Okanagan TSA

Forest Health Strategy

2019

Updated May 2020 by

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Updated October 2018 by:

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Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRO) –

Okanagan Shuswap Natural Resource District (DOS)

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Approved – 2019 Okanagan TSA Strategy

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1 GOAL

The goal of this Forest Health Strategy is to serve as a resource for directing forest health management and for communicating hazards or other relevant information on major pests in the Okanagan Shuswap Natural Resource District (DOS). It provides the tools necessary to improve sustainability and resiliency of forested ecosystems by identifying strategies and tactics to minimize losses from damaging insects, diseases and abiotic disturbances.

2 OBJECTIVES

The overall objective for forest health management of all forest health factors is to minimize timber losses and the hazard and risk from forest health factors by:

1. *maintaining a scheduled detection program for suppression Beetle Management Units and ongoing detection, identification and documentation of all other major forest health factors;*
2. *assessing and updating stand and landscape level hazard and risk using the "best available information";*
3. *identifying prevention and suppression strategies and tactics for major pests;*
4. *implementing strategies and tactics where economically feasible; and*
5. *evaluating management practices for the purposes of adaptive management.*

2.1 PROVINCIAL FOREST HEALTH MANDATE

The goal of the Provincial Forest Health Program represents one of the key objectives of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD); that is to:
"manage, protect and conserve the forest and range resources of the government, having regard to the immediate and long term economic and social benefits they may confer on British Columbia (Ministry of Forest and Range Act, Section 4b) " The provincial government's three key strategic forest health goals are :

1. *Pest impacts are monitored and assessed;*
2. *Practices are adapted to accommodate known forest health risks. ; and*
3. *Resources are protected .*

The Provincial Forest Health Strategy 2013-2016 can be found at
https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/PFHS/Forest%20Health%20Strategy.pdf

The province has amalgamated the forest health information onto a provincial website here:
https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health

3 LINKS TO THIS AND OTHER GOVERNMENT PLANS

2019 Overview of Forest Health Conditions in Southern British Columbia
https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/2019_south_area_forest_health_conditions_report.pdf

OK TSA FH Strategy 2018:
https://www.for.gov.bc.ca/ftp/DOS/external/!publish/Forest%20Health/

The Okanagan Shuswap Land and Resource Management Plan (OSLRMP) Web link to OSLRMP:
https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning/regions/thompson-okanagan/okanaganshuswap-lrmp

4 Overview of Okanagan Shuswap Natural Resource District

4.1 District Description

The Okanagan Shuswap Natural Resource District (DOS) encompasses approximately 2.25 million hectares. It occupies an area between the Canada – U.S.A. border from Osoyoos north to the Upper Shuswap, and in the west, from the Okanagan Range eastward to the Monashee Mountains. The landscape varies from hot, dry sagebrush and grassland communities in the south to wet cedar-hemlock forests in the north. Approximately 64% of DOS is considered productive Crown forests of which approximately 46% comprises the Timber Harvesting Land Base (THLB) at 782,693 hectares. We have an Annual Allowable Cut of 3.1 million m3. The district contains 7 biogeoclimatic zones and 21 subzones. This ecosystem diversity supports a wide range of habitats, including that for forest insects, diseases and abiotic agents. DOS is within one Timber Supply Area (TSA), namely the Okanagan TSA.

There are 4 Regional Districts and 27 communities, including 7 communities of the Okanagan Nation Alliane and 4 communities of the Lakes Division.

The district has 54 designated community watersheds(13 major water purveyors) and 150 range tenures. The population continues to increase, placing more pressure on urban interface. Current estimates have the population in the valley at 395,000.

4.2 Forest Health Issues

A number of insects and diseases occur within DOS. These forest pests range from those which cause minor damage to others which are capable of causing landscape level losses (Table 1); this document will focus on the latter. The most predominant are the tree-killing bark beetles which include mountain pine beetle, spruce beetle, Douglas-fir beetle, western pine beetle and western balsam bark beetle. Defoliators such as western spruce budworm, Douglas-fir tussock moth and western hemlock looper cause mostly growth reductions but can also lead to tree mortality. Armillaria and laminated root diseases are prevalent throughout much of DOS with higher incidences on disturbed sites containing Douglas-fir. Other pests include dwarf mistletoes, stem diseases, foliar diseases and heart rots.

Table 1. Ranking of Forest Health Factors for Forest Management Activities in DOS 2018-2019

FHF	Very Low	Low	Medium	High	Very High
Bark Beetles	*Western balsam bark beetle*	*Mountain pine beetle* *Spruce beetle*			*Douglas-fir beetle*
Abiotic				*Drought* *Fire*	
Diseases	*White pine blister rust* *Comandra Blister*	*Larch needle blight/cast* *Lophodermella needle cast*	*Dothistroma needle blight*	*Phellinus*	*Armillaria ostoyae*

Priority forest health factors (FHF) have been ranked based on the following factors: known impacts to forest resource values, availability of operational detection and treatment methods, costs and benefits of applying detailed detection and treatment activities, overall knowledge of the hazards and risks of each FHF and the collective knowledge of the Regional/District Forest Health Specialists.

DOS, like much of the interior of the province, experienced a rapid increase in many of the agents over the past decade that seriously affected the health of our forests (Table 2). Some of the reasons for the expansive growth included the escalating age of the timber resource, drought stress as a result of consecutive years of low precipitation and numerous mild winters which are conducive to low bark beetle brood mortality. Recently , we have seen a decrease of damaging agents such as Mountain Pine beetle and Spruce budworm as these pests have 'run their course', for the time being. Of increasing concern is Douglas-fir bark beetle and the impacts of recent drought and fires.

Table 2. Summary (hectares) of damaging agents detected during Regional aerial overview surveys from 2008-2019[1].

Damaging Agent	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Mountain pine beetle	*171,397*	*136,033*	*82,589*	*46,253*	*43,828*	*10,533*	*3,431*	*2,003*	*903*	*213*	*30*	*47*
Douglas-fir beetle	*389*	*438*	*531*	*308*	*675*	*906*	*797*	*1,305*	*1,634*	*2,901*	*1,974*	*2,526*
Spruce beetle	*4,000*	*5,240*	*130*	*101*	*213*	*350*	*17*	*64*	*110*	*29*	*8*	*114*
W. balsam bark beetle	*59,029*	*71,462*	*57,419*	*59,344*	*65,414*	*50,769*	*60,657*	*55,912*	*80,019*	*26,741*	*56,978*	*42,362*
W. spruce budworm	*74,411*	*121,383*	*40,900*	*76,993*	*110,162*	*1,764*	*662*	*1,484*	*16.1*	*0*	*0*	*0*
W. hemlock looper	*68*	*642*	*35*	*77*	*1,235*	*84*	*0*	*0*	*0*	*0*	*0*	*0*
Aspen Serp. leaf miner	*1,583*	*4,921*	*4,385*	*1,703*	*8,299*	*8,129*	*4,471*	*4,302*	*5,700*	*2,453*	*660*	*4,833*
Larch needle cast	*0*	*265*	*28*	*220*	*327*	*258*	*7*	*134*	*19*	*147*	*297*	*0*
Birch leaf miner	*738*	*499*	*2,093*	*214*	*624*	*92*	*215*	*696*	*478*	*70*	*935*	*58*
Drought								*12*	*927*	*14*	*44,343*	*790*
Wind throw	*1,743*	*12*	*119*	*0*	*70*	*0*	*7.1*	*0*	*0*	*1*	*83*	*45*
Fire	*253*	*14,029*	*500*	*14*	*501*	*5*	*151*	*146*	*125*	*11,696*	*36,565*	*3,564*
District Total	**313,611**	**354,924**	**188,729**	**185,227**	**231,348**	**72,890**	**70,415**	**66,058**	**89,931**	**44,265**	**141,873**	**54,339**

4.2.1

4.2.1 Bark Beetles

4.2.1.1 Mountain Pine Beetle

District Status: ↓ Regional Status: ↓ Forecast: Static

The mountain pine beetle (IBM) epidemic has run its course in the Okanagan TSA. Outbreaks have occurred within DOS for decades but the infestation levels of 2004 to 2012 were unprecedented. Currently, there are approximately 47 hectares of red attack in the SW portion of the TSA. The epidemic peaked in Okanagan TSA the summer of 2008 at over 171,000 hectares. There are still substantial high hazard green pine stands remaining in the Campbell and Penticton BMU's.

Hazard rating was completed in 2006 and in 2013 by the Regional Office using the most current methodology[1]. The largest proportions of moderate and highly susceptible stands are found mostly in the south central portion of DOS in the Montane Spruce biogeoclimatic zone (Table 3). The Region has completed new hazard ratings now that the epidemic has waned. For more information on hazard as it pertains to Bark Beetles see Section 8.

Table 3. Mountain pine beetle hazard[2] (in hectares) by biogeoclimatic zone for DOS.

	Very Low (0-5)	Low (5-33)	Moderate (34-66)	High (>66)	Total
BG	*9,270*	*933*		*58*	*10,261*
PP	*58,572*	*14,221*	*129*	*94*	*73,016*
IDF	*218,649*	*122,219*	*48,471*	*59,346*	*448,684*
ICH	*90,788*	*124,252*	*32,065*	*23,302*	*270,407*
MS	*67,095*	*70,328*	*103,734*	*111,082*	*352,239*
ESSF	*73,381*	*94,888*	*90,631*	*39,052*	*297,952*
Total	***517,754***	***426,840***	***275,029***	***232,935***	***1,452,558***

[1]Decision support systems. 2006. Shore, T.L.; Riel, W.G.; Safranyik, L.; Fall, A. Pages 193-230 (Chapter 8) in L. Safranyik and W.R. Wilson, editors. The mountain pine beetle: a synthesis of biology, management, and impacts on lodgepole pine. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia. 304 p.

[2] *Hazard ratings range from 0-100 and represent the eventual basal area killed in the event of a mountain pine beetle infestation as described in 1.*

4.2.1.1.1 1 Impacts of the Mountain Pine Beetle Epidemic

DOS is composed of many different tree species, with an estimated 27% of the mature timber stock being lodgepole pine. As such, the long term impacts of this infestation on harvest levels within DOS were not nearly as significant as elsewhere in the province. The Provincial projections estimate the peak year of annual mortality (red attack) in DOS was 2007. At the midpoint of the epidemic projections indicated as much as 80% of the pine component killed by 2020. Projections now indicate 18% of the pine component killed by 2020.

In response to the mountain pine beetle outbreak the AAC was increased for 5 years, effective in 2006, enabling the District to address infested stands through harvesting. This proactive approach contributed to reducing the overall impact of the epidemic. Recently the Okanagan Shuswap District has begun a new Timber Supply Review (TSR5) for the Okanagan TSA. The current AAC was set by the Chief Forester at 3.1 million m3 on Feb. 29, 2012. The new TSR will be used by the Chief Forester to set the next AAC for the Okanagan TSA. https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/timber-supply-review-and-allowable-annual-cut/allowable-annual-cut-timber-supply-areas/okanagan-tsa

4.2.1.2 Douglas-Fir Beetle

District Status: ↑ Regional Status: ↑ Forecast: Potential for ↑

Outbreaks of Douglas-fir bark beetle (IBD) are usually associated with fire, windthrow, drought, root diseases, and/or defoliation and do not usually have the explosive expansion rates of that of IBM. The area mapped as infested in 2018 was 1,974 hectares and 2,526 hectares in 2019. Ground surveys have verified a number of BMU's with increasing Douglas-Fir beetle populations. The largest infestations of the THLB based on 2019 Aerial Overview Surveys are in the Eagle River, Anstey, Salmon Arm, Upper Salmon, Shorts Creek, TFL49 B, Vernon, Trinity, Cherryville and Keremeos BMU's; particular areas of increase were observed along the Highway 1 corridor from Sicamous to Three Valley Gap, the Highway 6 corridor from Coldstream to east of Cherryville, Chase Creek, Ingram Creek, Equesis Creek and Keremeos Creek. There exists a potential for continued increase in populations due to a number of predisposing factors including fire, climate change and the likelihood of continued drought events in lower elevation Douglas-fir stands and the increase of blowdown in areas heavily harvested due to the Mountain Pine beetle outbreak. Outbreaks of IBD have occurred on many of the steep, shallow-soiled side slopes in the southern and western portions of the district. Anecdotal evidence suggests that high levels of root disease may be promoting rapid expansion of IBD populations in some of the warmer and wetter climatic zones.

The two summers 2017 & 2018 of increased fires have lead to further growth of IBD. New information regarding managing for IBD post fire can be found here:

https://www.for.gov.bc.ca/ftp/DOS/external/!publish/Forest%20Health/Douglas-fir%20bark%20beetle%20resource%20info/

Douglas-fir beetle hazard rating was completed in 2007 and updated in 2014 by the Regional Office using the most current methodology[3]. The majority (73%) of moderate and highly susceptible stands are found in the IDF, followed by the ICH (Table 4). All stands containing Douglas-fir were hazard-rated, hence some very low hazard stands are found at the upper and lower elevational extremes of the host distribution.

Table 4. Douglas-fir beetle hazard[4] (hectares) by biogeoclimatic zone for DOS.

	Very Low (0-5)	Low (5-33)	Moderate (34-66)	High (>66)	Total
BG	*133*	*657*	*82*	*0*	*871*
PP	*6,492*	*23,975*	*4,296*	*2*	*34,764*
IDF	*65,412*	*211,955*	*112,246*	*1,197*	*390,809*
ICH	*98,764*	*171,301*	*28,021*	*124*	*298,209*
MS	*31,172*	*21,349*	*8,366*	*103*	*60,990*
ESSF	*8,604*	*8,678*	*898*	*0*	*18, 180*
Total	***210,575***	***437,915***	***153,908***	***1,425***	***803,824***

4.2.1.3 Spruce Beetle

District Status: ↓ Regional Status: ↑ Forecast: static

Spruce beetle (IBS) populations occur endemically in most spruce stands. Outbreaks of spruce beetle in standing timber generally occur following build-up of populations in windthrow, from fires or other suitable breeding material, such as high stumps. Outbreaks in areas of extensive spruce can lead to high levels of mortality. The overall decline in populations from a high of over 5,000 ha in 2009 represents typical population fluctuations which characterize the two-year cycle of this bark beetle when there are no overlapping population cycles, while an expansion or increase may be indicative of a one-year cycle or overlapping cycles. It is difficult to capture spruce beetle outbreaks from the air as trees are slow to fade. As a result outbreaks can be under represented in the Regional Flight Overview data.

Spruce beetle hazard rating was completed in 2007 and updated in 2014 by the Regional Office using the most current methodology[5]. A very small portion of the stands containing spruce are considered high hazard (Table 5). The majority of these high hazard stands are located in the Mission and Upper Kettle River drainages. A large concentration of the moderate hazard stands are also found in the Upper and West Kettle River and on the Graystokes plateau.

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[3] A Susceptibility and Risk Rating System for the Douglas-fir Beetle in British Columbia. Draft version 10, April 2001. T.L. Shore and L. Safranyik. Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.".

[4] . The susceptibility index provides a relative indicator of which stands would experience the most losses in the event of a DFB infestation; as described in 3.

[5] A Susceptibility and Risk Rating System for the Spruce Beetle Dendroctonus rufipennis. *DRAFT Version 10, August 4, 2005. L. Safranyik and T.L. Shore, Canadian Forest Service, Pacific Forestry Centre.*

A substantial Spruce beetle outbreak is now occurring in the Omineca Region; for detailed information regarding increasing population levels and ongoing forest management follow the link: http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/spruce-beetle/omineca-spruce-beetle

Table 5. Spruce beetle hazard[6] (hectares) by biogeoclimatic zone for DOS.

	Very Low (0-5)	Low (5-33)	Moderate (34-66)	High (>66)	Total
IDF	*5,803*	*21,995*	*6,066*	*581*	*34,445*
ICH	*27,757*	*72,043*	*26,142*	*1,751*	*127,693*
MS	*25,215*	*51,351*	*27,976*	*1,017*	*105,558*
ESSF	*47,685*	*221,191*	*71,339*	*1,701*	*341,917*
Total	***106,460***	***366,580***	***131,523***	***5,050***	***609,613***

4.2.1.4 Western Balsam Bark Beetle

District Status: ↑ Regional Status: ↑ Forecast: Unknown

Historical records do not accurately reflect populations, as often funds were not available to survey high elevation stands. Western balsam bark beetle (IBB) attacks both windthrow and mature subalpine fir. IBB continues to remain active in the high elevation spruce balsam stands, with approximately 56,978 hectares infested in DOS in 2018 and 42,362 hectares in 2019, most of which had less than 1% attack.. Due to the scattered nature of the attack and lower sub-alpine fir component in many of these high elevation stands, very little district resources have been expended on monitoring this pest. Little IBB infested timber has been targeted for harvest over the past 10 years in the Okanagan. Recent work has found that trees that were more likely to be attacked had a lower percentage of the bole covered with constant crown, lower crown volume, lower radial growth in the last five years, and were older than un-attacked trees.

4.2.1.5 Western Pine Beetle

District Status: Static Regional Status: Static Forecast: Potential for Static

Western pine beetle (IBW) is thought to have caused extensive damage to ponderosa pine in the early 1900's in portions of the Okanagan. In the last two decades only scattered attacks of suppressed trees have been recorded. Recent hot dry summers however, combined with fires in the lower valley bottoms have resulted in large areas of stressed ponderosa pine. Ponderosa pine mortality from IBW can increase after fires, so monitoring for this pest in the next few years should be considered.. IBW is often found in conjunction with IBM or red turpentine beetle and this was evident in the affected areas of the Okanagan Mountain fire.

[6] *Range of 0-100 representing relative losses ranging from nil to high.*

Monitoring of IBW populations is a lower priority as outbreaks are generally not on Crown land. However due to the proximity to urban areas and fuel loading potential in the interface, consideration for surveys and treatments will continue to be assessed when funding permits.

4.2.2 Defoliators

4.2.2.1 Western Spruce Budworm

District Status: ↓ Regional Status: ↓ Forecast: ↓

A substantial collapse in the western spruce budworm population in the past number of years is due in part to the effective Regional spray program. In June of 2012 the Region undertook the largest spray program in their history covering over 54,000 hectares, with almost 26,000 hectares sprayed in the Okanagan. The Regional Entomologist conducts aerial biological control using Bacillus thuringiensis var. kurstaki (B.t.k.) and targets areas with high value stands which are forecast to have ongoing defoliation. Most of the Okanagan spraying took place in the southern portions of the TSA from Camp McKinney Rd. to Bear Creek. In June of 2013 just over 2,000 hectares were sprayed near Westwold. Two major outbreaks of western spruce budworm have been recorded in DOS, encompassing over 433,000 hectares. The largest infestation occurred in 1991 when 219, 900 hectares were defoliated. Stand density, stand structure, species composition, tree vigour, host tree age, elevation and aspect are all factors which contribute to stand susceptibility. Fire suppression and selective harvesting activities within the last 100 years have led to a succession of predominantly Douglas-fir stands; some of which have dense understories. In some cases the vertical structure of these stands combined with species composition and poor vigour has resulted in high hazard spruce budworm stands that are also vulnerable to high intensity fires.

Based on historical defoliation, Douglas-fir stands within the IDFxh, mw and dk have experienced widespread defoliation events. Forests of the IDF tend to sustain longer outbreaks, hence more damage than those of the ICH. The quality of foliage on drier sites and the multi-storied nature of stands contribute to increased susceptibility.

Reduced growth, top dieback, stem deformities or mortality may occur depending upon the duration and severity of defoliation. Suppressed understorey or intermediate trees usually suffer the most damage. Tree mortality can also occur as a result of a number of years of successive moderate or severe defoliation, or by secondary causal agents, i.e. Douglas-fir beetle and root diseases.

Information on the Regional spray program can be found at the bottom of this website link:
http://www.for.gov.bc.ca/rsi/ForestHealth/Western_Spruce_Budworm.htm

4.2.2.2 Western Hemlock Looper

District Status: Nil Regional Status: ↓ Forecast: ↓

Western Hemlock Looper has not been identified in the Aerial Overview Surveys since 2013, when a total of 84 hectares of grey defoliation was noted and mapped northeast and northwest of Seymour Arm (Anstey BMU). The preferred host of the looper is western hemlock and western red cedar, although during outbreaks, the looper feeds on almost any foliage, including broad leaved forest trees and shrubs. Although most outbreaks have occurred in mature and over mature hemlock and hemlock-cedar stands, some infestations have occurred in vigorous hemlock stands 80–100 years old. Denser, multi-layered mature to over mature stands dominated by western hemlock are most susceptible.

4.2.2.3 Douglas-fir Tussock Moth

District Status: Nil Regional Status: Nil Forecast: ↓

A number of outbreaks of Douglas-fir tussock moth have occurred in DOS. Many of the outbreak periods were reduced with the use of biological or chemical control, using aerial or ground applications. Efforts date back to 1962 when a nuclear polyhedrosis virus (NPV), which naturally occurs in the population, was used to combat tussock moth in the Okanagan Valley. An outbreak in the Okanagan peaked in 2009 at almost 3,000 hectares. Areas most severely impacted were the Trepanier Valley area west of Peachland and areas east of Carr's Landing along Ellison Ridge. The Regional Office conducted NPV aerial treatments within the Okanagan over approximately 2,600 hectares in 2010/2011. As a result, the Douglas-fir Tussock moth population crashed in the Okanagan.

The Douglas-fir tussock moth (DFTM) has started its outbreak cycle and numerous single tree epizootics and patches of defoliation were noted in 2019. The most extensive and severe defoliation was near Oliver in the Okanagan TSA. Defoliation was also mapped near Vernon, Kelowna and along near Stemwinder Provincial Park in the Merritt TSA. Sampling conducted near the end of larval feeding showed high levels of NPV (virus) in the Stemwinder and Anarchist Mtn. populations indication of a possible population collapse. I expect additional new areas of defoliation in 2020. Lorraine Maclauchlan, Ph.D.,R.P.F Regional Entomologist. Thompson Okanagan Region. September 13,2019

Information on the Douglas-fir Tussock moth can be found at this website link:
https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/defoliators/douglas-fir-tussock-moth

4.2.2.4 Two-Year Cycle Spruce Budworm

District Status: Nil Regional Status: ↓ Forecast: ↓

The damage by this defoliator is most notable in the second year of defoliation. In DOS these tend to be the even numbered years, however no defoliation was noted in 2006, 2008 or 2010. In 2012, 186 hectares were mapped near Mt. Kathleen. Several outbreaks of two-year cycle budworm have been recorded in DOS in areas confined to higher elevation spruce/sub-alpine fir forests mostly in the western portion of DOS.

4.2.2.5 Other defoliators

Aspen Serpentine Leaf miner has increased since 2017 & 2018, it was mapped at 660 hectares in 2018 and 4,833 hectares in 2019. This pest rarely causes tree mortality, however the silvery foliage is a distinctive diagnostic indicator.

Birch leaf miner has frequently caused defoliation throughout the range of host species in DOS. Defoliation from this pest was mapped at 935 hectares in 2018, up from 70 hectares in 2017, indicating a upward trend. It went down to 58 hectares in 2019.

Other Defoliators which have been historically recorded include larch budmoth, larch sawfly, pine butterfly, rusty tussock moth, pine needle scales and satin moth.

The defoliation program is primarily the responsibility of the Region. As noted above, detailed information can be found in the Overview of Forest Health for Southern British Columbia reports at this link:

https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/aerial-overview-survey-documents/si_2017_overview_report_web.pdf

4.2.2.6 Dwarf Mistletoes

Three of the four dwarf mistletoe species found in British Columbia are found in DOS. Douglas-fir dwarf mistletoe occurs mostly on Douglas-fir and is found from the Canada-US border north to a line which runs from Whiteman Creek to Ellison Provincial Park and mid-way up Kalamalka Lake. Lodgepole pine dwarf mistletoe is found throughout the range of lodgepole pine in DOS. Larch dwarf mistletoe is confined to two locations which are spatially distinct: approximately Shuttleworth Creek south to the US Border and near Monashee Summit along Hwy 6 to Nakusp.

4.2.3 Root Diseases

Armillaria (DRA) and Phellinus (laminated, DRL) root diseases are common throughout DOS, particularly on sites with a history of selective harvesting. Tomentosus root disease is less common and found in higher elevation spruce sub-alpine fir stands.

A 2018 updated Root Disease guidebook can be found here:

https://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Forest%20Health%20References/

Laminated root disease infects most of the primary roots, thereby killing the tree. In some instances, the trees become predisposed to bark beetle attack or windthrow. Armillaria moves through the bark and cambium to the root collar where it girdles the stem and kills the tree. Stand susceptibility to root diseases is based upon species composition and biogeoclimatic zone (Tables 6-8).

Table 6. Host susceptibility[7,8] to killing by DRA in 20-80-year-old trees by BEC zone and species.

Rated as Low (L), Medium (M) and High (H).

	Biogeoclimatic Zone				
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[9]	-	L	L	L	-
Cw[10]	-	L	-	L	L

[7] *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*

[8] *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.*

[9] *Lw becomes increasingly resistant to A. ostoyae only after the age of 20 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.*

[10] [4] *Mortality rates for young cedar are significantly lower than other conifers in juvenile stands. Smaller trees exhibit a high frequency of compartmentalization and callusing at the root collar and the rate of callusing increases with*

***Ep*[11]**	-	*L*	*L*	*L*	-
***At*[5]**	-	*L*	*L*	*L*	*L*
Ac	-	*L*	*L*	*L*	*L*

Table 7. Landscape level hazard for Phellinus and tomentosus by biogeoclimatic zone.

BEC Zone	BEC Subzone	*Phellinus sulphurascens*	*Inonotus tomentosus*
IDF	*dk1*	*H*	
	dk2	*H*	
	dm1	*H*	
	mw1	*H*	
	mw2	*H*	
	xh1	*H*[b]	
	xh2	*H*[b]	
ICH	*All*	*H*[a]	
	ICHmk1	*X*[c]	*X*[c]
MS	*dm1*		
	dm2		*X*[c]
ESSF	*dc2*		*X*[c]

[a] *Although both have been known to occur in this BEC not enough information is available to determine hazard. If root disease is suspected, consult Regional Pathologist.*

[b] ***Fir leading sites only.*** [c] ***Known to occur.***

tree size. Hence, resistance in Cw appears to occur much earlier than other conifers.

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

Table 8. Relative host susceptibility to root diseases (excluding Armillaria).

Susceptibility	Laminated root disease (non-cedar variety)	Tomentosus root disease	Blackstain root disease Douglas-fir type	Blackstain root disease Pine type
Susceptible	Douglas-fir Mountain Hemlock sub-alpine fir	Spruce	Douglas-fir	Lodgepole pine
Moderately Susceptible	larch spruce hemlock	Lodgepole pine		White pine, Ponderosa pine
Tolerant	lodgepole pine white pine	Abies, cedar, Douglas-fir, hemlock, larch, ponderosa pine, white pine		Spruce
Resistant	western red cedar ponderosa pine			
Immune	Hardwoods cedar	hardwoods	Western red cedar, Spruce, Pines, Deciduous	Douglas-fir, western red cedar, hemlock, deciduous

4.2.4 Foliar Diseases

*A number of foliar diseases have caused defoliation/discoloration of host species in DOS. These events generally coincide with favourable climatic conditions during which the needles are infected. The most common are Elytroderma needle cast (*Elytroderma deformans*), pine needle cast (*Lophodermella concolor*), and larch needle diseases (*Meria laricis, Hypodermella laricis *Less frequently encountered are Douglas-fir needle blight (*Rhadocline pseudotsugae*) and Dothistroma needle blight (*Dothistroma septosporum*).*

Pests of Young Stands: *A number of insects and diseases are found in young stands, some of which cause minor losses while others kill trees outright. These include the stem rusts, dwarf mistletoes, terminal weevils, root collar weevils, foliar and root diseases. Go to the "Journal of Ecosystems & Management" website at the link below to search for Stand Establishment Decision Aids and the relative hazard by biogeoclimatic zone of a few of the major pests (see Root Disease section for Armillaria and laminated root diseases Stand Establishment Decision Aids).*

https://jem-online.org/index.php/jem

4.2.5 Abiotic

Fire continues to impact the Ok TSA as a result of climate change and drought effects. 2018 was another significant fire year, with several fires burning over 36,500 hectares in the Okanagan. Interface fire continues to be a risk in the DOS. Damage from

windstorms was mapped at 83 hectares in 2018. Areas where fires and windthrow occur should be monitored during the field season for increased bark beetle activity.

5 STRATEGIES AND TACTICS

A strategy is defined as a broad level plan that is designed to achieve a specified end (Merriam-Webster); succinctly, a means to an end. The following strategies will be used to guide forest health management in DOS while providing for other resource values:

- *Identify and prioritize damaging bark beetles in DOS;*
- *Identify the risk posed by bark beetles using hazard mapping and take action on high risk sites as a priority,*
- *Reduce the spread of bark beetles;*
- *Recover the value from damaged stands to the greatest extent possible while protecting other forest values;*
- *Use adaptive management to manage forest health, including:*
    - *Annual update of the Okanagan TSA Forest Health Strategy;*
    - *Producing an Annual Report (measures/interprets results - see Summary of Aerial Overview Survey Reports : https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/aerial-overview-surveys/summary-reports and,*
    - *Reviewing and revising management intervention techniques in response to bark beetle populations (endemic/incipient/epidemic) and technological advances.*
    - *Formed a Forest Health Working group to collaboratively work together at managing forest health issues. The group meets twice a year and is made up of representatives from the major licensees, the Ministry and First Nations*
    - *Developed the Okanagan web mapping tool in 2018 amoung the major licensees and the Ministry. The major licensees are activelty sharing their planned cutblock shapes with the public. https://maps.forsite.ca/oktsa/*
- *Promote appropriate silviculture systems on sites;*
- *Manage the age class structure of susceptible timber types by focusing harvest on mature/overmature forest types;*
- *Create diverse species and age mosaics;*

A tactic is a management action applied to a specific area. Tactics must be appropriate for the strategy used to manage the area and must be consistent with other resource management objectives (for example community watersheds or protected areas). Available tactics may be divided into nine broad categories. Many of these apply specifically to bark beetles. A brief description of each tactic is given below.

***Surveys and Assessments**: Infestation presence and intensity may be assessed by overview flights, detailed flight surveys and ground detection (walkthroughs and probes). Requirements for detailed surveys may be determined by initial overview flights.*

Harvesting: *Harvesting may be divided into 3 categories: sanitation, salvage, and high hazard host removal and includes the development of a harvest priority rating system.*

Single Tree Treatment (bark beetles): *This tactic includes small patch and single tree selection, fall and burn, preventative insecticide, debarking and helicopter logging.*

Baiting and trap trees (bark beetles): *Aggregation semiochemicals or the intentional creation of patches of preferred host may be used to contain and concentrate beetle populations in an area where harvesting or other treatments are planned and access is available.*

Hauling Restrictions (bark beetles): *Restrictions may be considered during beetle flight if points of destination are located within uninfested, high hazard drainages.*

Access Development (bark beetles): *Access planning is important for short and long term management of the mountain pine beetle i.e. road building into high value and/or high hazard stands.*

Beetle Proofing (bark beetles): *Through stand manipulation, this tactic may reduce the attractiveness of a stand to the mountain pine beetle. Suitable stands must be chosen.*

Silvicultural Treatments: *Silvicultural treatments such as species and age class manipulation may reduce the level of potential future damage to the forest for a variety of pests including mountain pine beetle and western spruce budworm.*

Prediction: *A variety of predictive tools are available.*

For bark beetles:

- *hazard and risk rating,*
- *overwintering mortality studies,*
- *Lindgren funnel traps,*
- *and green to red ratio calculations*

For defoliators:

- *hazard rating based on historical information*
- *L2 sampling (Larval sampling predicts the next season's defoliation levels based upon the number of 2nd instar, overwintering larvae)*
- *Egg mass sampling*

Timely use of appropriate tactics, considering the biology of the pests and planning process, is critical to successfully achieving management goals.

5.1 MOUNTAIN PINE BEETLE

Mountain pine beetle has been the most destructive forest pest in DOS. Significant effort and resources have gone into developing management strategies and implementing tactics throughout the province. The District Manager's policy on the management of mountain pine beetle was included in past reports, but has been removed in this document since the epidemic in the Okanagan TSA has subsided, although the information is still available upon request. The strategies currently in effect in DOS are described in this section. Section 8 provides background information on derivation of some of the management concepts discussed below, and also expands upon some of the information outlined in this section.

5.1.1 Current DOS Strategies

The overall objectives for management of mountain pine beetle in DOS are:

- *aggressive management of mountain pine beetle to reduce the spread and impact in suppression areas; and*
- *maximizing fibre recovery and minimizing revenue losses to the Crown; and*
- *minimizing the impacts to all other resource values within the DOS.*

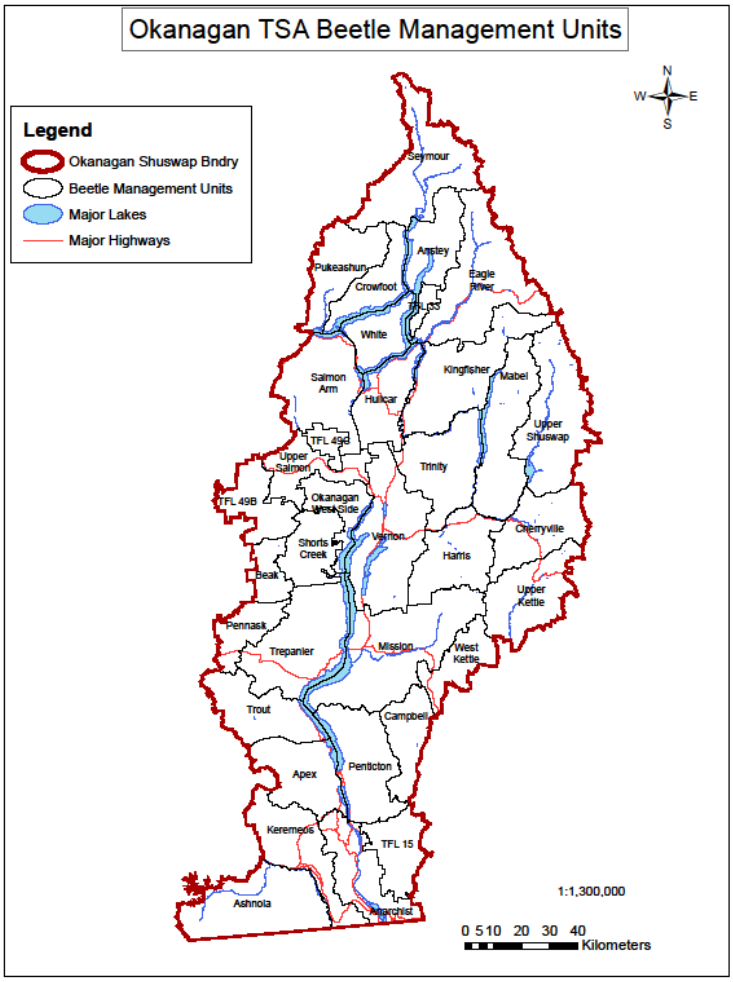
These objectives are achieved under the direction of the District Manager Mountain Pine Beetle Policy (see section 5.1.2) with additional strategic guidance from the Provincial Bark Beetle Management Technical Implementation guidelines on the establishment of Beetle Management Units.

The Beetle Management Units system was developed by the Ministry of Forests, Lands and Natural Resource Operations (FLNRO) for rationalizing the distribution of scarce resources allocated for bark beetle management. It is based on the biological assumption that successful suppression of outbreaks is achieved when at least 80% of the brood are destroyed before flight. This assumption was developed from 30 years of research conducted by the Canadian Forest Service. An outbreak's spread may be slowed or held if 50 to 80% of the infestations are addressed; while anything less will not have any impact. This system is composed of various strategies which are assigned to Beetle Management Units (BMU's). The overall intent of the establishment of BMU's is to clarify where and when specific management strategies and tactics are appropriate. For more information on DOS BMU strategy specifics refer to section 5.1.3 or Section 8.

As of 2005 MSMA (monosodium methane arsenate) has not been used for single tree treatments of beetle-infested trees. A Provincial policy was developed to identify and manage previously treated trees ('legacy' trees).

5.1.2 Beetle Management Unit Strategies

Beetle management units (BMUs) are planning and reporting units for operational beetle management within DOS, where a consistent strategy is applied within a discrete area. The strategies chosen for each BMU should be compatible with those of adjacent BMUs. Beetle Management Units provide a basis for evaluating damage to timber, impact on other resources, effectiveness of treatment, and resource allocation and monitoring. Additional BMU information including hazard and risk by BMU is provided in Section 8.



The following are DOSs' proposed treatment levels by Beetle Management Unit Strategy and are as per the recommendations found at https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/bark_beetle_management_guidebook.pdf . The treatment units include infestation level, (this is a total percent of green attack) and percent pine by volume in a given stand. As referenced in section 5.1.1., targets are biologically-based with the intent of reducing populations (Suppression), maintaining population levels (Holding) or fibre recovery (Salvage). These targets complement the guidance set forth by the District Manager Mountain Pine Beetle Management Policy referenced in Section 5.1.2. For Suppression, the biological target as recommended at the above-noted website and the District policy are very similar. For Holding and Salvage however, the biological and District policy are somewhat similar. The details for each Strategy are as follows:

Suppression BMUs

To reduce populations and/or maintain them at a relatively low level the target is to:

- *within 1 year of discovering, address[12] 70-80% of all known infestations >1% affected (including the THLB)*

For light infestations emphasis should be on single tree or small patch treatments. All harvest and treatment is directed at green attacked trees.

[12] *Address-includes monitoring*

Holding BMUs

To maintain the infestation at a relatively static level the target is to:

- *treat 50-70% of the known infestations in each year. That is, the level of harvest and/or treatment is equal to the rate of infestation expansion. Harvesting should be concentrated in green attack trees.*

The DOS policy however is to actively encourage all licensees to harvest or treat within 2 years of discovery, 100% of the operable infestations > 1% affected, in stands with > 50% pine.

***Note**: as there is no funding for single tree treatments in holding BMU's the treatment[13] targets are not possible in the non THLB.*

Salvage BMUs

To salvage for value recovery as the highest priority.

- *Indications are that holding the infestation static will fail due to influx of populations from heavily infested BMUs in proximity. Emphasis is more to retrieve values at risk and maximize Crown revenues by directing harvest towards killed stands prior to significant degrade.*

The district policy is to actively encourage all licensees to harvest within 2 years of discovery, all operable infestations >5% affected in stands with > 50% pine.

The strategy prescribed for suppression areas was chosen to reflect aggressive measures in stands where the infestation is still at a low level, with the intent of slowing the infestations' progression into uninfested stands. In the Holding and Salvage areas the targets are to be less aggressive with the intent of combining brood removal with volume recovery to minimize non-harvested losses. Target levels assigned to these areas would be subject to the harvest volume available for application to IBM infested stands.

(Note: For all BMUs harvest targets/priorities do not apply to stands identified as retention areas to address non-timber values.)

5.2 DOUGLAS-FIR BEETLE

The overall strategy for Douglas-fir beetle (IBD) management is that of suppression/monitor through the use of one or a combination of the following:

1. *Trap trees;*
2. *Antiaggregation pheromones (MCH);*
3. *Traps trees and (MCH); and*
4. *Clean harvesting practices.*

DOS recognizes that given the recent increase in populations of Douglas-fir beetle across the Region (a result of drought, overstocking and western spruce budworm defoliation), and the western spruce budworm outbreak which peaked locally in 2012, management actions are likely to be utilized in high hazard areas. Terrain and access, however, often restrict management activities to "aerial monitor only". This status remains in effect until the infestation increases to a size where substantial volume losses may occur due to the threat to adjacent Douglas-fir forests. Often infestations will diminish on their own without any course of action.

[13] *Treatment-single tree, bait, or small patch harvest*

Douglas-fir bark beetle outbreaks can be controlled where accessible using an ongoing combination of single tree removal, trap trees, MCH (antiaggregation pheromone) and/or clean logging. In areas of chronic IBD outbreaks, which are usually associated with root disease, small-scale salvage is not recommended.

Because of the thickness of the bark and the large size of Douglas- fir, fall and burning is a less effective and more expensive strategy when used to control IBD. Trap trees are a very effective control tool given the IBD's preference of downed material. Trap trees can be used as a preventative or a remedial measure, which gives forest practitioners opportunity to be very proactive with controlling IBD. Trap trees are large healthy trees (>30cm dbh) that are felled in shady areas of the stand prior to beetle flight to attract Douglas-fir Beetle and then removed post flight.

*MCH (3-methylcyclohex-2-en-1-one) has been used successfully to prevent emerging IBD from attacking windthrow and/or susceptible host trees. MCH functions by emitting chemicals which tells emerging IBD that the host material is fully occupied. The IBD will disperse outside the treated area and may or may not succeed in finding suitable host. MCH is a particularly suited to areas with access limitations or management constraints ex. mule deer winter range, where other management tactics are limited. The 2006 Southern Interior Overview Report stated that in 2006 MCH was successfully used and deployed at a rate of 75 baits/ha (12M*12M grid) in the Cariboo portion of the southern interior. The report concluded that a push-pull treatment program using trap trees and MCH is recommended for infestations over 10 trees in order to reduce the risk of overflow attack. The larger the treatment site, the greater the risk of overflow attack in the surrounding forest. Pushing beetle infestation centres greater than 25 trees is not recommended without using trap trees.*

The district distributes MCH, Funnels Traps, and Lures for use on crown land.

More information on Douglas-fir bark beetle management is available from an updated Forest Practices Code Guidebook at

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/bark-beetles/bark_beetle_management_guidebook.pdf

5.3 SPRUCE BEETLE

The overall strategy for spruce beetle (IBS) management is that of suppression using one or a combination of the following:

1. *Trap trees;*
2. *Trap trees combined with two-component spruce beetle lures; and*
3. *Clean harvesting practices.*

In the last few years the majority of spruce beetle has been confined to the extreme southwestern portion of DOS. Major outbreaks generally correspond to fire or windthrow events, since downed material is the preferred host of spruce beetle. Contiguous spruce forests provide an ample food source once the populations become established. Climatic factors and predators aid in reducing populations. Often early detection can be obtained through the mapping of recent blowdown and concentrating beetle probes in those areas. Also late winter aerial surveys looking for bark fragments on snow from woodpecker foraging on the IBS broods, can be an effective means of detection.

Once identified and evaluated the IBS like the IBD can be prevented, and or controlled through judicious use of trap trees, a combination of trap trees and spruce beetle lures and clean harvest practices. Healthy large diameter spruce (>35cm) are felled prior to beetle flight to attract spruce beetle and then removed post flight. Spruce beetle lures can be combined with trap trees and are particularly useful in areas where snowpack hinders a trap tree program. When dealing with high value stands in riparian reserves, parks, protected areas etc., single tree disposal and trap trees can be used.

More information is available from the Forest Practices Code Guidebook at :
https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/forest-pests/bark-beetles/spruce-beetle/management

5.4 WESTERN BALSAM BARK BEETLE

The overall strategy for western balsam bark beetle (IBB) is monitoring.

Although wide spread in many of the subalpine-fir stands throughout DOS the incidence is generally trace to light. This is in part due to the lack of homogenous stands of sub-alpine fir and the population dynamics of IBB. Susceptible types tend to be climax stands containing a mixture of sub-alpine fir and spruce unlike the seral stands of mostly lodgepole pine favoured by IBM. Unless the incidence of attack is moderate-high, or the outbreak is in or adjacent to proposed blocks on a development plan, very little survey and control work is initiated in IBB infestations at this time.

Regional Entomologist Lorraine Maclauchlan, has been conducting research on IBB with the establishment of several Permanent Sample Plots (PSP's) since 1998. Ten one hectare plots have been established and are being monitored. A paper was published in 2015 "Quantification of Dryocoetes confuses-caused mortality in subalpine fir forests of southern British Columbia". Observations to date have seen "Subalpine-fir stands ...rapidly losing volume and succession driven by D. Confuses (IBB) attack"; and "Results clearly show that subalpine fir stands over 100 years in all ecosystems sustain continuous attack from D. confusus. To minimize future losses to this bark beetle, subalpine fir stands should be managed for a rotation age less than 100 years and mixed species stands promoted where climatically feasible." The complete document can be found here:
https://www.researchgate.net/publication/283154074_Quantification_of_Dryocoetes_confusus-caused_mortality_in_subalpine_fir_forests_of_southern_British_Columbia

5.5 WESTERN PINE BEETLE

The overall strategy for western pine beetle (IBW) is monitoring and in some instances suppression.

Ponderosa pine, the exclusive host for IBW, grows in the lower slopes and valley bottoms which are frequently located on private land. As such, DOS will act primarily as an informational resource in dealing with the control of this bark beetle.

As the market for ponderosa pine is sporadic, harvesting as a control tool is not dependable nor in most instances profitable. In high value stands within or adjacent to recreational sites and Provincial Parks, single tree disposal or peeling and burning has been done to protect adjacent stands. These methods may be considered again in similar situations.

5.6 DEFOLIATORS

Defoliator management strategies can be viewed as either short- or long-term. DOS will promote long-term strategies which reduce landscape level susceptibility while ensuring that other resource objectives are met; this generally involves a species mix and/or

mosaic of age classes across the landscape. More information is available from the FPC Defoliator Management Guidebook at https://www.for.gov.bc.ca/ftp/hfp/external/!publish/FPC%20archive/old%20web%20site%20contents/fpc/fpcguide/defoliat/defoltoc.htm Short-term strategies involve the use of biological control and are the responsibility of the Regional Entomologist.

5.7 DWARF MISTLETOES

Management of dwarf mistletoe is relatively simple where susceptible tree species grow in even-aged stands, and an even-aged stand is desired. Although control might be less certain or even problematic in other situations, some management or treatment options are available to reduce dwarf mistletoe impacts under almost any silviculture system (See FPC Dwarf Mistletoe Management Guidebook at https://www.for.gov.bc.ca/ftp/hfp/external/!publish/FPC%20archive/old%20web%20site%20contents/fpc/fpcguide/dwarf/dwarftoc.htm

The levels of dwarf mistletoes can be reduced over time by creating species diverse stands where possible. The opportunity exists at the regeneration phase to plant a species mix or favour non-host trees during stand treatments in areas where dwarf mistletoe exists.

5.8 ROOT DISEASES

Identification of root disease on a site prior to harvesting is a critical step in the reduction of future root disease potential. Walkthroughs and stratification of harvesting blocks by root disease incidence allow the forest manager to prescribe and implement the appropriate methods for inoculum reduction or removal.

On high hazard subzones as identified in Tables 7 and 8 (Section 4.2.3), root disease incidence should be described as low, moderate or high as per descriptions below.

Each incidence stratum should be broken down into treatment strata to a minimum size of 2 hectares. Since there are valid concerns over the accuracy of certain surveys, identification of root disease species and incidence should therefore be gathered during a prescription walkthrough, in conjunction with sketch mapping, if required.

Low:

Little or no root disease symptoms in the stand such as dead and dying trees, thinning or chlorotic foliage, distress cone crops, blowdown with root balls. Stand structure is generally intact, with little or no reduction in volume.

Moderate:

Some of the above ground symptoms scattered throughout the stand in single trees or small patches. No large centres showing advanced signs of root disease within the strata (greater than 1 ha). Overall, volume in the strata is in decline, but volume reductions are minor in nature.

High:

Numerous small patches having root disease symptoms, or scattered smaller patches in conjunction with larger patches with advanced root disease symptoms. Stand structure is declining, with a noticeable reduction in volume from that expected from a similar uninfected stand.

The above general ocular estimations must be backed up with below the ground checks, to confirm type of root disease. Sketch mapping of root disease centres, root disease levels, and treatment units should be considered on moderate and high strata incidence.

Depending upon root disease incidence the following strategies are recommended to reduce losses in the next stand.

Low pest incidence - Generally no restrictions on regeneration survey. Species mixes are still desirable for general forest health reasons, unless not ecologically suitable for the site. Normal target densities are recommended.

Moderate pest incidence – A more intensive strategy is required than above. A minimum of 2 species should be planted, with a target of 3 species, unless ecologically unsuited for the site. Consider target stocking densities of normal plus 10%. Good quality, acceptable or preferred species. Broad leaf species, particularly birch, should be encouraged up to 200 stems/ha.

High pest incidence – Due to probable significant impact on potential rotation and production, reduction of inoculum should be the first priority on treatable areas, with the emphasis on spot vs. broadcast treatments to minimize soil disturbance. If a significant portion of an area is prescribed for inoculum reduction [stump removal], consider the pest incidence to be reduced to moderate or low, with associated strategies.

If no inoculum reduction is feasible due to site constraints or other resource values, other strategies of risk reduction should be introduced. Recommended strategies are:

- *Species mixes – on those subzones where opportunities exist, 3 species should be planted. Where not ecologically suitable, or where similar sites have a definite history of filling in with other species i.e. Cw/Hw, a minimum of two species should be planted.*
- *To minimize the impact on volume losses, consider increasing target densities to 20% above normal, with minimum inter-tree distance to be reduced to 1.5 metres, as a recognition of managing to higher than 'normal' densities.*

Broad-leaved mixtures, preferably birch, will be encouraged up to 200 stems per ha. Good quality, natural regeneration can be considered 'preferred', similar to the conditions outlined in 'moderate'.

5.8.1 Tomentosus Root Disease

The 'Tomentosus Root Rot Forest Health Stand Establishment Decision Aid (SEDA)' can be found at this link:

http://jem-online.org/index.php/jem/article/view/562

5.8.2 Armillaria Root Disease

A Stand Establishment Decision Aid (SEDA) is available for Armillaria root disease in the southern interior of BC and can be found at http://jem-online.org/index.php/jem/article/view/397.
SEDA provides detailed information on hazard and risk, as well as a decision matrix/flowchart.

A link to root disease control using stumping methods based on empirical trials can be found at:
https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/Root%20Diseases/Stump%20and%20large%20root%20removal%20to%20control%20root%20disease_2.0_hk_Sep%2030.pdf

6 IMPLEMENTATION OF BARK BEETLE TACTICS

6.1 SUSCEPTIBILITY AND RISK RATING

Stand susceptibility refers to the inherent stand characteristics which can lead to bark beetle infestations. Stand characteristics which define hazard vary by bark beetle species. For instance, basal area, age, density and location are factors used to derive susceptibility for IBM. Hazard rating for bark beetles was completed in 2006 and updated in 2014 by the Region using the most current methodologies. The geo-referenced hazard maps for each bark beetle by TSA can be found here: *https://www.for.gov.bc.ca/ftp/RSI/external/!publish/Forest%20Health/Bark%20Beetle%20Hazard%20Maps/2014/*

Risk is a function of stand susceptibility and beetle pressure. Risk is defined as the short-term expectation of tree mortality in a stand as a result of a bark beetle infestation. Stand risk refers to the likelihood of an outbreak arising within a stand based on its proximity to an infested stand. Risk can be determined by overlaying current infestations on hazard maps and delineating areas within 1 km of an infestation, greater than 1 km, and within mountain pine beetle attack. Mountain pine beetle risk is a dynamic factor and is prone to change suddenly if climate conditions fluctuate or if there is an immigration of beetles from another area. To arrive at a risk rating, the size of the infestation and the distance of the infestation from the stand being assessed must be measured. Risk rating is a planning tool which should be updated as bark beetle populations change. However often local knowledge of beetle populations, hazard, and terrain, etc. will generally suffice for planning purposes.

It is recognized that the hazard rating is based on the inventory data available at the time and does not always reflect the true susceptibility at a stand level. In addition, the methodologies currently do not reflect true tree susceptibility, and are only an indicator of potential stand level impacts; this is important when assessing the hazard of mountain pine beetle in mixed species stands with ponderosa or white pine. Mixed stands may have a low hazard but the overall impact to the pine component may be significant.

6.2 ANNUAL AERIAL OVERVIEWS AND OPERATIONAL DETAILED FLIGHTS

DOS operational detailed flights commence in mid to late summer each year, when funding permits, coinciding with crown fade in the previous year's attacked trees. When these operational detailed surveys are conducted, the preferred methodology is a combination of sketch mapping on 1:20,000 orthos, and GPS linked digital photography in areas of heavier attack. The results of these two products are coalesced and digitized. The digitized results are then distributed to major licensees, woodlot licensees, community forest agreement holders, applicable municipalities and ministries.

As only fading or red crowns can be mapped, this data reflects where the beetles were, and not necessarily where they are. The inventory is intended as a guide for ground survey work, to assess location and extent of current attack.

The DOS forest health program conducted detailed heli flights in 2016 and ; if funds permit, flights will occur again. The data is stored here: *https://www.for.gov.bc.ca/ftp/DOS/external/!publish/Forest%20Health/*

The Regional Forest Health Program completes high elevation fixed wing overview surveys at a smaller scale (1:100,000) annually. All timber types are flown with an emphasis on capturing all forest health concerns. Although this has some use as an operational planning tool, it is not intended to replace more detailed aerial and ground surveys. The operational and overview flight data, coupled with hazard rating, form the basis for allocating management resources and responsibilities. Annual Regional Forest Health reports are prepared from the overview flight data and can be found at this link:

https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-health/aerial-overview-surveys/summary-reports

Ground Surveys

DOS and Forest Licensees annually carry out bark beetle surveys on priority areas, when funding permits. The primary focus of ground surveys has moved from Mountain Pine beetle to Douglas-fir beetle. The forest health program provides probe and or recce data, when available, to the licensees for their use in strategic forest harvesting and development planning.

When possible recce / probe work in the Suppression Zone is completed in areas not already under cutting permit and well enough in advance of snow-cover to facilitate the collection of Site Plan data and to meet operational planning needs. The window of opportunity for this is from early September to about mid-November. Some seasonal adjustments may be required.

In many areas, recce work can and should be undertaken in the absence of aerial overview data. This is important where blocks have not been harvested pre-flight and there is a potential for spread into adjacent stands requiring further amendments to existing blocks.

Ground survey information should only be considered accurate and applicable for the current beetle flight period. If a beetle flight has occurred after survey work has been completed, the level and location of infestation may have changed significantly and further assessments will normally be required.

Recce or walk-thru ground surveys which locate and delineate spatially discrete pockets of infestation are most applicable to the current situation in the suppression management units of the District. When these surveys are required, the following information is recommended to be collected:

Mapping

- *a map which clearly identifies and numbers the beetle infestation polys*
- *a map which stratifies the polygons by 10-20 percent increments or number of attack at specific sites; i.e. 0-20%, 30-40% and 50+%*

Infestation Details

- *identifies the insect code and the total # of green/reds/greys tallied in the walk-thru*
- *identifies the estimated infested volume and the area to be logged*
- *identifies the expansion ratio and attack height*
- *identifies the general condition and stages of beetles under the bark,*
- *identifies attack intensity and density of the stand and provides a hazard rating*
- *identifies the susceptibility of the adjacent stand*

Stand and Site Description

- *identifies the species composition, diameter range, average height, stems per ha*
- *identifies the site aspect, slope, terrain condition and accessibility*

Management Options and Comments

- *identifies the most appropriate management option (i.e. harvest, single tree disposal (STD), Bait or monitor)*

Where it is anticipated that the treatments for an infestation surveyed by one agency will need to be carried out by another agency, the identification, layout and transfer of information should be carried out in a manner and time frame which facilitates the most efficient implementation of treatments.

6.3 HARVESTING TREATMENTS

Harvesting is to be considered the preferred treatment for all infestations where it is operationally feasible. Treatment may include a single harvest regime or combination of harvest regimes ranging from large cut blocks, to single tree selection or small patch where appropriate.

The treatment goal is to remove as much, if not all of the current attack prior to the next beetle flight period. Within the Suppression Zone action plans must contemplate harvest before the next flight period. If this is not achievable, or the likelihood of pre-flight harvest is low, then these areas should be tabled as opportunities for other Licensees by at least April 1st of the following year (See Section 6.10 for details on type of information to submit).

Direct single tree treatments are not to be considered an alternative for harvest where the recovery of otherwise lost timber values and sanitation of beetles, i.e. removal of trees with brood can be attained. Where resources are insufficient to address the removal of all infestations prior to the next beetle flight, consideration must be given to minimizing block sizes and/or harvesting only those portions of the block that are infested this should be considered a short-term strategy until resources permit the removal of logical openings.

It is imperative the operational planning requirements are scheduled accordingly and where necessary to meet tight time frames. If necessary, expedited approvals should be requested and are appropriate where infestations are identified post-flight and where harvest is planned to take place prior to the next beetle flight.

6.4 PRIORITY HARVEST RATING

When considering harvest priorities, consideration should be given to the importance of other resource values impacted by the bark beetle. Harvest priorities and allocation of resources will coincide with those identified in the District Manager Policy (Section 5.1.2) and ideally assigned in the following order:

1st Sanitation in the Suppression Zone	*Highest to lowest risk*
2nd Sanitation in the Holding Zone	*Highest to lowest risk*
3rd Sanitation in Salvage Zone	*Highest to lowest risk*
3rd Salvage	
4th Susceptible host reduction	
5th Other timber	

6.5 SMALL SCALE SANITATION

Licensees should consider a small-scale sanitation program as required to meet overall objectives. Sanitation is defined as the removal of infested material prior to beetle flight. Sanitation is to be used, where necessary, to balance resource allocations to optimize the effectiveness of harvesting and single tree treatment strategies and maximize the recovery of otherwise lost timber values.

Sanitation should also be considered where landscape level disturbances and impacts dictate a light footprint approach and where a minimum of one truck load (40 m^3) of operable timber can be recovered, within reasonable skid distance (400 metres) of established logging truck access; the objective is to remove all infested trees prior to the next beetle flight. Only under exceptional circumstances where the methods cannot be applied should these sites be baited and held over flight.

If it is determined that harvesting prior to the next beetle flight is impossible then consideration should be given to expanding the harvest area to include the area baited, as well as sufficient susceptible host.

6.6 HAULING AND MILLING GUIDELINES

The following guidelines should be considered when areas surrounding the mill site are in or near urban areas, or in areas not yet affected by bark beetles.

In recognition of ***the potential for bark beetles to fly from milling facilities into adjacent areas*** *the following guidelines apply during the biological flight timeline of the bark beetle being managed or for an extended period of April 1 to September 15.*

- *Manage -spring break up inventories of infested timber for priority processing prior to the above-noted period.*
- *Keep mill inventories and deliveries of bark beetle infested wood at a minimal operational level to meet business needs.*
- *Mill profile requirements permitting, prioritize processing beetle- infested sources over uninfested sources.*
- *Establish Lindgren funnel traps in and around log yards, log decks and log booms to assist in monitoring bark beetle flight and to serve as a control measure. Traps should be monitored at least weekly and contents destroyed.*

In recognition of ***the potential for bark beetles to fly from infested cut blocks*** *(standing trees or decks) to adjacent timber, the following guidelines apply:*

- *In Salvage BMU's, no special considerations*
- *In Suppression and Holding BMU's:*
  - ✓ *For infested cut blocks that are not harvested/hauled prior to beetle flight, consider baiting in an attempt to minimize spread. Licensees should, where practical, plan operations that avoid leaving decks of infested timber on site.*
  - ✓ *Communication of business needs/expectation for awareness between licensee and DOS prior to spring break-up/next beetle flight is required.*

In recognition of ***the potential for bark beetles to fly from trucks during transport*** *the following guidelines apply:*

- *Inform truck drivers when they are hauling green attack loads and that the beetle flight period extends from April 1st to Sept. 15th.*
- *Inform truck drivers that extended delays along the way can result in bark beetles flying from the load into the adjacent forest land base.*
- *When practical, hauling of beetle infested logs should be as direct as possible from the cutting area to the mill.*

6.7 PHEROMONE PLACEMENT

Pheromone placement is to occur in ***infested stands only****, where beetle control activities cannot be implemented until after the next flight and in mop up operations around harvested and treated infestations. In the case of larger blocks with isolated concentrations of attack, only the infested portions of the block should be baited. The district distributes baits for use on crown land.*

The use of pheromone baits must always be followed by actions to remove or eradicate the concentrated beetle populations. All pheromone placement plans should be shared at operational beetle planning meetings, including scheduling follow-up treatments and responsibilities .

Pheromone placement can be implemented throughout the spectrum of treatment strategies including fall and burn. Pheromones should not be placed in operable areas where population levels are extremely high and increasing, or in inoperable areas where population levels are endemic and declining.

The responsibility to carry out follow-up treatments to remove or eradicate concentrated beetle populations resulting from baiting lies solely with the placement agency (Section 41 of the Forest Planning and Practices Regulation (FPPR)*). Follow-up actions must be carried out prior to the subsequent beetle flight unless specifically exempted by the District Manager (Section 91 of the FPPR*).

Licensees, excluding TSL holders not operating under a cutting permit authority, should consider pheromone bait placement in unharvested portions of beetle infested blocks prior to beetle flight , where due to unforeseen circumstance the Licensee will not be able to complete harvest prior to the beetle flight.

All pheromone placement activities must be carried out in a manner which allows for future identification and location of baited trees. Baited trees must be marked conspicuously in the field using flagging, and the placement agency must be identified at each bait site. Maps identifying all baited areas should be provided to the District by September 15th each year. Detailed guidance and protocols on the use of pheromones is provided in "Strategies and Tactics for Managing the Mountain Pine Beetle", developed for the B.C. Forest Service by Lorraine Maclauchlan and J. E. Brooks (http://www.for.gov.bc.ca/ftp/HFP/external/!publish/MPB_booklet/).

6.8 FALL AND BURN TREATMENTS

Fall and burn is primarily considered in incidences where high value stands are determined to be at risk and is a direct treatment of lightly infested areas or areas of scattered attack adjacent to larger infestations. Fall and burn has been used successfully in Provincial Parks and Recreation Sites.

6.9 SCHEDULE FOR BARK BEETLE ACTIVITIES

Aug 15	*District aerial overview completed (when funding permits)*
Sept. 15	*District aerial overview preliminary data distributed.*
	Post flight ground surveys underway.
Oct. 15	*Co-ordinate survey activities, confirm harvest plans, and co-ordinate treatments. Probes underway.*
Nov. 01	*Single tree disposal on inaccessible infestations commences.*
Nov. 30	*Priority harvest assessments completed. Remove Trap Trees fallen in the spring.*
Dec 1	*Aerial overview data updated to Okanagan Webtool*
Jan. 31	*Review performances of harvesting against beetle spread and prioritize activities accordingly.*
Feb 1	*Fall and Burn completed for IBM*
April 1	*Fall Trap Trees for IBD.*
April 1	*Review harvest plans, review treatment plans, and co-ordinate bait plans, Pheremone placement.*
July 15	*Consider implementing hauling restrictions and or flight monitoring*

7 BARK BEETLE RESPONSIBILITY COORDINATION

The Okanagan TSA Forest Health Strategy will be shared with the Licensees for their review and submitted to the District Manager through the Forest Health specialist.

Detailed bark beetle surveys are carried out to determine the nature and extent of bark beetle infestations within the area of the plan. Specific areas requiring surveys are identified from aerial overview maps and previously known infestations.

If significant risks to forest resources are identified from surveys, actions to reduce risks are identified and reported within bark beetle survey reports and shared with the appropriate licensee. The responsibility to carry out these actions or measures is the responsibility of the licensee. Licensees are committed to sharing information and attending the Forest Health working group.

7.1 FH MATRIX CONDITIONS

1. *Responsibilities are assigned in this matrix according to funding source. Although there are allowances for some activities under the appraisal system, the responsibilities assigned include the implementation and funding of these activities.*
2. *In the event that a Forest Licensee must carry out activities within the operating area of another Forest Licensee, the responsibility for bark beetle management activities post-harvest are to be negotiated in advance.*
3. *Where special management areas have been identified such as areas of interest for the Protected Areas Strategy, the responsibilities identified in this matrix may be amended to address specific management guidelines for these areas.*

7.2 DOS FH RESPONSIBILITY MATRIX

DISTRICT RESPONSIBILITIES	REGIONAL RESPONSIBILITIES
Prepare an annual Okanagan TSA Forest Health Strategy when time and funding permits	*Conduct annual aerial overview surveys and provide digital data to districts to produce overview maps and to distribute to DOS clients*
Info sharing at TSA Steering Committee meetings	*Produce and distribute the Provincial annual forest health overview surveys*
Conduct detailed aerial and ground surveys within the Okanagan TSA where deemed appropriate	*Conduct aerial treatments for defoliators (ex. spruce budworm Bt spraying)*
	Conduct defoliator monitoring
Produce maps from the aerial surveys and provide ground survey information and maps to Licensees and clients	*Provide overwinter mortality estimates of bark beetles*

Forest Licensees have a responsibility to track, monitor and treat forest health factors. The following table covers the responsibilities for Licensees and FLNRO.

ACTIVITY	FLNRO	LICENSEES
Monitor and evaluate forest health activities (Utilize the best current information to detect and manage forest health factors)	X	X
Conduct treatment of defoliator outbreaks (FLNRORD regional responsibility)	X	
Develop annual reports of bark beetle activities for the Province	X	
Conduct bark beetle treatments as required	X	X
Maintain and share records of collected survey information	X	
Conduct ground surveys as required to verify incidence and severity of forest health pests	X	X
Conduct aerial overview forest health surveys and report on results (FLNRORD region)	X	
Conduct detailed aerial surveys focusing on suppression beetle management units	X	
Submission of survey and treatment data to FLNRORD		X

8 BARK BEETLE MANAGEMENT SUPPLEMENTARY INFORMATION

8.1 OVERVIEW OF BARK BEETLE STRATEGIES

Beetle Management Units (BMUs) within TSA's were developed to assist with planning and reporting of operational beetle management. Their purpose is to facilitate the implementation of beetle management activities. Resource management objectives should be consistent throughout the unit. Strategies should be evaluated for compatibility with adjacent BMUs.

Four strategies have been defined to manage bark beetles: Suppression, Holding, Salvage and Monitor. Several factors govern the selection of a specific strategy to a Beetle Management Unit (Table 9). ***Suppression*** *may be used in areas with a low level of infestation and where resources are available for aggressive management actions to maintain the area in a relatively uninfested state. The objective is to reduce populations and maintain them at a relatively low level. Target is to treat ~80% of known infestation centers in each year. The objective of a* ***Holding*** *strategy is to maintain the infestation to a relatively static level by treating ~50-70% of known infestations in each year. That is, the level of harvest and/or treatment is equal to the rate of infestation expansion. Harvesting should be concentrated in green attacked trees.* ***Salvage and/or Monitor*** *is intended for areas where management efforts cannot reduce the beetle population, and/or harvesting capacity and/or access is unavailable. The objective is to retrieve values at risk and maximize Crown revenues by directing harvest towards killed stands prior to significant degrade.*

Table 9. Rationale for assigning a strategy to a BMU and goals/expectations for that strategy.

STRATEGY	RATIONALE	GOALS AND EXPECTATIONS
Suppression	*Aggressive direct control is expected to keep the BMU in a relatively uninfested state* *Resources are available for direct control and harvesting/milling capacity is available*	*Treat at least 80% of currently infested areas within 1 year of detection and 100% within 2 years.* *Aggressive application of available options can be expected to achieve a substantial reduction in infestation size and spread*
Holding Action	*Chronically infested area* *Spread is at a level that can be dealt with using available resources and within the AAC*	*Objective is to treat 50-70% of detected infestations within 1 year* *Maintain population at a static level using spot and grid baiting and limited harvest until a more aggressive approach is feasible* *Accommodate expected beetle activity in the normal planning process and deal with new infestations as they arise* *Prevent rapid increases in beetle with directed harvesting and limited single tree treatments (i.e. "leading edge"); rigorous detection efforts are key* *Containment baiting to be used where appropriate* *Stand prioritization based on hazard and risk*
Salvage and/or Monitor	*Area where management efforts cannot reduce the beetle population, harvesting capacity and/or access is unavailable*	*Delineate affected areas and salvage log stands to recover losses and rehabilitate*

Source: Based on information contained within the Provincial Bark Beetle Management Technical Implementation Guidelines, Spring 2003.

Table 10. Framework for showing factors considered when selecting management strategies or control objectives for bark beetle strategic planning.

Factor	Suppression	Holding	Salvage	Monitor (no action)
Amount of current infestations to treat	*80%*	*50-70%*	*<50%*	*0%*
Hazard class	*Mod to high (low, when adjacent to M/H)*	*Mod to high*	*Mod to high*	*All (adjacency issues)*
Risk class	*Mod. To high*	*Mod to high*	*Low to mod*	*All*
Access (existing or potential)	*Required*	*Required (must within 2 yrs)*	*Planned within 5 year period*	*Not required, not available*
Status of infestation (based on overview surveys)	*Incipient (pre-epidemic)*	*Chronically infested, larger outbreak areas*	*Extensive outbreaks*	*Irrelevant*
Location of infestations	*Within THLB*	*Within THLB*	*Within THLB*	*Inside or outside THLB*
r-values (rate of population increase)	*Positive, population increasing*	*Zero, Population stable or increasing*	*Negative, Population decreasing or static*	*N/A or any other combination*
Green: red ratios	*High (many:1)*	*Stable (1:1 to >1:1)*	*Low (1: many)*	*Irrelevant*
2-3 year infestation history and trends	*Started within last 3 yrs.*	*Ongoing for ≥3 yrs.*	*Outbreak ongoing for several years*	*Irrelevant*
Annual detailed aerial surveys	*Required*	*Required*	*Not required*	*Not required*
Adjacent BMU strategy selection	*Prevention or suppression (sanitation)*	*Suppression, Sanitation*	*Sanitation or monitor/no control*	*Salvage, sanitation*
Available harvesting power (ACC & any approved uplift)	*Required*	*Required*	*If available*	*NA*
Other forest health factors	*Caution with root rots, mistletoes (STT)*	*Caution with root rots, mistletoes (STT)*	*Caution with root rots, mistletoes (STT)*	*Monitor*
Change in achieving control of beetle	*High*	*Moderate*	*Low*	*Low*
Change in achieving management objectives	*Low*	*Moderate*	*High*	*100%*
Resource availability	*High*	*Inadequate to deal with all infestations*	*Low*	*NA*
Duration of strategy	*3 years max.*	*Temporary (2-3 years depending on hazard/ risk classes)*	*5 year time frame after infestation*	*Indefinitely*

Source: Based on information contained within the Provincial Bark Beetle Management Technical Implementation Guidelines, Spring 2003.

Table 11. Okanagan Shuswap BMU's and assigned strategy for IBM and IBD 2012-2019

	BMU Name	Beetle	Strategy 2012	Strategy 2013	Strategy 2014	Strategy 2015	Strategy 2016	Strategy 2017	Strategy 2018	Strategy 2019
1	**Seymour**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD*	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
2	**Pukeashun**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
3	**Crowfoot**	IBM	No Action	No Action	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
4	**Anstey**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding
5	**Eagle River**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding
6	**White**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding
7	**Kingfisher**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
8	**Salmon Arm**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding	Supression
9	**Hullcar**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
10	**Mabel**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding
11	**Upper**	IBM	Holding	Holding	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
	Shuswap	IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
12	**Okanagan**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
	Westside	IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding	Suppression
13	**Upper**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
	Salmon River	IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding	Holding
14	**Trinity**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
15	**Beak**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Monitor	Monitor

Table 11. Okanagan Shuswap BMU's and assigned strategy for IBM and IBD 2012-2018 (con't)

	BMU Name	Beetle	Strategy 2012	Strategy 2013	Strategy 2014	Strategy 2015	Strategy 2016	Strategy 2017	Strategy 2018	2019
16	**Vernon**	IBM	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
17	**Harris**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
18	**Cherryville**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
19	**Upper Kettle**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	No Action	No Action	Suppression	Suppression	Suppression	Suppression	Monitor	Suppression
20	**Pennask**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	No Action	No Action	No Action	No Action	No Action	No Action	No Action	No Action
21	**Mission**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
22	**West Kettle**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	No Action	No Action	Suppression
23	**Trout**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Monitor	Suppression
24	**Apex**	IBM	Holding	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
25	**Penticton**	IBM	Holding	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppresion
26	**Campbell**	IBM	Holding	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
27	**Keremeos**	IBM	Holding	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Suppression
28	**Anarchist**	IBM	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
29	**Ashnola**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding

30	**Shorts creek**	IBM	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Holding	Holding
31	**Trepanier**	IBM	Salvage	Salvage	Salvage	Salvage	Suppression	Suppression	Suppression	Suppression
		IBD	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression	Suppression

8.2 HAZARD AND RISK BY BMU

8.2.1 Mountain Pine Beetle (IBM)

A total of 35 BMU's exist in DOS of which 4 are within TFL's or Community Forests (see BMU map Section 5.1.3) and not included in this section. Of the remaining 31 BMU's, all are now designated as Suppression (Table 11). Many of the BMU's previously designated as Salvage have reverted back to Suppression in the past few years as the IBM has moved out of these areas.

Hazard rating for IBM is based on a system developed by the Canadian Forest Service which considers stand age, host basal area, stand density, and elevation (Table 12). High hazard stands are those where high volume losses can be expected should a beetle outbreak arise. The majority of high hazard stands are located in the Montane Spruce biogeoclimatic zone. The Region has updated hazard ratings to account for the depletion of pine volumes due to the IBM.

The Ashnola, Penticton, Trepanier, Trout, Mission and Campbell BMU's have the greatest area of moderate to high hazard stands.

Table 12. IBM hazard in 2013(ha)[1] in the Timber Harvesting Land Base , by BMU.

BMU	THLB (ha)	Hazard				
		Very Low (0-5)	Low (5-33)	Moderate (33-66)	High(66-100)	Total Hazard
Anarchist	10,120	2,364.10	2,127.50	1,219.10	250.9	5,961.60
Anstey	20,948	1,422.90	1,235.60	744	190.4	3,592.90
Apex	22,045	5,390.20	8,573.80	6,702.30	1,603.70	22,270.00
Ashnola	15,629	22,365.10	24,305.10	18,931.70	3,478.00	69,079.90
Beak	22,733	9,144.40	8,366.20	2,843.20	977.3	21,331.10
Campbell	41,357	18,222.20	13,294.90	6,674.90	4,213.10	42,405.10
Cherryville	45,336	11,339.00	10,319.90	2,634.00	1,029.30	25,322.20
Crowfoot	20,875	2,239.00	1,258.40	10	0	3,507.40
Eagle River	55,570	2,131.20	1,772.60	232.6	9.9	4,146.40
Harris	46,609	12,978.60	15,252.70	4,191.50	2,121.70	34,544.50
Hullcar	21,041	5,098.80	6,934.70	1,299.20	720	14,052.60
Keremeos	23,247	9,232.70	9,288.60	6,112.90	2,073.80	26,707.90
Kingfisher	57,127	4,863.10	7,400.20	845.9	61.6	13,170.80
Mabel	59,992	5,037.20	7,504.00	1,105.00	369.7	14,015.90
Mission	64,093	28,959.10	18,416.90	7,352.00	4,349.80	59,077.70
OK West Side	18,375	4,526.20	8,390.40	1,957.00	675	15,548.70
Pennask	26,291	13,223.20	10,085.30	4,210.70	1,996.60	29,515.60
Penticton	41,630	16,521.00	11,834.90	11,116.70	5,604.90	45,077.50
Pukeashun	39,932	2,566.60	1,500.20	531.3	21.9	4,620.00
Salmon Arm	49,152	20,742.50	14,438.30	1,361.30	405	36,947.00
Seymour	49,282	3,406.60	1,993.80	423.6	102.6	5,926.60
Trepanier	35,661	22,779.40	19,559.50	8,712.70	6,383.30	57,434.90
Trinity	45,623	7,874.70	12,405.40	2,519.20	483.1	23,282.40
Trout	43,235	13,106.30	13,364.80	8,789.70	4,501.40	39,762.20
Upper Kettle	64,954	23,338.20	13,016.70	2,308.40	359.1	39,022.40
Upper Salmon	20,354	8,835.40	8,057.50	1,106.10	346.8	18,345.90
Upper Shuswap	39,371	1,569.20	4,082.70	879.6	70	6,601.50
Vernon	33,897	11,129.30	14,903.50	3,213.80	885.3	30,131.80
West Kettle	31,024	16,446.20	9,957.70	2,144.20	1,255.10	29,803.20
White	19,938	2,020.90	4,303.00	115.7	38.8	6,478.30
Total	**1,085,441**	**308,873**	**283.945**	**110,288**	**44,578**	**747,684**

8.2.2 Douglas-fir Beetle (IBD)

Hazard rating for Douglas-fir beetle is based on a system developed by the Canadian Forest Service which considers stand age, basal area of Douglas-fir, diameter, and a growth factor for derivation of hazard. Trepanier BMU has the highest amount of hazard (Table 13), while Keremeos, Salmon Arm and Ashnola BMUs have the highest of moderate to high hazard stands.

Table 13. IBD hazard 2013 (ha)[14] in the THLB, by BMU.

BMU	THLB (ha)	Hazard						
		Very Low (0-5)	Low (5-20)	Low/Mod (20-40)	Moderate (40-60)	High (60-80)	Very High (80-100)	Total Hazard
Anarchist	10,120	6,384.2	14,065.1	4,437.6	3,682.3	1,308.4	1,796.1	31,673.
Anstey	20,948	5,227.6	6,782.5	4,317.3	3,751.9	957.0	494.1	21,530.
Apex	22,045	5,307.3	9,546.1	4,778.5	5,622.5	4,547.5	2,107.6	31,909.
Ashnola	15,629	11,918.8	10,263.9	7,120.1	4,042.3	4,862.1	5,560.2	43,767.
Beak	22,733	827.9	510.4	36.2	117.7	86.0	4.2	1,582.5
Campbell	41,357	6,447.3	2,415.9	1,955.5	899.4	317.5	29.3	12,064.
Cherryville	45,336	7,489.0	11,863.2	7,331.1	5,356.2	1,380.2	420.2	33,839.
Crowfoot	20,875	5,870.1	7,039.2	3,948.5	3,184.7	577.9	57.9	20,678.
Eagle River	55,570	8,737.5	13,710.4	7,118.8	2,737.8	495.9	73.5	32,873.
Harris	46,609	5,529.9	8,117.0	6,244.8	5,610.7	1,382.5	81.1	26,966.
Hullcar	21,041	6,774.4	12,759.5	7,378.3	4,320.7	775.8	196.4	32,205.
Keremeos	23,247	5,799.0	12,079.3	6,544.8	5,596.1	6,368.1	7,210.3	43,597.
Kingfisher	57,127	10,753.2	20,957.7	10,457.9	4,350.9	442.4	162.5	47,124.
Mabel	59,992	9,827.1	15,520.3	8,443.1	4,085.2	905.7	319.0	39,100.
Mission	64,093	13,280.9	15,876.8	8,998.1	9,036.5	3,102.1	1,838.0	52,132.
Okanagan West	18,375	4,281.5	9,513.2	3,180.8	3,350.0	1,092.8	470.9	21,889.
Pennask	26,291	391.4	53.3	40.5	0.8	0.0	0.0	486.0
Penticton	41,630	9,125.0	8,766.4	5,142.8	3,820.3	1,669.9	671.1	29,195.
Pukeashun	39,932	6,638.5	6,033.6	4,071.7	3,069.1	851.1	59.7	20,723.
Salmon Arm	49,152	7,499.7	14,201.3	9,311.7	10,209.0	4,296.2	1,762.7	47,280.
Seymour	49,282	9,993.7	8,858.4	3,990.0	1,582.1	406.6	47.3	24,878.
Trepanier	35,661	18,737.8	18,728.8	7,533.9	7,634.1	3,522.9	2,403.1	58,560.
Trinity	45,623	9,084.9	15,534.2	13,068.5	9,829.9	2,079.5	315.6	49,912.
Trout	43,235	8,573.6	9,031.1	3,646.9	4,136.1	3,789.7	2,301.2	31,478.
Upper Kettle	64,954	5,300.7	4,467.8	3,044.7	762.7	69.7	31.0	13,676.
Upper Salmon	20,354	4,014.9	12,493.7	4,270.6	4,371.4	2,775.3	1,371.5	29,297.
Upper Shuswap	39,371	7,750.8	16,330.9	5,081.0	2,138.3	573.6	47.8	31,922.
Vernon	33,897	6,364.9	13,064.6	8,489.8	8,643.9	3,845.6	480.8	40,889.
West Kettle	31,024	3,220.5	1,654.1	812.3	681.0	364.9	122.9	6,855.8
White	19,938	3,282.1	10,948.1	4,998.4	3,692.8	557.9	288.9	23,768.
Total	**1,085,441**	**214,434**	**311,187**	**165,794**	**126,316**	**53,405**	**30,724**	**901,861**

[14] Shore, T.L. and L. Safranyik. 2001. A susceptibility and risk rating system for the Douglas-fir beetle in British Columbia. Draft version 10. Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C. 4 p.

8.2.3 Spruce Beetle (IBS)

A hazard rating system for spruce beetle has also been developed by the Canadian Forest Service. This system uses the following to determine susceptibility: site quality, age, basal area of spruce, location (latitude, longitude and elevation), stand density and growth rate. Upper Kettle, Mission, West Kettle and Harris BMU's have the highest amounts of moderate to high hazard stands (Table 14).

Table 14. IBS hazard 2013 (ha)[15] in the THLB, by BMU.

BMU	THLB (ha)	Hazard						
		Very Low (0-5)	Low (5-20)	Low/Mod (20-40)	Moderate (40-60)	High (60-80)	Very High (80-100)	Total Hazard
Anarchist	10,120	637.8	821.2	249.5	204.0	0.0	0.0	1,912.4
Anstey	20,948	1,680.9	12,395.2	3,197.8	463.4	3.4	0.0	17,740.7
Apex	22,045	1,947.3	4,760.9	4,486.2	802.3	117.5	7.3	12,121.6
Ashnola	15,629	6,247.1	22,196.7	15,912.8	2,983.1	424.3	4.4	47,768.3
Beak	22,733	910.8	9,139.6	4,777.4	2,041.9	600.9	46.8	17,517.4
Campbell	41,357	6,166.2	9,956.7	3,962.7	1,125.3	119.3	13.1	21,343.3
Cherryville	45,336	727.4	15,927.7	10,543.8	3,613.7	261.4	5.7	31,079.7
Crowfoot	20,875	1,398.5	11,009.9	3,627.0	655.3	39.1	0.0	16,729.8
Eagle River	55,570	4,033.2	35,844.6	12,422.0	2,269.1	502.9	49.1	55,120.9
Harris	46,609	1,541.9	14,909.8	10,770.1	3,786.7	776.4	0.0	31,784.9
Hullcar	21,041	408.9	2,891.8	1,600.3	230.0	0.0	0.0	5,131.0
Keremeos	23,247	1,796.7	7,846.7	5,638.3	1,724.7	118.8	13.0	17,138.1
Kingfisher	57,127	1,308.6	25,928.1	10,459.9	2,531.0	262.3	0.0	40,490.0
Mabel	59,992	1,109.4	23,497.9	10,884.1	4,029.3	344.9	0.0	39,865.6
Mission	64,093	7,780.3	21,935.2	17,670.6	7,421.7	1,127.4	20.7	55,955.9
Okanagan West	18,375	305.8	2,933.9	1,110.7	201.0	21.8	0.0	4,573.1
Pennask	26,291	2,629.0	13,708.1	7,188.0	1,594.0	323.3	0.0	25,442.5
Penticton	41,630	4,456.9	11,429.5	6,769.7	2,211.2	111.6	0.0	24,979.0
Pukeashun	39,932	3,625.4	24,410.5	11,942.0	3,701.4	702.3	94.9	44,476.6
Salmon Arm	49,152	1,178.5	14,731.0	7,074.9	1,891.5	232.8	8.9	25,117.6
Seymour	49,282	8,013.0	37,048.4	12,769.0	2,132.5	125.9	0.0	60,088.8
Trepanier	35,661	6,140.2	16,238.6	10,171.7	3,252.1	421.8	8.3	36,232.7
Trinity	45,623	468.6	6,109.7	6,602.1	1,911.5	267.1	0.0	15,359.1
Trout	43,235	4,216.7	9,484.0	5,828.6	1,630.4	166.1	0.0	21,325.7
Upper Kettle	64,954	4,418.4	36,146.0	16,757.9	7,688.3	981.4	11.7	66,003.7
Upper Salmon	20,354	1,474.3	4,845.1	901.2	196.9	13.0	0.0	7,430.5
Upper Shuswap	39,371	1,818.6	32,958.7	13,791.4	3,761.9	517.6	20.9	52,869.2
Vernon	33,897	1,514.8	9,729.3	5,584.1	2,354.4	315.1	15.0	19,512.8
West Kettle	31,024	3,665.8	13,678.8	11,699.9	4,606.2	137.4	0.0	33,788.1
White	19,938	365.0	2,917.0	1,288.2	152.2	0.0	0.0	4,722.4
Total	**1,085,441**	**81,986**	**455,431**	**235,682**	**71,167**	**9,036**	**320**	**853,621**

[15] *Safranyik, L. and T.L. Shore. 2005. A susceptibility and risk rating system for the spruce beetle, Dendroctonus rufipennis. Draft version 10. Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C. 10 pp.*

9 CLIMATE CHANGE ADAPTATION

In 2016, "Climate Action Plan Thompson / Okanagan Region 2016-2020" was released for climate action regarding the following natural resource values and policy areas for the region: Water Resources, Fish and Aquatic Ecosystems, Wildlife, Forest Ecosystems, Grassland Ecosystems, Natural Disaster Management, Public Safety and Infrastructure, Climate Change Mitigation, and First Nations; this document is available from the Regional Office in Kamloops .

Website for Climate Change and Adaptation in B.C. Forests is

https://www2.gov.bc.ca/gov/content/environment/natural-resource-stewardship/natural-resources-climate-change

The Thompson Okanagan Region has produced a new climate action plan entitled "Climate Action Plan Thompson/Okanagan Region 2016-2020". This document is currently on a secure SharePoint site here:

https://www.for.gov.bc.ca/ftp/DCS/external/!publish/2016%20FSP%20Renewals/FSP%20Supporting%20Information/TORegionClimateActionPlan_16March2016_v8.0.pdf

If unable to access the SharePoint site please request a copy from the Region or the district Forest Health Specialist.

The United Nations Food and Agriculture Organization have published "Climate change guidelines for forest managers" and it can be found http://www.fao.org/3/a-i3383e.pdf

10 STOCKING STANDARDS RESOURCES

"Tree Species Selection Tool": The goal "is to provide forest practitioners with the best available science-based tree species selection related information for a given geographical location." The link to this tool is:

http://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/tree-species-selection

In February 2014 the Resources Practices Branch published "Updates to the Reference Guide for FDP Stocking Standards (2014): Climate-Change related Stocking Standards" and this important document can be found at the link below under "All things Stocking Standards".

All things Stocking Standards including the newly updated FDP Stocking Standards reference guide can be found at:
https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/silviculture/stocking-standards

Fire Management Stocking Standards:
https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/fire_management_stocking_standards_guidance_document_march_2016.pdf

11 OTHER IMPORTANT RESOURCES

Please see the links below for important information about the research and work conducted on updating our Biogeoclimatic Ecosystem Classification (BEC)

http://www.for.gov.bc.ca/hre/becweb/program/climate_change/index.html

http://www.for.gov.bc.ca/hre/becweb/index.html

The Thompson Okanagan Region has produced a new climate action plan entitled "Climate Action Plan Thompson/Okanagan Region 2016-2020". This document is currently on a secure SharePoint site here:
https://www.for.gov.bc.ca/ftp/DCS/external/!publish/2016%20FSP%20Renewals/FSP%20Supporting%20Information/TORegionClimateActionPlan_16March2016_v8.0.pdf

"Silvicultural Options for the Endangered Whitebark Pine" can be found here:
http://www.fgcouncil.bc.ca/Whitebark_Pine_Silviculture_2013.pdf

FOREST HEALTH PUBLICATION: "Field Guidelines for the Selection of Stands for Spacing (Interior)" – March 2012
https://www.for.gov.bc.ca/hfp/publications/00021/FS448b%2020120329.pdf

Maps depicting pest hazards published in FORREX Stand Establishment Decision Aids:
https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Forest_Health/SEDA_maps/Individual%20Regional%20PDFs/Thompson%20Okanagan%20Region/

FLNRORD's Natural Resource Sector Monitoring and Evaluation initiative is a new collaborative project plan to facilitate science-based monitoring in support of existing programs such as the Forest and Range Evaluation Program (FREP), Water Sustainability Act, Compliance and Enforcement, Species at Risk, among others. Developments of the initiative can be found online as they become available to the public at www.for.gov.bc.ca

FLNRORD continues to support the BC government work on cumulative effects. A newly published "Cumulative Effects Framework Engagement overview" is now available at this link:http://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/cumulative-effects/phase_2_engagement_overview_april_27_final.pdf

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