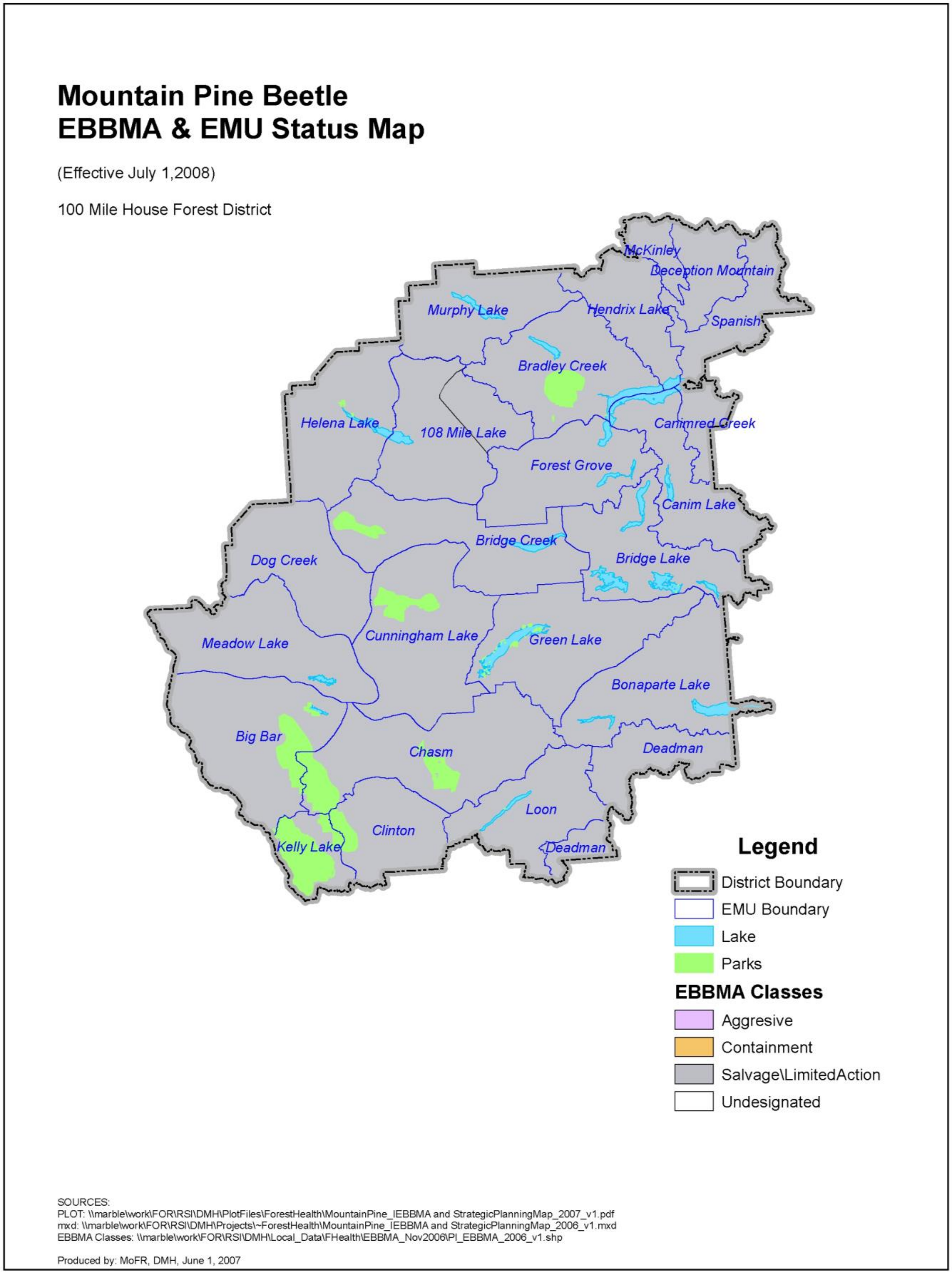
Reporting To The Chief Forester:

The effectiveness of the districts forest health strategy will be evaluated in April of each year to fulfil the requirements of the district AAC uplift. The strategy will be evaluated to see if the suppression goals to control >80% of current attack is being accomplished in all BMUs

This requirement is stated in the 100 Mile House, Rationale for Allowable Annual Cut (AAC) determination (page 42) which states: "I urge BCFS district staff to report on how well the 100 Mile House district health strategy is being implemented and opportunities for improvement so that this can be factored into the next determination."

Beetle Management Units
100 Mile House Forest District
Mountain Pine Beetle

BMU	STATUS May 2008
108 Mile Lake	salvage
Big Bar	salvage
Bonaparte Lake	salvage
Bradley Creek	salvage
Bridge Creek	salvage
Bridge Lake	salvage
Canim Lake	salvage
Canimred	salvage
Chasm	salvage
Clinton	salvage
Cunningham	salvage
Deadman	salvage
Deception	salvage
Dog Creek	salvage
Forest Grove	salvage
Green Lake	salvage
Helena Lake	salvage
Hendrix Lake	salvage
Kelly Lake	salvage
Loon Lake	salvage
McKinley	salvage
Meadow Lake	salvage
Murphy Lake	salvage
Spanish	salvage


Mountain Pine Beetle
EBBMA & EMU Status Map
(Effective July 1,2008)
100 Mile House Forest District
McKinley
Deception Mountain
Hendrix Lake
Spanish
Murphy Lake
Bradley Creek
Helena Lake
108 Mile Lake
Canimred Creek
Forest Grove
Canim Lake
Bridge Creek
Bridge Lake
Dog Creek
Meadow Lake
Cunningham Lake
Green Lake
Bonaparte Lake
Big Bar
Chasm
Deadman
Loon
Clinton
Kelly Lake
Deadman
Legend
District Boundary
EMU Boundary
Lake
Parks
EBBMA Classes
Aggresive
Containment
Salvage\LimitedAction
Undesignated
SOURCES:
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EBBMA Classes: \\marble\work\FOR\RSI\DMH\Local_Data\FHealth\EBBMA_Nov2006\PI_EBBMA_2006_v1.shp
Produced by: MoFR, DMH, June 1, 2007

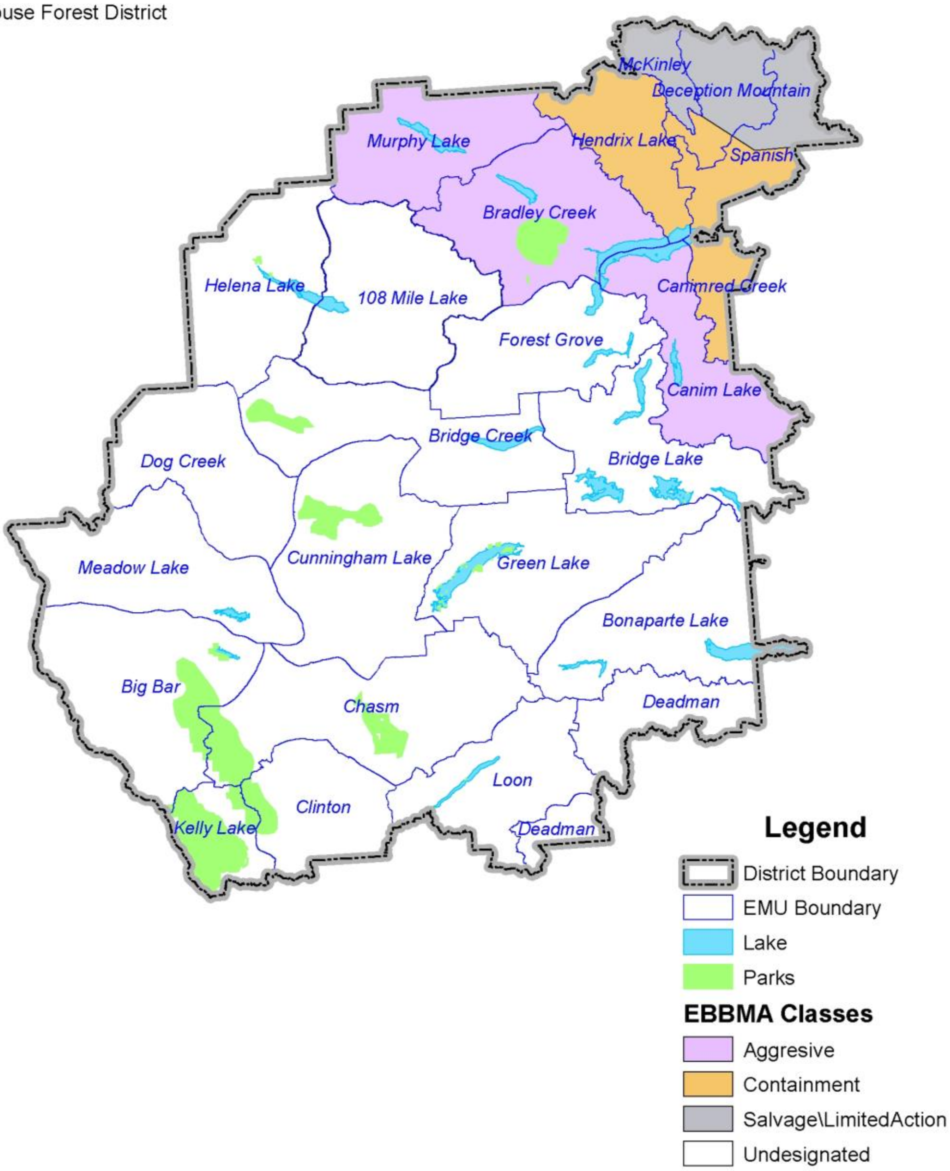
Beetle Management Units
100 Mile House Forest District
Spruce Beetle

BMU	STATUS May 2008
108 Mile Lake	aggressive
Big Bar	aggressive
Bonaparte Lake	aggressive
Bradley Creek	**aggressive**
Bridge Creek	aggressive
Bridge Lake	aggressive
Canim Lake	**aggressive**
Canimred	**Containment**
Chasm	aggressive
Clinton	aggressive
Cunningham	aggressive
Deadman	aggressive
Deception	**Salvage/Containment**
Dog Creek	aggressive
Forest Grove	aggressive
Green Lake	aggressive
Helena Lake	aggressive
Hendrix Lake	**Containment**
Kelly Lake	aggressive
Loon Lake	aggressive
McKinley	**Salvage**
Meadow Lake	aggressive
Murphy Lake	**aggressive**
Spanish	**Salvage/Containment**

Spruce Bark Beetle
EBBMA & EMU Status Map

(Effective July 1,2008

100 Mile House Forest District



SOURCES:
PLOT: \\marble\work\FOR\RSI\DMH\PlotFiles\ForestHealthSpruceBeetle_IEBBMA and StrategicPlanningMap_2007_v1.pdf
mxd: \\marble\work\FOR\RSI\DMH\Projects\~ForestHealth\SpruceBeetle_IEBBMA and StrategicPlanningMap_2006_v1.mxd
EBBMA Classes: \\marble\work\FOR\RSI\DMH\Local_Data\FHealth\EBBMA_Nov2006\Sx_EBBMA_2006_v1.shp

Produced by: MoFR, DMH, June 1, 2007

Douglas Fir Beetle
EBBMA & EMU Status Map

(Effective July 1,2008)

100 Mile House Forest District

SOURCES:
PLOT: \\marble\work\FOR\RSI\DMH\PlotFiles\ForestHealth\DouglasFir_IEBBMA and StrategicPlanningMap_2007_v1.pdf
mxd: \\marble\work\FOR\RSI\DMH\Projects\~ForestHealth\DouglasFir_IEBBMA and StrategicPlanningMap_2006_v1.mxd
EBBMA Classes: \\marble\work\FOR\RSI\DMH\Local_Data\FHealth\EBBMA_Nov2006\Fd_EBBMA_2006_v1.shp

Produced by: MoFR, DMH, June 1, 2006

Beetle Management Units
100 Mile House Forest District
Douglas-fir Beetle

BMU	STATUS May 2008
108 Mile Lake	aggressive
Big Bar	aggressive
Bonaparte Lake	aggressive
Bradley Creek	aggressive
Bridge Creek	aggressive
Bridge Lake	aggressive
Canim Lake	aggressive
Canimred	aggressive
Chasm	aggressive
Clinton	aggressive
Cunningham	aggressive
Deadman	aggressive
Deception	aggressive
Dog Creek	aggressive
Forest Grove	aggressive
Green Lake	aggressive
Helena Lake	aggressive
Hendrix Lake	aggressive
Kelly Lake	aggressive
Loon Lake	aggressive
McKinley	aggressive
Meadow Lake	aggressive
Murphy Lake	aggressive
Spanish	aggressive

Appendix 1

Stand Establishment Decision Aid (Michelle Cleary July 2008)– Armillaria Root Disease – Southern Interior Forest Region

Introduction:

In the Southern Interior of British Columbia, Armillaria root disease (DRA) causes considerable losses in immature stands by killing natural and planted coniferous trees. Tree mortality usually begins about 5-7 years after stand establishment, peaks around age 12 and then declines, although mortality can continue throughout a rotation. Repeated non-lethal infections on roots of older trees will result in growth loss. The disease also increases the susceptibility of trees to attack by other pathogens and insects. DRA poses a long-term threat to forest productivity and sustainable forest management because current silviculture practices increase the amount and potential of Armillaria inoculum and put regeneration or residual trees at risk of becoming infected by the fungus. This threat can be moderated by planting trees that are more resistant to Armillaria or by modifying silviculture practices to minimize exposure of trees to Armillaria inoculum in managed, second-growth stands.

The likelihood that trees will be infected and damaged or killed by DRA varies among species and also between Biogeoclimatic (BEC)[a] zones. Two major factors are involved: 1) the frequency of exposure to inoculum and the quality of that inoculum (= inoculum potential); and 2) host reactions to contact and invasion by DRA inoculum (= host resistance). The former varies by BEC zone, subzone, and site series, with the highest exposure probably occurring in the ICHmw. The latter varies by species, host genetics, age and vigour (adaptation to local site).

The probability of significant damage in infected stands is a combined function of both factors. Differences between Southern Interior BEC zones in DRA-caused damage are largely attributable to differences in the distribution of inoculum. In all but the driest and wettest site series in the ICH, DRA is universally present. In the other zones Armillaria is distinctly patchwise distributed, typically within large (at least 1 ha and sometimes >10 ha) patches. Subzones can differ significantly and, in theory, a much more precise ranking could be provided at a subzone level. For instance the IDFmw may be similar to the ICH with respect to DRA distribution and damage. However, in general we lack the necessary information to distinguish between subzones.

Resistance (being the ability to ward off or limit infection after exposure to inoculum) depends in part on tree vigour, which is generally greater in the ICH than in the IDF, MS, PP and ESSF zones. A revised table of host susceptibility ratings for species is provided in this extension note (Table 1). This table is intended to supercede those host susceptibility tables presented in the Root Disease Management Guidebook[b] and in Morrison et al. 1991. Only those species that are well adapted to a particular zone are considered. For instance, Bl is only ranked in the MS, ICH and ESSF.

The purpose of Table 1 is to present information about the susceptibility of various species to killing by DRA. The table does not describe the frequency or extent of damage on host species within their corresponding BEC zone nor is it intended to replace BC MFR stand establishment guidelines for preferred and acceptable species.

Forest managers need tools to help make informed decisions about DRA and best management practices. This Stand Establishment Decision Aid (SEDA) provides such a tool in the form of a decision key (Fig. 1), which describes several different treatments. The main outcomes (treatments) are: 1) ignore DRA and accept a loss of volume at rotation, 2) plant or encourage natural regeneration of DRA-resistant species or uniform mixtures containing resistant species, and 3) remove inoculum. Use of the latter two treatments may be limited by site factors or management constraints not related to DRA (e.g. erodible or calcareous soils, ecological sensitivity, etc.). The necessity of dealing with DRA, when it is present and threatening, is seldom the only consideration in regeneration decisions.

The decision key is actually a 'decision flowchart', which first differentiates between the distribution of DRA and the extent of damage within BEC zones and subzones and then provides appropriate measures to minimize losses to DRA in regenerating stands.

[a] See Meidinger and Pojar (1991) for an explanation of Biogeoclimatic Ecosystem Classification (BEC) Zone, subzone, and variant abbreviations

[b] Anonymous. 1995. British Columbia Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1995. Root disease management guidebook. Forest Practices Code, Victoria, B.C.

Characteristics of Susceptible Stands:

- Newly established and managed stands of highly susceptible conifers (see Table 1), especially in the ICH, but also in the IDF, MS, and ESSF zones.
- Moist climatic regions like the ICH have higher incidence of infection than wet (e.g. ESSF) or dry (e.g. IDF) climatic regions. Furthermore, the wettest and driest site series generally have a lower incidence of Armillaria than mesic site series.

Hosts: All coniferous trees, deciduous trees, shrubs and some herbaceous plants are susceptible to infection by the fungus. Relative susceptibility of host trees to killing by *Armillaria ostoyae* is given in Table 1.

Table 1. Host susceptibility[1,2] to killing by DRA in 20-80-year-old trees by BEC zone and Species rated as Low, Medium and High.

Species	BEC ZONES PP	IDF	MS	ICH	ESSF
Fd	M	H	H	H	-
Bl	-	-	H	H	H
Bg	-	H	-	H	-
Hw	-	-	-	H	H
S	-	M-H	M-H	M-H	M-H
Py	M	M	-	M	-
Pw	-	-	-	M	-
Pl	-	M	M	M	M
Lw[3]	-	L	L	L	-
Cw[2]	-	L	-	L	L
Ep[4]	-	L	L	L	-
At[4]	-	L	L	L	L
Ac	-	L	L	L	L

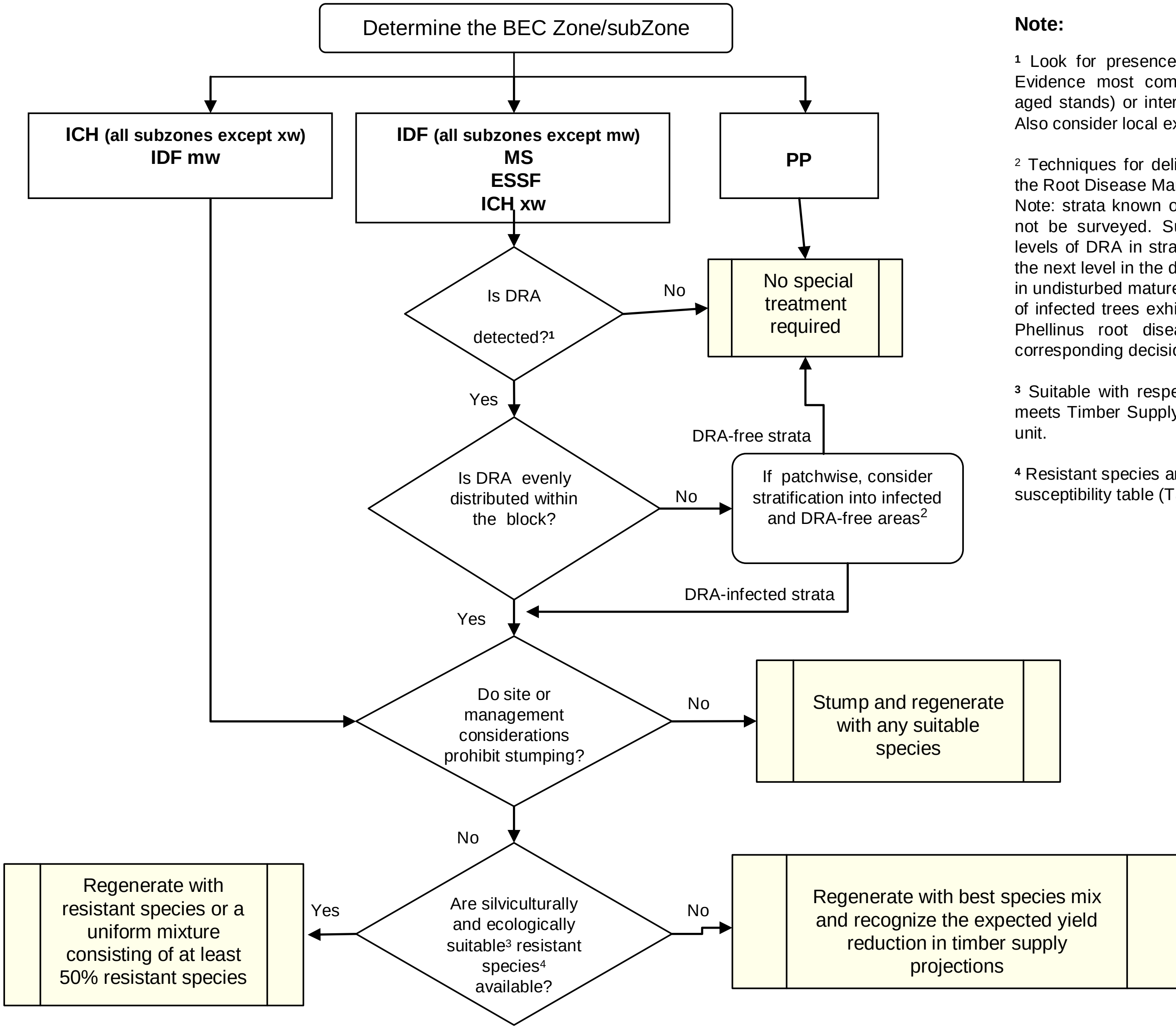
[1] Susceptibility is not a good single index of damage. For example, in undisturbed stands in the IDF, Fd is as susceptible or more so than in the ICH, but is not exposed to inoculum as often as in the ICH. Hence DRA impact on Fd is much lower in the IDF than in the ICH. Ratings are only provided for species common in and suitable for the respective BEC zones

[2] **All conifer species are quite susceptible to killing when young (with the possible exception of Cw)**. The ratings here reflect the degree to which they become resistant with age, usually starting about age 15-20. Mortality rates for young cedar are significantly lower than other conifers in juvenile stands. Smaller trees exhibit high frequency of compartmentalization and callusing at the root collar and the rate of callusing increases with tree size. Hence, resistance in Cw appears to occur much earlier than other conifers.

[3] Lw becomes increasingly resistant to *A. ostoyae* only after the age of 20-25 years. On good sites, rapid growth characteristics of Lw at early ages enable trees to contact inoculum sooner than other regenerating conifers which results in high mortality rates for Lw in younger stands, comparable to that of Fd.

[4] Ep and At have low susceptibility to killing until about age 40 or until they are overtopped, then susceptibility increases.

Armillaria Root Disease – Southern Interior Forest Region



Note:

[1] Look for presence of DRA in pre-harvest stand. Evidence most commonly found on younger (all-aged stands) or intermediate and suppressed trees. Also consider local experience in similar cutblocks.

[2] Techniques for delineating strata are described in the Root Disease Management Guidebook.
Note: strata known or assumed to be infected need not be surveyed. Surveys detecting even minimal levels of DRA in stratified blocks should advance to the next level in the decision key bearing in mind that in undisturbed mature stands, only a small proportion of infected trees exhibit above ground symptoms. If Phellinus root disease is present, refer to the corresponding decision aid.

[3] Suitable with respect to performance on site and meets Timber Supply objectives of the management unit.

[4] Resistant species are classified as 'L' in the host susceptibility table (Table 1).

Figure 1. Decision Key for different treatment strategies for Armillaria-infested sites by BEC zone/subzone for the southern interior region of BC.

General Information:

•*Armillaria ostoyae* is the most widespread and damaging root disease pathogen of conifers in the southern Interior of BC. It causes mortality and, in trees that sustain non-lethal infections, limits growth potential.

•*A. ostoyae* is a facultative parasite. During its parasitic phase it invades and kills host tissue (mainly roots and fresh stumps). In undisturbed mature stands in the ICH, especially on moist site series, up to 90% of trees will have Armillaria lesions on their roots. After harvest of stems on diseased sites, root systems remain alive for a couple years during which time the fungus can escape from small contained infections and invade the whole stump and root system. Spread within the host is limited to the parasitic phase. During the saprophytic phase it uses invaded tissues as a food source and produces rhizomorphs (shoe-string-like bundles of fungal mycelium) that seek out new hosts. In this state, it can survive for many years on larger dead roots and stumps.

•Disease spread occurs belowground by mycelial growth across root contacts between infected tissue and healthy, adjacent trees or via rhizomorphs growing through the soil. Infection by spores is very rare.

•Aboveground symptoms of disease include basal resinosus in most conifers, chlorosis of needles, reduced terminal growth, and stress-induced cone crops. However, aboveground symptoms on individual trees are variable in both kind and extent and may only become evident immediately preceding death of the tree. This is particularly true for individual trees in young stands.

•To confirm occurrence of *A. ostoyae* on suspect infected trees, close examination under the bark of roots and root collar area is recommended. White mycelial fans can be seen under the bark or along the cambial zone on colonized roots. Another species of Armillaria, *A. sinapina*, co-exists with *A. ostoyae* throughout much of its range. *A. sinapina* is usually considered a weak pathogen that at times assumes the role of a secondary parasite, attacking stressed trees including those under attack by *A. ostoyae*. It is difficult to distinguish between *A. ostoyae* and *A. sinapina* in the field as both species form white mycelial fans. If there is tree mortality, assume you are dealing with *A. ostoyae*.

•Rhizomorphs may be found on infected roots or in the soil. Advanced decay appears as yellow stringy white rot. Clusters of honey mushrooms may be formed in the late summer/early fall at the base of infected trees or stumps or overlying infected roots.

•Armillaria may be associated with other root diseases such as *Phellinus sulphuracens* (= *P. weirii*).

•Distribution of the disease can be uniform or patchy depending on the climatic region and/or BEC zone.

•In young plantations and natural stands the disease is manifest as small groups of two or three symptomatic or killed trees and there may be many such groups per hectare.

Harvesting and Silviculture Considerations:

•Many forestry practices affect the incidence and severity of Armillaria root disease. Any practice that creates stumps, especially large ones, increases the amount of inoculum on infested sites. Rapid regeneration of infested sites after harvest with highly susceptible conifers will result in considerable mortality as young trees are exposed to inoculum when it is at or near its peak potential. Treatment strategies for managing DRA consist of either inoculum reduction (stump removal), or selection of species for regeneration that have a low susceptibility to killing. They will vary by BEC zone (refer to the Decision Key, Figure 1). In some cases no treatment strategies are suitable/available. In these circumstances a significant yield reduction should be expected.

•Following partial cutting the build-up of inoculum in stumps allows the pathogen to invade and kill trees in the residual stand. Mortality usually starts about five years after the partial cut and often continues for many years thereafter because each newly killed tree adds fresh inoculum.

•Surveys are not practical for predicting disease levels, especially during the free-to-grow window because mortality in conifers in the regenerating stand usually begins 5-7 years after stand establishment and does not peak until trees reach about the age of 12 years old.

•In the ICH, surveys of disease incidence in undisturbed (pre-harvest) stands are unreliable. However, if the disease is detectable it is clearly present and probably serious. The pathogen can be completely quiescent in such stands, (i.e., it is present only as contained root lesions), but following cutting there can be widespread invasion of stumps and root systems and high inoculum potential.

Regeneration/Establishment:

Site Preparation:

•The impact of Armillaria root disease in new plantations can be reduced by mechanical removal of stumps and major roots during harvest (push-over harvest) or after harvest. Stumping is not a practicable treatment on all sites, especially those with constraints such as steep slopes, erodible and calcareous soils.

•The testing of biological agents such as *Hypholoma fasciculare* to treat forest root disease is a relatively recent development in B.C. Currently, no proven biological agents are commercially available for use against root pathogens.

Planting:

•When inoculum removal is not an option, regenerating stands with resistant species is preferred.

•Plant conifers that have a low susceptibility to killing by the fungus (Table 1). Use of species from the
High and Moderately susceptible categories in very high proportions is not recommended. Early survival of more susceptible host species (e.g. Douglas-fir) could be enhanced if planted in uniform mixtures containing at least 50% of a resistant host such as western redcedar. Uniform species mixtures comprising up to 50% of resistant conifers (e.g. Cw, Lw) and no more than 50% of hosts with high susceptibility to killing is recommended. If moderately susceptible hosts are available, the proportion of resistant hosts in mixtures may be reduced to 30% provided the proportion of susceptible hosts is less than 40% of the species composition. Choice of species may be limited by ecological suitability.

•To increase stocking and species diversity, natural regeneration of resistant hosts (e.g. Cw) may be encouraged. Reliance on the ingress of natural regeneration to meet the minimum proportion of

resistant hosts on an infested site is not recommended because it is unlikely to result in the uniform mixture required to achieve reduced mortality and disease spread between trees.
•Faster growing species may die more quickly than slow-growers because they tend to contact inoculum much sooner and they contact it when the inoculum potential of the fungus is high. Lw is a such a fast growing species that suffers high mortality rates when less than 15 years old.
•Similar to western redcedar, hardwoods may help mitigate damage caused by DRA in new plantations. However, hardwoods may become more susceptible to killing after age 40, especially in stands where they are mixed with conifers and overtopped. Hardwood stumps can become inoculum sources after they die or are cut down.
•Resistant conifers may be fill-planted in openings caused by the disease to improve stocking levels.

Plantation Maintenance:

•Cleaning or brushing of hardwoods can increase DRA inoculum. If brushing is unavoidable, it is best done as early as possible so that the stumps created are small. Cutting of herbaceous material or woody shrubs apparently has little effect on increasing DRA inoculum.
•Because precommercial and commercial thinning increases the amount of inoculum on site , these activities also increase DRA incidence and severity. This increase in inoculum can be prevented by using techniques like pop-up spacing, which remove infected roots and stumps from the soil.
•Multiple stand entries maintain high fungal inoculum potential because the stumps that feed the fungus become available at regular intervals.
•On infested sites, retain or favour healthy planted or naturally regenerated tree species with high resistance to DRA (e.g. western redcedar and paper birch); this practice will increase the number of barriers acting to deter spread by the fungus between susceptible host species.

Potential Productivity Implications:

•Forest management practices that create stumps and conduct rapid regeneration of sites with susceptible hosts may exacerbate disease levels over and above that which would normally occur in nature by exposing trees to inoculum while its potential is still high.
•Armillaria is universally present in all subzones throughout the southern ICH except perhaps on the driest and wettest sites. The proportion of diseased trees that show above ground symptoms is lower in the ICH than in any other zone.
•In the MS, IDF, and ESSF, the distribution of Armillaria can be somewhat patchy, occurring as distinct centres typically within larger (1-10+ hectares) patches. Infected patches are usually characterized by scattered single or small clumps of dead and symptomatic trees; however the actual incidence of infection is always noticeably higher than what can be detected above ground.
•Increased inoculum on sites will lead to mortality or growth loss in trees that sustain non-lethal infections, hence reducing ecosystem productivity. Indirect effects of the disease include increased susceptibility to windthrow and insect damage.

•Cumulative mortality in Douglas-fir stands in the ICH can be as much as 20% by age 20-years resulting in unacceptable stocking in juvenile stands.
•The probability of infection by *A. ostoyae* increases with increasing DBH because roots will continue to contact inoculum in the soil throughout the course of a rotation.
•An operational adjustment factor (OAF) developed for Armillaria root disease and applicable to Douglas-fir managed stands in the ICH showed that for medium severity Armillaria infections, the long-term productivity was reduced by 7.2%.

Resource and Reference List:

Anonymous. 1995. British Columbia Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. 1995. Root disease management guidebook. Forest Practices Code, Victoria, B.C. URL: www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/root/roottoc.htm

Cleary, M.R. 2007. Host responses in Douglas-fir, western hemlock and western redcedar to infection by *Armillaria ostoyae* and *Armillaria sinapina*. Ph.D Thesis. The University of British Columbia. 328 pp.

Cruickshank, M. 2000. Volume loss of Douglas-fir infected with *Armillaria ostoyae*. *In* Proceedings, From science to management and back: a science forum for southern interior ecosystems of British Columbia. C. Hollstedt, K. Sutherland, and T. Innes (editors). Southern Interior Forest Extension and Research Partnership, Kamloops, B.C., pp. 127–9. URL: http://www.forrex.org/publications/forrexseries/ss1/paper34.pdf

Cruickshank, M.G., Morrison, D.J., and Punja, Z.K. 1997. Incidence of Armillaria species in precommercial thinning stumps and spread of *Armillaria ostoyae* to adjacent Douglas-fir trees. Canadian Journal of Forest Research 27: 481-490. URL: http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfr&volume=27&calyLang=eng&articleFile=x96-185.pdf

Lloyd, D., Angrove, D., Hope, G., and Thompson, C. 1990. A guide to site identification and interpretation for the Kamloops Forest Region. B.C. Min. For., Victoria, B.C. Land Management Handbook. No. 23 URL: www.for.gov.bc.ca/hfd/pubs/Docs/Lmh/Lmh23.pdf

Meidinger, D. and Pojar, J. 1991. Ecosystems of British Columbia. B.C. Min. For., Victoria, B.C. Spec. Rep Ser. No. 6. URL: www.for.gov.bc.ca//hfd/pubs/Docs/Srs/SRseries.htm

Morrison, D.J., Pellow, K.W., Nemec, A.F.L., Norris, D.J., and Semenoff, P. 2001. Effects of selective cutting on the epidemiology of Armillaria root disease in the southern interior of British Columbia. Canadian Journal of Forest Research 31:59-70. URL: http://article.pubs.nrc-cnrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&journal=cjfr&volume=31&calyLang=eng&articleFile=x00-144.pdf

Morrison, D.J., Pellow, K.W., Norris, D.J., and Nemec, A.F.L. 2000. Visible versus actual incidence of Armillaria root disease in juvenile coniferous stands in the southern interior of British Columbia. Canadian Journal of Forest Research 30:405-414. URL: http://article.pubs.nrc-nrc.gc.ca/ppv/RPViewDoc?_handler_=HandleInitialGet&Journal=cjfr&volume=30&calyLang=fra&articleFile=x99-222.pdf

Morrison, D.J., Merler, H., and Norris, D. 1991. Detection, recognition and management of Armillaria and Phellinus root disease in the Southern Interior of British Columbia. Forestry Canada and B.C. Ministry of Forest. FRDA Report 179. 25p. URL: http://www.for.gov.bc.ca/hfd/pubs/Docs/Frr/Frr179.pdf

Morrison, D.J. 2000. Armillaria root disease: A major impediment to sustainable management of southern interior ecosystems. *In*: C. Hollstedt, K. Sutherland, and T. Innes, editors. Proceedings, From science to management and back: a science forum for southern interior ecosystems of British Columbia. Southern Interior Forest Extension and Research Partnership, Kamloops, B.C. p. 23-26. URL: http://www.forrex.org/publications/forrexseries/ss1/paper08.pdf

Morrison, D.J., Wallis, G.W., and Weir, L.C. 1988. Control of *Armillaria* and *Phellinus* root diseases: 20 year results from the Skimikin stump removal experiment. Pac. For. Res. Cent. Inf. Rep. BC-X-302, Can. For. Serv. 16 p.

Robinson, R.M. and Morrison, D.J. 2001. Lesion formation and host response to infection by *Armillaria ostoyae* in the roots of western larch and Douglas-fir. For. Path. 31:371-385.

Stearns-Smith, S., Gordon Neinaber, Michael Cruickshank and Albert Nussbaum. 2004. Demonstrating growth and yield adjustments (TIPSY OAFs) for Armillaria root disease in a timber supply analysis. Stearns-Smith and Associates, Victoria, BC