The Kamloops Future Forest Strategy

ECOLOGICAL NARRATIVES- BACKGROUNDER:

The ecological narratives that follow formed the context for the management vulnerability workshops. At those workshops we gathered together local specialists and practitioners with a solid grounding in local management for a number of resource values – timber, habitat and biodiversity, First Nations culturally important plants, watershed management, visual landscape management and interface fire management. We examined the key questions for management from each of those resource values. As well, we considered current direction and expectations to see if there adjustments that need to be made.

Note that the narratives avoid using qualifiers and stating all the uncertainties around every prediction. We accumulated general trend information that includes considerations of uncertainties, which we provided to each participant in our management discussions. We are intentionally going out on a limb in the narratives with how we paint the picture of the future, mostly because we wanted the picture to be vivid and clear, not vague and virtually meaningless. You may have concerns that these narratives could be wrong. Our intent is not to get them "right". We want to paint the clearest picture we can without making statements that don't make any ecological sense, however we do not expect that we can actually predict the future.

We think that these narratives are entirely plausible given the information available today. We do not expect them to be correct. However, we think they are less unbelievable than assuming that nothing will change. The key thing we are trying to achieve is to not blindly paint ourselves into a corner as our climate changes, with only a few difficult options. This strategy will not be the final word. These narratives and the associated management direction in the strategy should be updated as new information emerges.

The direction and options that flow from this exercise will not be earth-shattering. That is, the world will not fall apart if we are wrong. The strategy will encourage and target harvesting more or less in certain stand types in certain subzones over the near future. The strategy will encourage different tree species mixtures for reforestation. It may build in some considerations for our management approaches regarding a specific habitat or reserve. Of course, all of these things must be able to work right now if they are to be implemented now; we will not start planting Garry oak in the ICHdw. Looking to the future however, we may for example be less open to pure plantations of lodgepole pine. In this way, any direction provided in the strategy WILL NOT include adaptive actions that will create huge problems if we find out that we are wrong ten years down the road and need to alter course. At the same time, the type of direction we are trying to design should be prudent just in case these types of impacts actually occur.

And - To design prudent management direction we have to envision just how sensitive these forests may be over time. That is what these narratives are all about.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

ICHdw

Short- term Vulnerability = HIGH
Long-term Vulnerability = HIGH

Ecological Narrative for the ICHdw through to 2080:

2008 to 2050

The influence of climate change

This subzone will go through a very dynamic transition up to 2050, whereby most mature and maturing tree species that currently exist will be increasingly vulnerable to disease, drought and insects. This process has already begun and is evident in this subzone with Douglas-fir, birch, and lodgepole pine, already reducing the merchantability of the mixedwood stand types that dominate the subzone. From now till 2050 increased warmth with good inputs of moisture in the spring and fall may improve vitality of *Armillaria* root disease, which is ubiquitous in this subzone. This will likely boost a mortality rate already increasing in older Douglas-fir when combined with an expected small increase in summer drought and a higher risk from bark beetles. While redcedar is more tolerant to *Armillaria* in these stands, vigour in redcedar will likely continue to decline and top dieback will increase due to summer drought, especially on warmer slopes.

A slightly prolonged summer drought period with increased fuels will provide a small to moderate increase in fire risk across the subzone, which will fluctuate periodically up to 2050. This shifting local risk will emerge in pulses as concentrations of dead trees pass through high risk phases that may coincide with dry summers. The further expansion of broadleaf trees and shrubs, which are already common in this subzone, into newly created gaps may help lower fire risk over time. Nevertheless, there is a moderate risk of several large wildfires in this subzone over the next 40 years, particularly beyond 2020 when warm cycles may coincide.

Estimated future forest condition of stands currently mature

The result will be that birch and redcedar will likely disappear from warmer southern and western slopes. The presence of mature Douglas-fir in the common mixedwood types will be reduced to scattered pockets. Many older stands will therefore be dominated by low vigour non-merchantable species such as aspen, birch, redcedar, and shrub species such as maple. Harvestable older forest types with concentrations of merchantable species and sizes will become fragmented and more isolated. South slopes will see more aspen and dry-complex shrubs with much less birch.

Large scale fire disturbance may facilitate re-establishment of conifers in isolated portions of the subzone, however such disturbance could also significantly impact non-timber resource values and encourage invasive plants.

Estimated future forest condition of young stands

Where past logging was followed by stumping to reduce pathogenic innoculum, Douglas-fir dominated plantations will persist and grow well. Lodgepole pine in such plantations may see greater impacts from rusts, root collar weevil and other pests. Relatively pure plantations of pine less than 40 years old may have moderate to high levels of mortality, with a subsequent impact on their productivity. Stand mixtures with other species (including either Douglas-fir, western larch, or ponderosa pine) may be more resilient with reduced mortality.

2050 to 2080

The influence of climate change

Beyond 2050, where Douglas-fir has established in disturbed areas after logging or fire ,these younger and maturing Douglas-fir cohorts may see less mortality as climates become very hot and dry, gradually reducing

the vitality of *Armillaria* root disease and its associated impacts. Where young and maturing stands were established post-harvest after stumping, a common treatment in this subzone, this reduction in mortality will be most evident. However, growth and general vigour will likely decline on most young and maturing stands in response to dramatic increases in summer temperatures and drought.

Fire risk may continue to increase due to hotter and drier summers providing more small to medium-sized disturbances. However, the spread of large fires may be limited by the fragmented, varied and discontinuous nature of the vegetation on the landscape.

Estimated future forest condition of stands currently mature

In old ecosystems not disturbed with a stand-replacing event in the past 100+ years (1950-1980), birch and redcedar will gradually disappear, except on moister sites where they will remain non-merchantable due to poor growth and vigour. Aspen may expand in some areas, possibly showing acceptable vigour and growth on moister sites. The very scattered local concentrations of older Douglas-fir will see less mortality, although growth and vigour will decline. Moist-site shrubs such as maple will decline in presence and possibly be replaced by drought tolerant shrubs and herbs (facilitated greatly with disturbance), and an increased presence of invasive species.

Estimated future forest condition of young stands

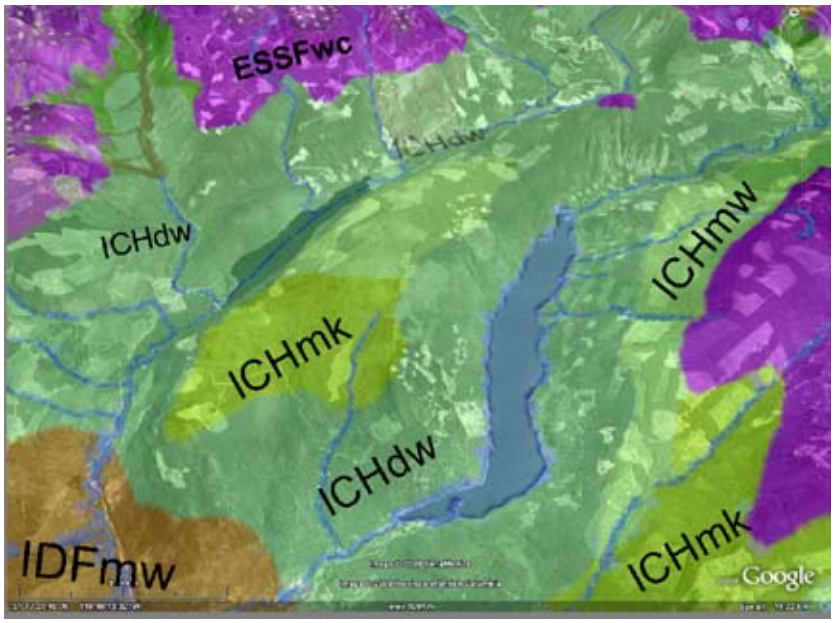
Scattered mortality distributed throughout maturing Douglas-fir stands, from a combination of drought and bark beetle, will reduce densities, especially on drier aspects and lower elevations creating more open stands. The maturing lodgepole pine (originally established in plantations) may start to see significant to wide-spread mortality at this point, possibly exacerbated by bark beetles. Younger to maturing stands planted with larch may see some scattered mortality in the larch, especially on hotter and drier sites, while ponderosa pine should continue to cope well with the changing climatic conditions, unless bark beetles build to epidemic proportions in surrounding stands and subzones (an unclear risk).

Vulnerability summary

The stands in the ICHdw are likely to see significant changes toward less merchantable types, with widespread subsequent mortality over the next 40 to 80 years, mostly from a combination of drought stress, insects and disease. Fire may play a minor role.

CURRENT CONDITIONS

5% of the TSA
6% of the THLB (141,069 ha)



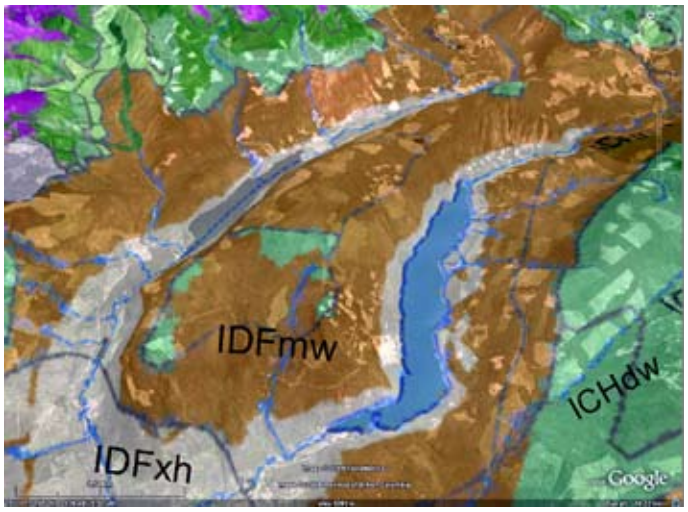
E. Barriere Lk.

Sites Naturally Associated with ICHdw	Plant Communities Associated with Current Subzone
Zonal site association	Gentle slopes and northern slopes; closed Fd, Pl, Cw, Hw, Sxw & Ep mixedwood stands; moderate shrub cover of falsebox, soopalallie, spirea, Saskatoon; moderate herb layer of twinflower, bunchberry, sarsaparilla, queen's cup; moderate cover of feathermosses
Dry site association	Crests and steep south slopes; open Fd, Pl (At, Ep) stands; moderate-sparse shrub cover of soopalalie, falsebox, spirea, Saskatoon, snowberry; moderate herb layer of pinegrass, twinflower, prince's pine; sparse to moderate feathermoss and pelt lichens
Wet site association	Seepages, stream edges, fluvial sites; dense Cw, Hw, Sxw, Fd, Ep (Act) stands; rich shrub cover of huckleberry, gooseberry, devil's club, twinberry, dogwood; moderate herb layer of oak fern,ladyfern, foamflower; moderate cover of feathermosses

Age Classes	Leading Stand Species	% of ICHdw
<20	Fd44% Pli37% (Sx,Ep,At)	13
20-60	Fd26% Pli25% Ep17% (Sx Cw)	9
60-120	Fd47% Pli29 At12% (Ep Sx)	52
120+	Fd63% (Pl, Sx, Cw)	26

Climate Scenarios

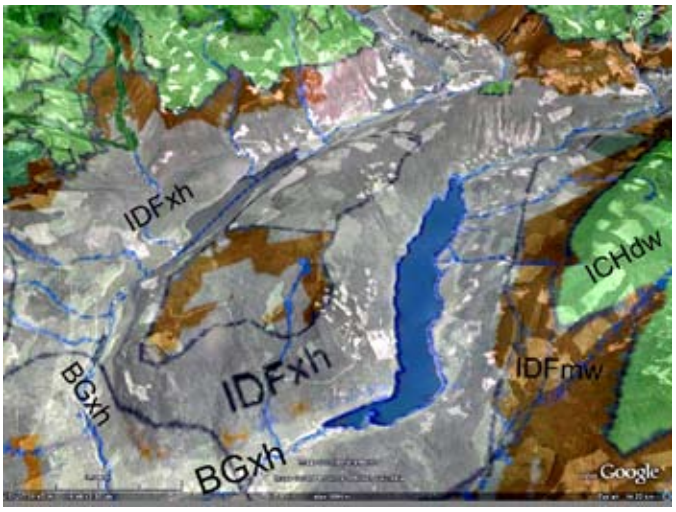
PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% ICHdw
Upper	ICHdw	12
Upper boundary areas may have slightly moister conditions		
Mid	IDFmw	78
Upper boundary areas may have slightly moister conditions		
Lower	IDFxh	10
Valley and upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	4.1	5.1	1.1
mean summer temp. (°C)	13.5	14.8	1.3
mean temp warmest month (°C)	15.3	17.0	1.7
frost free period (days)	94	111	19%
number of frost free days	167	184	10%
mean annual precipitation (mm)	738	770	4%
mean summer precipitation (Jun-Aug) (mm)	309	306	-1%
precipitation as snow (mm)	264	248	-6%
annual heat:moisture index	20	21	3%
mean summer heat:moisture index (May-Sept)	51	57	12%

HAD-A1F1 2050 (most change)



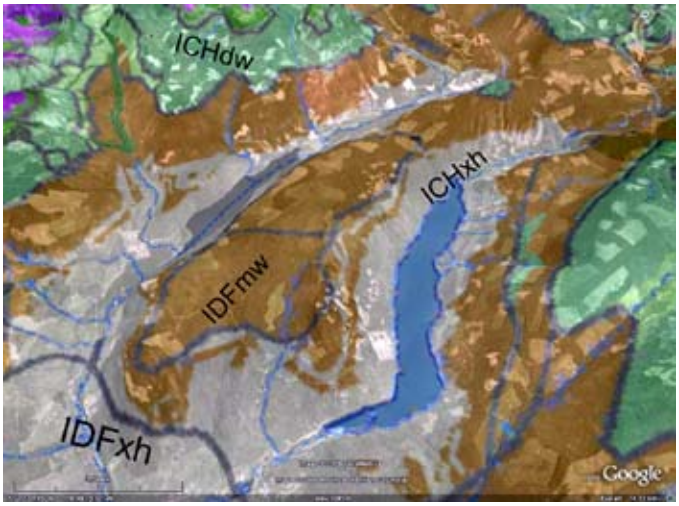
Relative Elevations	Predicted Subzone Climate	% of ICHdw
Upper	IDFmw	32
Mid	IDFxh	41
Rarely, a few areas may have slightly moister conditions		
Lower	BGxh	17
Most areas have slightly to much wetter conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	4.1	7.3	3.2
mean summer temp. (°C)	13.5	18.3	4.8
mean temp warmest month (°C)	15.3	20.6	5.3
frost free period (days)	94	121	38%
number of frost free days	167	214	28%
mean annual precipitation	738	767	4%
mean summer precipitation (Jun-Aug)	309	279	-10%
precipitation as snow (mm)	264	213	-19%
annual heat:moisture index	20	24	19%
mean summer heat:moisture index (May-Sept)	51	76	49%

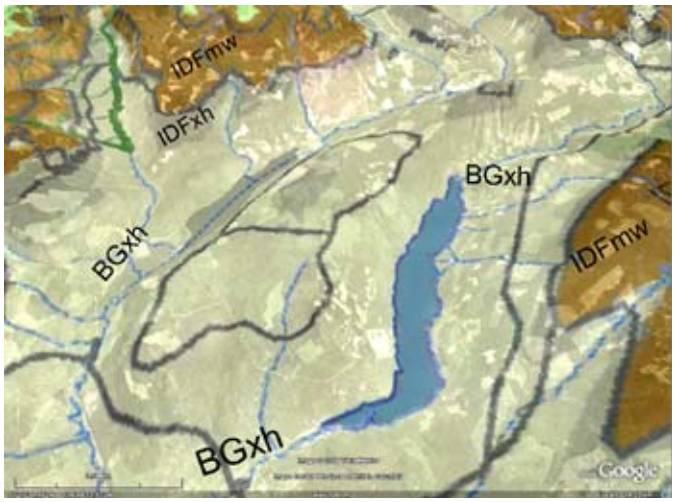
Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate Focussing on 2050:

General Description

The amount of precipitation and the drought code for the least-change PCM scenario will likely keep this subzone in an ICH subzone climate, but warmer than normal (warm enough at lower elevations to come close to the IDFxh temperatures). With the most-change HAD scenario, it could get even warmer and likely just dry enough (especially in summer) to generally experience an IDF subzone climate. The drought code in the HAD scenario is somewhere between the ICHdw and the IDFmw.

Summary of Ecological Vulnerabilities and Opportunities

ROOT DISEASE – *Armillaria* will become more problematic with higher temperatures, as the fungus metabolism may increase and overwhelm already stressed susceptible conifers. In drought years, which will occur more often, old and mature trees will be become even more susceptible to mortality, similar to what we have seen in the past 10 year dry cycle.

INSECTS – Increased damage from miners and borers on the broadleaf species (similar to past 5 years or so) can be expected. There is also an increased potential for Douglas-fir bark beetle problems in conjunction with increased stress from *Armillaria* and drought.

FIRE– Dieback in Douglas-fir, redcedar and birch will create considerable fuel issues. This is already happening in this subzone.

Regeneration Vulnerabilities and Opportunities

ALL SITES:

- Maintain and promote Douglas-fir and introduce more larch. Provenance testing may first need to be done with larch as there is evidence of a tendency for it to fork above 3 m in height.
- Plant ponderosa pine where suited on more southerly slopes at lower elevations first.

• Lodgepole pine may be acceptable on difficult sites, but higher densities may be needed to help deal with health issues and quality over time.
• Strategically promote aspen where it will best meet objectives for biodiversity and other values.
• Limit use of western white pine in this subzone.

Maturing / Mature Stand Vulnerabilities and Opportunities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Fdi	Mod	Minor for PCM?	*Armillaria* likely will become more active and together with Douglas-fir beetle and increased summer droughts will continue to take its toll in pulses. As stands thin out, some Fdi may actually do better (especially on northerly or easterly aspects) however pure Fd stands are rare here, so stands may have some large Fd, but few of them.
Cw	High	Nil	Warmer temperature will provide drier summers that will be limiting on southern and perhaps western aspects. Growth and quality will be poor except on the wetter sites.
Ep	Very high	Nil	Most are currently experiencing dieback and die by approximately 80 years of age. Increased warmth and drought will likely increase stress followed by top dieback and willow-poplar borer. It will persist on northern slopes but quality and vigour will be poorer.
At	Mod	Nil	Will continue to have problems with leaf miners and the willow-poplar borer but it may be the best suited broadleaf species for this subzone.
Pli	Mod	Nil	Not clear if bark beetles will be an issue in 40-60 year old stands at 2050. Rusts and other pests may be a greater challenge in younger stands.
Sx	High	Nil	Likely will be restricted to moister riparian situations. Drought stress will increase damage from bark beetles and other pests.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

ICHmw

Short- term Vulnerability = LOW - MOD
Long-term Vulnerability = MOD - HIGH

Ecological Narrative for the ICHmw through to 2080:

2008 to 2050

The influence of climate change

The ICHmw is expected to experience some subtle changes between 2008 and 2050. Warming summer temperatures will slowly increase drought stress on some sites, which together with *Armillaria*, bark beetles and other pests will increase the mortality in older conifers, including Douglas-fir. South and west aspects (particularly at lower elevations and steep upper slopes and crests) will experience more noticeable impacts with subtle impacts on other slopes.

A moderately prolonged summer drought period and increased fuels will contribute to a slightly-to-significantly increased fire risk, especially on warm aspects, fluctuating periodically up to 2050. As new conifer and broadleaf regeneration fill in the newly created gaps, the fire risk will lower over time.

Estimated future forest condition of stands currently mature

Conifer-broadleaf mixtures on wet sites throughout the subzone will change very little. However the rich diversity of the mixedwood landscape in this subzone will be dramatically altered on warm aspects and lower elevations. Redcedar, hemlock, spruce, and birch will experience significant mortality on lower to mid elevations, warm aspects and drier sites. Warmer south and west aspects will become fragmented stands of Douglas-fir, with brushy openings and a component of aspen. Merchantable stands of Douglas-fir throughout the subzone will have noticeable mortality gaps from drought, *Armillaria*, and bark beetles.

Broadleaf species (aspen, birch and cottonwood) on cooler north/east slopes and higher elevations will likely expand into gaps left by scattered mortality in older conifer species. Large disturbances such as fires may encourage even a greater mix of species on these cooler slopes. Redcedar and spruce will maintain a significant presence.

Estimated future forest condition of young stands

Where past logging was followed by stumping to reduce pathogenic inoculum, Douglas-fir dominated plantations will persist and grow well, possibly even improving in growth. Non-stumped stands may see scattered mortality that could spike in dry cycles. Significant mortality in redcedar, hemlock, spruce and birch will be evident over time on warmer aspects and lower elevations. On cooler aspects these species will mostly develop as understory species with limited chance of achieving crop status. Lodgepole pine in plantations may see greater impacts from rusts, root collar weevil and other pests at low-mid elevations. Dense stand mixtures of Douglas-fir, redcedar, white pine, lodgepole pine, ponderosa pine, birch and aspen, will be more resilient to change at mid to higher elevations, and on northern slopes. At lower elevations, mixtures of western larch, ponderosa pine and aspen with Douglas-fir may be more resilient.

2050 to 2080

The influence of climate change

This subzone will go through a more dynamic transition up to 2080, where mature and maturing tree species will be increasingly vulnerable to disease, drought and insects. Mortality in Douglas-fir, birch, and lodgepole pine, will jeopardize the merchantability of the dominant mixedwoods. *Armillaria,* combined with summer drought and bark beetles, will cause significant scattered mortality. Redcedar will also continue to decline with

top dieback increasing due to summer drought, especially on warmer slopes.

A slightly prolonged summer drought period with increased fuels will provide a significant increase in fire risk in lower elevations, which will fluctuate periodically up to 2080. This shifting local risk will emerge in pulses as concentrations of dead trees pass through high risk phases that may coincide with dry summers.

Estimated future forest condition of stands currently mature

The result will be that birch and redcedar will mostly disappear from warmer southern and western slopes, especially at lower and mid elevations. The presence of mature Douglas-fir in the common mixedwood types will be reduced to scattered pockets. Many older stands will be dominated by low vigour, non-merchantable species such as aspen, birch, redcedar, and shrub species such as maple. Harvestable older forest types with concentrations of merchantable species and sizes will become fragmented and more isolated. South slopes will see more aspen and dry-complex shrubs with much less birch.

Large scale fire disturbance may facilitate re-establishment of conifers in isolated portions of the subzone, however, such disturbance could also significantly impact non-timber resource values and encourage invasive plants.

Estimated future forest condition of young stands

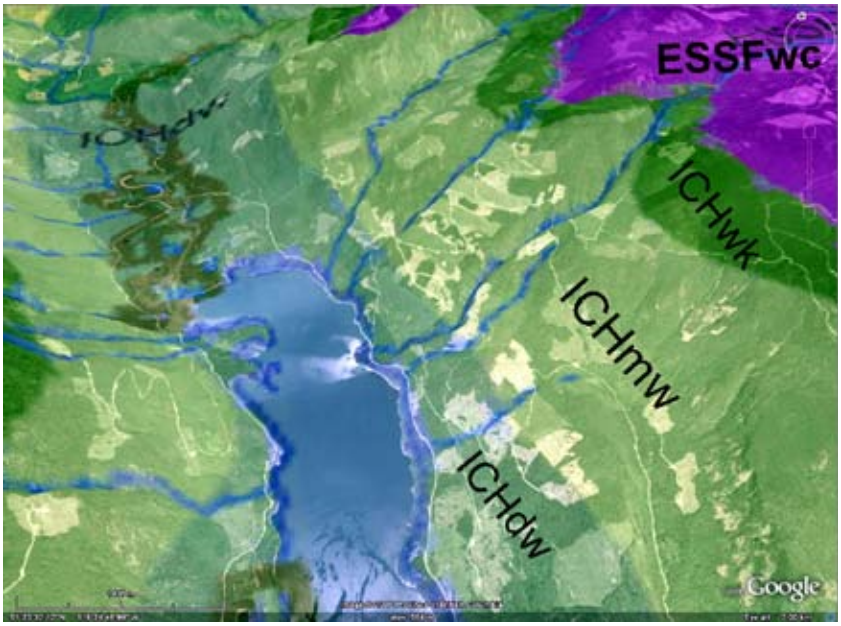
Where past logging was followed by stumping to reduce pathogenic inoculum, Douglas-fir dominated plantations will mostly persist and grow well (with some possible survival challenges at lower elevations). Lodgepole pine may see significant impacts from rusts, root collar weevil and other pests with moderate to high levels of mortality. Stand mixtures with other species (Douglas-fir and ponderosa pine on south slopes and lower elevations, and Douglas-fir, rust resistant white pine and western larch on north slopes and higher elevations) may be more resilient with reduced mortality.

Vulnerability summary

The stands in the ICHmw are likely to see mortality and changes in species composition over the next 40 to 80 years, mostly beyond 2050 from a combination of drought stress, insects and disease. Fire may play a role.

CURRENT CONDITIONS

8% of the TSA
10% of the THLB



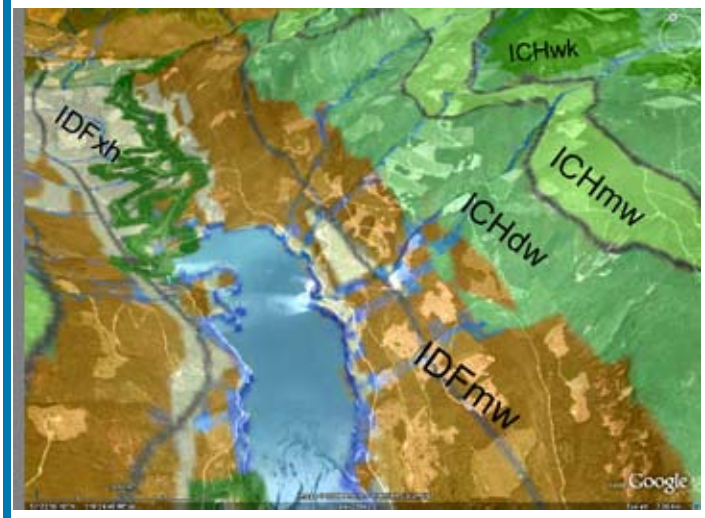
N. Adams Lk.

Sites Naturally Associated with ICHmw	Plant Communities Associated with Current Subzone
Zonal site association	Gentle slopes and northern slopes; closed Fd, Cw, Hw, Sxw, Pl & Ep stands; moderate shrub cover of falsebox, huckleberry, blueberry; moderate herb layer of twinflower, bunchberry, queen's cup; abundant feathermosses
Dry site association	Crests and steep south slopes; open Fd & Pl (Cw, EP & Pw) stands; moderate-sparse shrub cover of falsebox, spirea, rose, juniper, huckleberry; moderate herb layer of pinegrass, twinflower, prince's pine; moderate cover of feathermoss and clad lichens
Wet site association	Seepages, stream edges, fluvial sites; Cw, Hw, Sxw (Act) stands; rich shrub cover of devil's club, gooseberry, twinberry, dogwood; moderate herb layer of oak fern, lady fern, foamflower; variable feathermosses & leafy mosses

Age Classes	Leading Stand Species	% of ICHmw
<20	Fd 40% Pl 33% (Sx+other)	11
20-60	Fd 30% Sx 22% (Cw, Pl, Hw)	10
60-120	Fd 38% Pl 29% (At, Sx)	45
120+	Fd 38% Cw 21% (Sx, Hw)	34

Climate Scenarios

PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% ICHmw
Upper	ICHdw	54
Upper boundary areas may have slightly moister conditions		
Mid	IDFmw	40
Upper boundary areas may have slightly moister conditions		
Lower	IDFxh	4
Upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	3.2	4.2	1.1
mean summer temp. (°C)	14.7	14.8	0.1
mean temp warmest month (°C)	14.4	16.0	1.6
frost free period (days)	82	100	22%
number of frost free days	156	173	11%
mean annual precipitation (mm)	917	957	4%
mean summer precipitation (Jun-Aug) (mm)	366	363	-1%
precipitation as snow (mm)	369	355	-4%
annual heat:moisture index	16	16	4%
mean summer heat:moisture index (May-Sept)	42	47	12%

HAD-A1F1 2050 (most change)

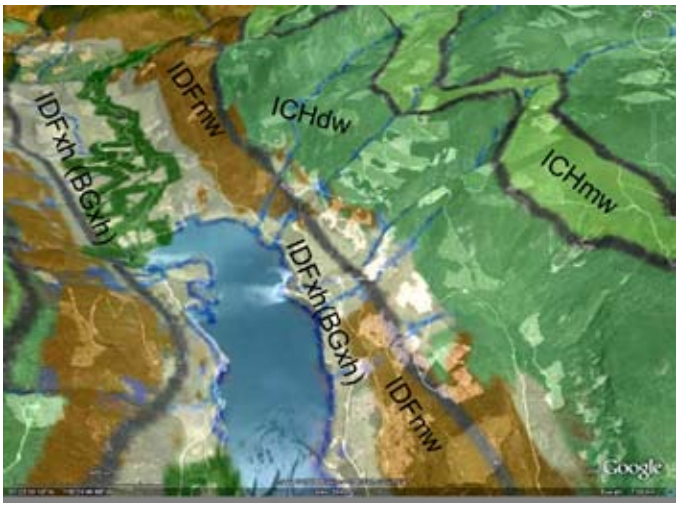
Relative Elevations	Predicted Subzone Climate	% of ICHmw
Upper	ICHdw	34
Mid	ICHmw	32
Lower	IDFxh	16
Rarely, a few areas may have slightly drier or moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	3.2	6.4	3.2
mean summer temp. (°C)	13.5	18.3	4.8
mean temp warmest month (°C)	14.4	19.7	5.3
frost free period (days)	82	119	45%
number of frost free days	156	201	29%
mean annual precipitation	917	958	4%
mean summer precipitation (Jun-Aug)	366	332	-9%
precipitation as snow (mm)	369	307	-17%
annual heat:moisture index	16	19	19%
mean summer heat:moisture index (May-Sept)	41	63	51%

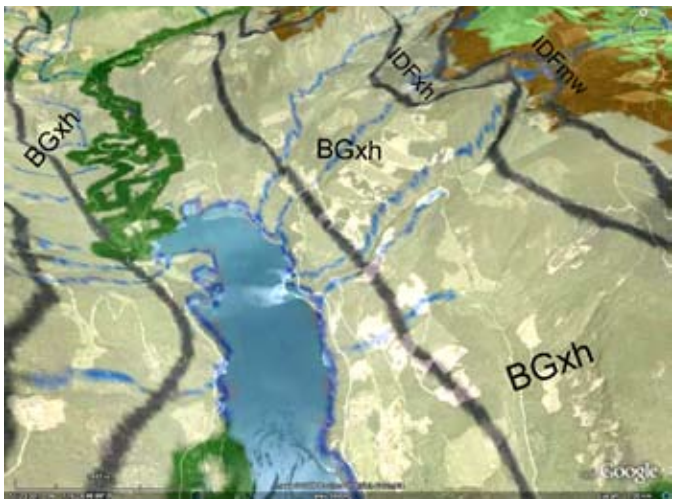
Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate focussing on 2050:

General Description

In both bookend scenarios, the overall temperature is warmer than the normal climate envelope for ICHmw. Precipitation will stay at ICHmw levels, except it will likely be a bit higher in spring and fall but less in summer (although still relatively high). With the precipitation and a drought index significantly lower than even the IDFmw, the climate will often seem more like a warmer ICH or moister IDF (considerably warmer under the most-change HAD scenario).

Summary of Ecological Vulnerabilities and Opportunities

DRY SITES - These may convert to open grassy knolls, while south slopes will continue to be dominated by Douglas-fir, but with more gaps.

FIRE – Drier and warmer summers will lead to more stand destroying fire events which may be exacerbated in places by the fuel loading due to unsalvaged mortality. As the proportion of younger stands in the subzone increases, the amount of foliar moisture will decrease and increase the risk of fire (high hazard ratings have been increasing by a couple days every year already). This subzone is also expected to incur greater human population growth and therefore face interface fire challenges.

PATHOGENS – Increased tree mortality due to pathogens is not expected, though some top dieback induced by drought may occur. Drought stress and lower vigor will lead to insect induced mortality and consequently increased fuel loads.

HYGRIC OR WETTER SITES – Due to edaphic reasons, these sites will remain as they are in most cases. A warmer climate may lead to increased productivity (for brush species too).

ARMILLARIA – As it is known that cold climates keep it in check (in the ESSF), it could likewise become more active in stands in warmer climates. While it is expected that spread will continue to be slow, the rate of spread may increase slightly. Expect increased losses on some sites in the ICHmw.

RUSTS – As spring moisture and temperatures increase, rusts may prove to be problematic in regenerated stands where lodgepole pine is abundant already. Gall rusts and *Commandra* are anticipated to be significant problems in the ICH, though less so in the drier ICHdw. Orographic location might be an important factor in that valley bottoms may be more susceptible than slopes, but this is not certain. Pine plantations in Clearwater, for instance, have *Attropellis* and *Lopherdermella*, while *Dothostroma* in pine is in valley bottoms at Valemount. Recent concern about rusts may be due to nurseries or poor seedlot selection as there has been less rust in recent years. However, all foliar diseases may increase, including *Rhabdocline* in Douglas-fir and *Dothostroma* in western white pine.

Regeneration Vulnerabilities and Opportunities

MESIC SITES:

- On zonal or north slopes Douglas-fir may do better (certainly at mid to upper elevations).
- The first 10 growing years for young Douglas-fir will be tricky in the more extreme locations (especially lower elevations) in 2050+.
- There is a lot of potential for western white pine with rust resistant stock on all sites except south and west facing slopes.
- There will also eventually be a lot of potential for western larch in mid to upper elevations (perhaps some at lower elevations too). As western larch flushes earlier in the spring than other species it may be able to take advantage of expected wetter springs and put on decent growth before the onset of summer drought periods. However, since flushing rates in general will be earlier due to a warming climate, larch in particular may be squeezed into an early spring window where it could be much more susceptible to frost. Choosing less frost prone planting locations will be essential.
- Rely less on hemlock and redcedar natural regeneration, especially at lower elevations, and west or south slopes. Redcedar may still be fine in moist draws or at upper elevations.
- AVOID planting subalpine fir. There may be possibilities for grand fir on some moister sites, but this is not certain.
- Encourage more broadleaf species where appropriate on north slopes and upper elevations through natural regeneration or planting (aspen is now a good option). An increase in broadleafs can reduce fire hazard as fires burn in these types with a lower intensity. Assess potential based on, elevation, aspect and what is growing there currently.
- Managing to reduce root disease innoculum (e.g. stumping) at mid to upper elevations and north slopes could lead to significant growth improvements.

SUBMESIC/SUBXERIC SITES:

- Avoid spruce, redcedar and hemlock on south and west slopes, especially at lower elevations.

CURRENT SPECIES DEPLOYMENT:

- The high quantity of lodgepole pine that has been planted in the past here (some licensees up to 30%) may lead to vulnerabilities in the future (i.e. rusts).

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Fd	Low - Mod	Minor - Significant (mid to upper elevations or north slopes)	Fd may increase in growth due to warmer temps but could be compensated for by increased activity of Armillaria. However if stumps are removed there could be some growth improvements. On zonal or north slopes Fd may do better (certainly at mid to upper elevations).
Sx, Hw, Cw	Mod (upper) High to Very High (mid to lower)	Nil	Expect Cw top dieback and beetle and other pest problems to increase in Sx and Hw – will create lots of fuel – if not salvaged – increased fire risk.
Ep and At	Low (upper) High to Very High (lower)	Significant (upper)	The ICHdw has lots of these species so as the climate warms they may be quite important at upper elev. Especially if lost lower down.
Pw	Low (upper / mid) Mod (lower)	Minor – possibly in upper elevations	

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

ICHwk

Short- term Vulnerability = NIL - LOW
Long-term Vulnerability = LOW - MOD

Ecological Narrative for the ICHwk through to 2080:

2008 to 2050

The influence of climate change

This subzone will likely see some minor impacts from climate change to 2050. Most mature and maturing tree species that currently exist may see a slight to moderate increase in vigour and growth as temperatures rise and the growing season lengthens, but this could be offset somewhat by increased impacts from *Armillaria* and other pests. Precipitation will stay high, although summers may be somewhat drier, which is unlikely to impact stands except in extreme years. Winters will be milder with less extreme cold events, and a slightly reduced winter snowpack due to a shortened season at either end.

Wildfire risk in this subzone is currently low. The wet and cool conditions currently make stand-replacing wildfires a one in 350 to 500+ year event. Warmer summer temperatures and summer drought conditions at low-mid elevations (similar to the ICHdw or ICHmw) may reduce the fire return interval throughout this subzone making large fires a possibility. The anticipated increase in severe weather may increase the potential for lightning-caused fires, although the overall risk may still continue to be between low and moderate.

Estimated future forest condition of stands currently mature

The redcedar/hemlock/spruce dominated landscape with lesser amounts of Douglas-fir could increase in vigour (and subsequently improve growth), particularly on north and east aspects where current growth is slower. Localized mortality could increase in periodic pulses, from hemlock looper or *Armilaria* root disease. These mortality events could be significant at times in some locations. Fire may have some local impacts but the landscape will continue to be dominated by mature and old forests. A mix of species will fill in the small disturbed gaps, including broadleafs at lower elevations.

Estimated future forest condition of young stands

Growth and vigour of the full range of species in young stands and plantations may actually improve up to 2050. As well, the growth and vigour of shrubs and herbaceous plants will remain high except on the driest sites. Near 2050, summer drought could challenge establishment of spruce on lower elevations particularly on warmer aspects, where Douglas-fir, lodgepole pine and larch may do well.

Spruce weevil could start to have a significant impact on growth and development of young spruce after 2030 or 2040. In the absence of stumping, significant mortality from *Armillaria* will emerge throughout many plantations. Where broadleaf species, such as aspen, birch and cottonwood, gain a foothold they will thrive.

2050 to 2080

The influence of climate change

Warming summer temperatures will increase drought stress on some sites, which together with *Armilaria*, bark beetles and other pests may increase the mortality in older conifers, especially during dry cycles. South and west aspects (particularly at lower elevations and steep upper slopes and crests) will experience the most noticeable impacts. Elsewhere, impacts will be subtle, possibly even negligible.

Fire risk may increase slightly, especially on warm aspects. As new conifer and broadleaf regeneration fill in the newly created gaps from disturbance, the fire risk will lower over time, as fine fuels subside.

Estimated future forest condition of stands currently mature

Most redcedar/hemlock/spruce dominated stands will change very little up to 2080. However, mortality on well-drained sites at lower elevations and on warm aspects will create significant open patches. A mix of species will fill in these gaps, including broadleafs at lower elevations. Stands dominated by Douglas-fir and other species such as lodgepole pine and larch may be less vulnerable. Past disturbances from fire and logging will encourage a greater mix of broadleaf species to emerge through the subzone.

Estimated future forest condition of young stands

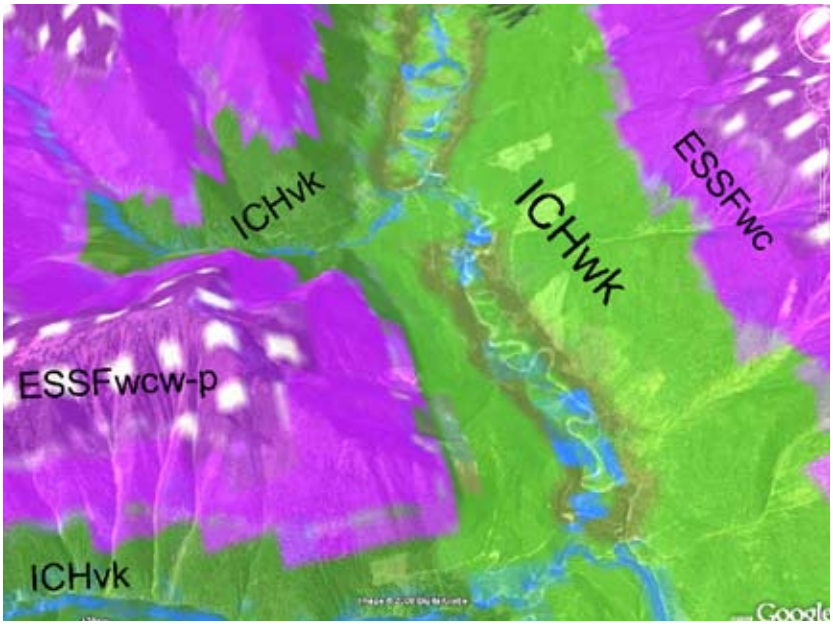
Where past logging was followed by stumping to reduce pathogenic inoculum, plantations will persist and grow well, possibly even improving in growth. Non-stumped stands may see significant mortality from root disease that could spike in dry cycles. Spruce plantations may continue to see significant growth impacts from weevil throughout this subzone. Lodgepole pine plantations at low elevations may see some impacts from rusts, root collar weevil and other pests. Young stand mixtures of Douglas-fir, white pine, lodgepole pine, redcedar, spruce, birch and aspen, will be more common and provide resilience. Introductions of larch as a stand component may do well on warm aspects.

Vulnerability summary

This subzone will see very subtle changes, some positive, over the next 40 years. Only when near 2080 will this subzone see some significant negative impacts. Even then, these impacts will not be huge, and numerous options for stand mixtures will be available to help facilitate resilience.

CURRENT CONDITIONS

5% of the TSA
6% of the THLB (141,069 ha)



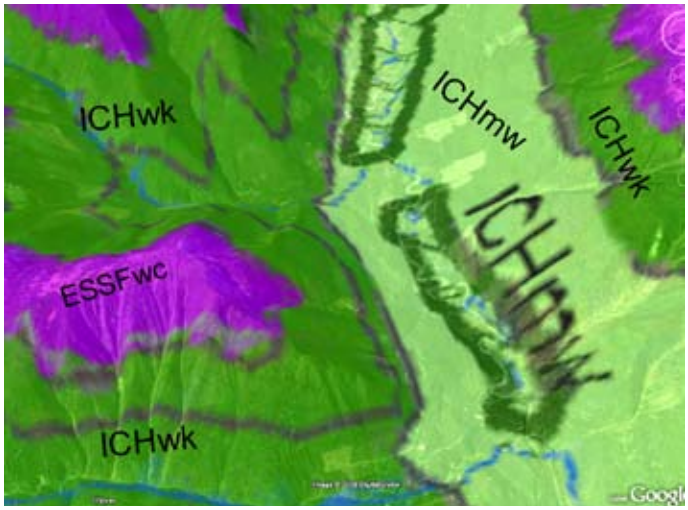
N. Thompson / Canvas Ck.

Sites Naturally Associated with ICHwk	Plant Communities Associated with Current Subzone
Zonal site association	Gentle slopes and northern slopes; Hw & Cw (Bl, Sxw) stands, some Pl & Ep in seral stages; moderate shrub cover of huckleberry, blueberry, azalea; rich herb layer including foamflower and oak fern; abundant feathermosses and pipe-cleaner moss
Dry site association	Crests and steep south slopes; Hw & Cw (Fd), with more Fd in seral stages; moderate shrub cover of huckleberry, blueberry, azalea; moderate herb layer with prince's pine, twinflower and bramble; moderate cover of feathermosses
Wet site association	Seepages, stream edges, fluvial sites; Cw, Hw, Sxw (Act) stands; rich shrub cover of devil's club, gooseberry, twinberry, dogwood; moderate herb layer of oak fern, lady fern, foamflower; variable feathermosses & leafy mosses

Age Classes	Leading Stand Species	% of ICHwk
<20	Sx 58% - the rest Cw, Fd (Pl, Hw)	11
20-60	Sx 40% (Bl, Pl, Cw, Fd, Hw)	20
60-120	Fd 31%, Sx 22%, (At, Pl, Hw, Bl)	23
120+	Hw30%, Cw30%, Sx30% Fd10%	46

Climate Scenarios

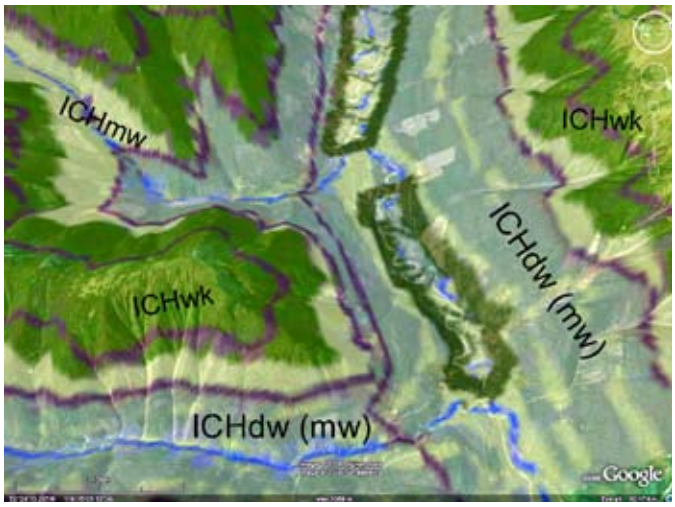
PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% ICHwk
Upper	ICHwk	1
Mid and Lower	IDFmw	99

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.3	3.4	1.1
mean summer temp. (°C)	13.1	14.4	1.3
mean temp. warmest month (°C)	13.6	15.2	1.6
frost free period (days)	72	90	18
number of frost free days	146	162	11
mean annual precipitation (mm)	1136	1185	48
mean summer precipitation (Jun-Aug) (mm)	440	437	-0.5%
precipitation as snow (mm)	498	485	-3%
annual heat:moisture index	32	36	12
mean summer heat:moisture index (May-Sept)	12	12	4.2

HAD-A1F1 2050 (most change)



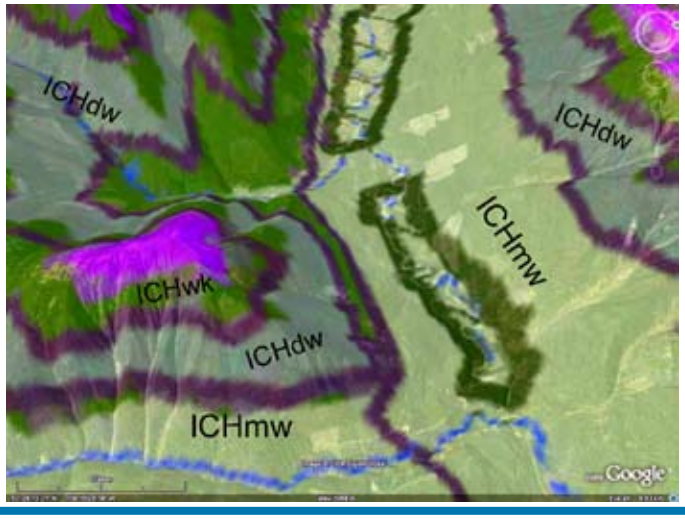
Relative Elevations	Predicted Subzone Climate	% of ICHwk
Upper	ICHmw	25
Lower boundary areas may have slightly drier conditions		
Mid	ICHdw	65
Rarely, a few areas may have slightly moister conditions		
Lower	IDFmw	6
Lower	BGxh	3
All areas are slightly to much wetter		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.3	5.5	3.1
mean summer temp. (°C)	13.1	17.7	4.6
mean temp. warmest month (°C)	13.6	18.7	5.2
frost free period (days)	72	109	37
number of frost free days	146	189	29
mean annual precipitation	1136	1192	56
mean summer precipitation (Jun-Aug)	440	402	-9%
precipitation as snow (mm)	498	429	-14%
annual heat:moisture index	32	49	51
mean summer heat:moisture index (May-Sept)	12	14	20

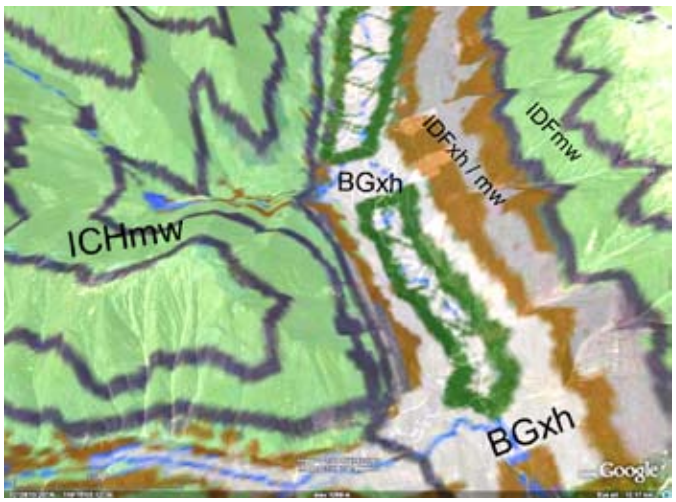
Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate focussing on 2050:

General Description

Precipitation for the bookend scenarios remains high (similar to ICHwk), but summer temperatures increase to something between the ICHdw summer temperature (PCM) and the PPxh summer temperatures (HAD). Meanwhile summer precipitation will likely remain relatively high, with drought codes ranging from slightly higher than the ICHwk (PCM) up to those approaching the ICHmw (HAD).

Summary of Ecological Vulnerabilities and Opportunities

ROOT DISEASE – *Armillaria* will likely become more active but remain fragmented and centralized in pockets for some time.

INSECTS – Pests like looper may become more active. Bark beetles may also increase, especially in subalpine fir.

FIRE – Though fires may not be frequent, this subzone may start to see some large fires during extreme years, especially since convective storms may increase in frequency.

Regeneration Vulnerabilities and Opportunities

ALL SITES:

- Maintain Douglas-fir and promote western larch (assess provenances carefully). Start at lower elevations and warmer aspects. Lodgepole pine may be useful to mix in or use on more difficult sites.
- Spruce could become limited to upper elevations, cooler aspects or wetter sites due to increased summer drought, especially beyond 2030. Spruce may also become more vulnerable to increasing pest pressure such as terminal weevil, though the degree of vulnerability is yet unknown.
- As there are good prospects for broadleaf species (aspen, cottonwood, birch), they should be promoted and perhaps even strategically planted in targeted locations for habitat purposes and to assist as fire breaks.

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Sx	Low-Mod	Minor - Significant	Similar to ESSF sites, for mature Sx the impacts may be similar to an aspect change in this zone since the precipitation remains relatively high. Root disease may have a greater impact.
Cw	Low	Significant to Minor	Again, increased warmth and growing season may improve productivity and possibly quality of Cw.
Hw	Low-Mod	Minor to Significant	Improved growing season and temperatures may provide better productivity and quality on moderate to cooler sites. Pests, such as hemlock looper and root pathogens will likely take a greater toll.
Fd	Low	Minor to Significant	Improved growing season and temperatures may provide better productivity and quality on moderate to cooler sites. Pests, such as root pathogens will likely take a greater toll but may expand slowly.
Bl	Low-Mod	Minor to Nil	Likely will not respond as well to warmth as Sx. May be more vulnerable to pests.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

IDFdk

Short- term Vulnerability = MOD
Long-term Vulnerability = HIGH

Ecological Narrative for the IDFdk through to 2080:

2008 to 2050

The influence of climate change

Up to 2050 climate change will result in hotter and drier summers with more extremes. While upper elevations will be relatively unaffected, lower elevations and southern exposures will experience greater drought stress with associated reductions in tree vigour and increases in mortality during high stress cycles. Insects such as tussock moth may increase while *Armillaria* and spruce budworm could decrease. Douglas fir beetle may become an issue, especially if it moves to two generations per year. Increased summer drought stress could also impact spruce vigour and increase mortality possibly assisted by the spruce beetle, although spruce-leading stands are relatively minor in the landscape (< 10%).

Fire is a concern in the remaining dead pine stands for the near term, where localized high risks persist. Once these stands are either salvaged or beyond the most susceptible stages, the threat of fire will be reduced due the predominance of early seral stands. This lower fire risk may change soon after 2050.

Estimated future forest condition of stands currently mature

Current stand conditions vary substantially based on slope and aspect. Previously closed stands of Douglas-fir, with lesser amounts of spruce and lodgepole pine on northern aspects and mesic sites will have scattered openings from pine and possibly spruce mortality. The remaining Douglas-fir will be under greater summer drought stress that will reduce growth but likely cause limited mortality.

In both zonal and drier Douglas-fir stands, openings and open stands may be more evident in localized areas hit by the tussock moth. Wet sites with spruce, redcedar, cottonwood and birch will experience slowed growth, top dieback and some mortality possibly contributing to scattered brushy openings. On southern and drier sites open stands of Douglas-fir (and possibly some rare remnant ponderosa pine) will experience significant drought stress, impacting growth and contributing to scattered mortality assisted by bark beetles. Mortality and warmer, drier summers throughout this subzone and in other surrounding subzones create a high risk of large intense fires which could leave significant area in early seral conditions.

Estimated future forest condition of young stands

Most young stands in this subzone are reforested mainly with Douglas-fir and lodgepole pine. Spruce is found on wetter sites. Up to 2050 it is projected that most of the subzone will have a IDFxh-like climate. Thus, a large proportion of lodgepole pine plantations will be growing in a climate that is not conducive to lodgepole pine. The increased drought stress will lower vigour and increase mortality from a range of potential forest health agents, including: western gall rust, needlecast, terminal weevil, dwarf mistletoe, and possibly bark beetles (as trees mature).

Lodgepole pine established on cooler aspects will have a higher likelihood of prolonged survival. Douglas-fir and ponderosa pine, once established, should be well adapted up to 2050, as will spruce on wetter sites. Douglas-fir may be prone to frost damage and mortality on susceptible terrain - trees with some shelter, even dead pine, may fair better.

2050 to 2080

The influence of climate change

Beyond 2050 and up to 2080, the warming climate will encourage a greater presence of grassy openings or grasslands through this subzone. Lodgepole pine will be well outside of its ecological tolerances, with much hotter drier summers, approaching that found in the BGxh. By 2080 surviving lodgepole pine stands will be significantly weakened by drought stress will be at high risk of mortality, possibly in combination with bark beetles and other forest health agents. The resulting mortality may increase the likelihood of large stand-replacing fires.

Douglas-fir will also be under considerable stress, making it more susceptible to tussock moth and possibly Douglas-fir beetle.

Estimated future forest condition of mature stands

By 2080 most if not all of the lodgepole pine regenerated early in the century will be either dead or struggling under the hotter drier conditions. Pine mortality and past wildfires may contribute to greatly expanded early seral stands or grasslands. Mature Douglas-fir stands will be mostly found on cool aspects and higher elevations. On warm slopes Douglas-fir will be limited to moist draws. Ponderosa pine if previously established, will fair better on these warmer sites and throughout the zone than Douglas-fir.

Estimated future forest condition of young stands

Beyond 2050 to 2080, a number of key parameters for species survival will be impacted. Ponderosa pine will be the lone conifer adapted to drier sites. Douglas-fir will be limited to mesic or moister areas and will require shade for establishment. Lodgepole pine will not be an option as it will be outside of its ecological tolerances.

Vulnerability Summary

There will be a trend away from a lodgepole pine dominated subzone to one suited to widespread ponderosa pine, restricted Douglas-fir and grasslands.

CURRENT CONDITIONS

10% of the TSA
16% of the THLB

Tranquille Cr. / Sawmill Cr.

Sites Naturally Associated with IDFdk	Plant Communities Associated with Current Subzone
Zonal site association	Closed stands of Fd & Pl (with At & Pl in seral stages); moderate shrub cover of spirea, falsebox, saskatoon, soopalallie, snowberry; moderate herb layer of bunchberry, twinflower, prince's pine; moderate cover of feathermosses
Dry site association	Open stands of Fd and Py; sparse shrub cover of juniper, spirea, falsebox, saskatoon, and soopalallie; sparse herb layer of pinegrass, bluebunch wheatgrass, kinnikinnick, showy aster; sparse feathermosses, ragged moss and lichens
North slope site association	Dense stands of Fd (Pl, Sxw) with more Pl in seral stages; moderate shrub cover of snowberry, maple, mtn alder, soopalallie; moderate herb layer of pinegrass, arnica, twinflower; moderate to dense feathermosses, ragged moss & pelt lichens
Wet site association	Dense stands of Sxw & Fd (Cw, Act) with more Fd & At in seral; moderate shrub cover of dogwood, maple, devil's club, gooseberry, twinberry; moderate herb layer of oak fern, twistedstalk, sweet cicely; moderate cover of ragged moss and leafy mosses

Age Classes	Leading Stand Species	% of IDFdk
<20	Fd51% Pl43% (At Sx)	13
20-60	Pl50% Fd30% At20	2
60-120	Fd60% Pl30% (At Sx)	28
120+	Fd80% Pl18 (Sx, At)	57

Climate Scenarios

PCM-B1 2050 (least change)

Relative Elevations	Predicted Subzone Climate	% IDFdk
Upper	IDFdk	8
A few areas may have slightly drier conditions		
Mid	IDFxh	83
A few areas may have slightly moister conditions		
Lower	PPxh	9

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	3.6	4.6	1.0
mean summer temp. (°C)	14.0	15.3	1.3
Mean temp warmest month (°C)	14.5	16.2	1.7
frost free period (days)	85	103	22%
number of frost free days	158	175	11%
mean annual precipitation (mm)	421	438	4%
mean summer precipitation (Jun-Aug) (mm)	201	199	-1%
precipitation as snow (mm)	152	145	-5%
annual heat:moisture index	33	34	3%
mean summer heat:moisture index (May-Sept)	73	83	12%

HAD-A1F1 2050 (most change)

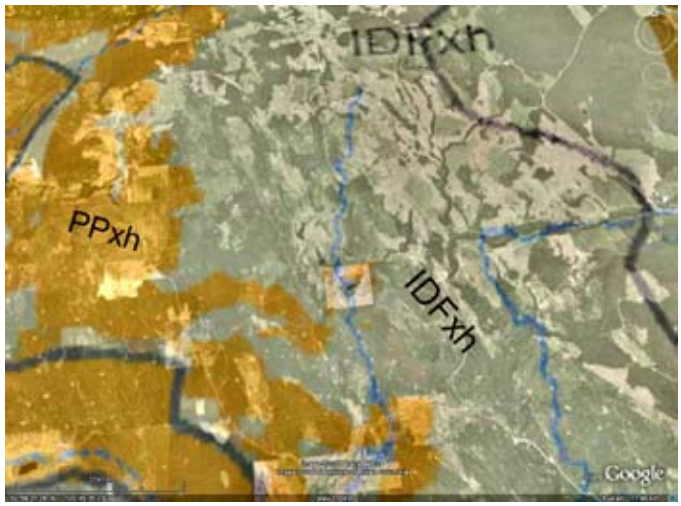
Relative Elevations	Predicted Subzone Climate	% of IDFdk
Upper	IDFxh	15
Lower boundary areas may have slightly drier conditions		
Mid	PPxh	30
Rarely, a few areas may have slightly moister conditions		
Lower	BGxh	55
A few areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	3.6	7.0	3.4
mean summer temp. (°C)	14.0	18.9	4.9
mean temp warmest month (°C)	14.5	20.6	6.1
frost free period (days)	85	122	45%
number of frost free days	158	207	31%
mean annual precipitation	421	430	2%
mean summer precipitation (Jun-Aug)	201	178	-12%
precipitation as snow (mm)	152	119	-21%
annual heat:moisture index	33	40	23%
mean summer heat:moisture index (May-Sept)	73	118	60%

Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)

Overview of Changing Climate focussing on 2050:

General Description

The temperature is likely going to be a bit warmer than IDFxh, especially in spring. Precipitation will stay at IDFdk levels, but likely a bit higher in spring and fall and less in summer (although still relatively high). With this precipitation, Douglas-fir will likely remain (rather than a PP subzone), but will be stressed by increased temperatures (drought index between the IDFdk and xh).

Summary of Ecological Vulnerabilities and Opportunities

As in other subzones, there will likely be more extreme weather events.

INSECTS - Tussock Moth might be a problem here, but it is not known if it will be significant. There are some concerns about Douglas-fir bark beetle here but it is expected that western spruce budworm will weaken.

Regeneration Vulnerabilities and Opportunities

MESIC SITES:

- In regenerating Douglas-fir there have historically been issues with nursery stock, pinegrass competition and growing season frosts and establishment is expected to continue to be challenging. Provide shelter to new regeneration.
- Restrict lodgepole pine to northerly aspects as high temperatures and more extreme droughts will limit it. Scattered pine may be used as nurse crop for Douglas-fir.
- Introduce western larch onto northerly and eastern slopes that drain cold air effectively. It will not be suitable for winter ranges but seldom grows as a pure stand anyway.
- Ponderosa pine will be a good option, however, seed might need to be sourced from the USA for sufficient quantities and better suited provenances.
- Restrict spruce to the moistest sites.
- Encourage aspen as much as possible mixed with other species. Do not rely on it, however, as it will be moderately vulnerable and do best in cooler, moister situations.

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Fd	Low - Mod	Nil	Likely PCM will show better growth with some growth slowing in HAD.
At	Mod	Nil	Will increase in susceptibility but need to keep it as much as possible here.
Sx	Mod - High	Nil	This subzone appears to be moving out of the optimal range for Sx. Sx will likely be quite vulnerable to insects and drought stress except on wet sites.
Pli	Mod	Nil	Not clear if bark beetles will be an issue in 40-60 year old stands at 2050. Rusts and other pests may be a greater challenge in younger stands.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

IDFmw

Short- term Vulnerability = HIGH
Long-term Vulnerability = HIGH

Ecological Narrative for the IDFmw through to 2080:

2008 to 2050

The influence of climate change

Up to 2050, profound climate changes will occur in this transition zone in response to dramatic increases in summer temperatures and drought. The greatest impact will be noticed with mortality in species such as redcedar (drought top-dieback) and birch (drought top-dieback and stem borers). Most young and maturing stands will likely see a decline in growth and vigour. Younger and maturing Douglas-fir cohorts, established in disturbed areas after logging or fire, may see less overall mortality due to the decline of root disease vitality as it gets hotter and drier. Where such stands were established post-harvest after stumping, a common treatment in this subzone, this reduction in mortality will be most evident.

Fire risk may increase substantially for a period due to hotter and drier summers with increased fuel loading. Presence of fine fuels during dry cycles may create a high risk situation especially since this subzone is close to the urban interface and recreational areas.

Estimated future forest condition of stands currently mature

In older stands, birch and redcedar will gradually disappear, except on wetter sites where they will remain non-merchantable due to poor growth and vigour. Aspen may expand in some areas, possibly showing acceptable vigour and growth on moister sites. A combination of drought, root disease and bark beetles will continue to increase mortality of older Douglas-fir on north and east slopes, further fragmenting these types. These stands may see less mortality as they approach 2050, although growth and vigour will decline. Moist-site shrubs such as maple will decline in presence and possibly be replaced by drought tolerant shrubs and herbs (facilitated greatly with disturbance), and an increased presence of invasive species.

Stands on warm south and west facing slopes will see some minor mortality uniformly scattered throughout due to drought, creating more open, gappy stands. Dry site shrubs and grasses will fill these voids. Ponderosa pine established at lower elevations will grow well.

Estimated future forest condition of young stands

Scattered mortality distributed throughout maturing Douglas-fir stands, from a combination of drought and bark beetle, will reduce densities, especially on drier aspects and lower elevations creating more open stands. The maturing lodgepole pine (originally established in plantations) may start to see significant to wide-spread mortality at this point, possibly exacerbated by bark beetles. Younger to maturing stands planted with larch may see some scattered mortality in the larch, especially on hotter and drier sites, while ponderosa pine should continue to cope well with the changing climatic conditions, unless bark beetles build to epidemic proportions in surrounding stands and subzones (an unclear risk).

2050 to 2080

The influence of climate change

This subzone will become even hotter and subsequently drier after 2050, moving away from a tree-dominated subzone to one where grasslands will become a prominent component on warm aspects, due to widespread mortality in the mature and maturing stands.

Hot dry summers will lower vigour of established Douglas-fir and ponderosa pine stands that are already under frequent drought stress on warm aspects. The result will be more frequent grassy openings on south slopes. Tussock moth will increase as a significant threat to Douglas-fir in this subzone. Western spruce budworm however may decline with the drier conditions, reducing its impact on Douglas-fir. Warming and drying over time may reduce *Armillaria* vigour and its impacts within stands.

An increased summer drought period with increased fuels and a high exposure to public access will provide a significant increase in the risk of wildfires across this subzone. Fire disturbance may shift areas from treed to grasslands, possibly resulting in an expansion of invasive plant species. This will be most evident on south slopes where fine fuels will remain on site for a number of years due to slow decay rates, increasing the time the area is vulnerable.

Estimated future forest condition of mature stands

Douglas-fir will remain the dominant species on mesic sites. Increased mortality from drought, Douglas-fir bark beetle and tussock moth will create a more open, discontinuous, or uneven aged stand structure. Warm aspects may have concentrations of dead timber or open grassy openings. Grasslands could be significantly expanded due to fire.

On wet sites after 2050 there will be significant stress for the cedar, spruce and cottonwood. Although impacts may be less for aspen and birch, some mortality may occur.

Estimated future forest condition of young stands

Mature trees and regeneration may be intermixed in gappy open stands[1] as a result of harvesting or fire, resulting in abundant Douglas-fir regeneration in gaps on north slopes and relatively open and sparse regeneration on southern exposures. With an increase in severity and length of droughts, there is a likelihood of increased stress in both understory and overstory trees. This stress could result in high levels of periodic mortality due to cyclical spruce budworm and Douglas-fir tussock moth – both insects that thrive in these uneven-aged stand conditions. However as climate continues to warm, spruce budworm impacts may occur less often.

Shade will become important for early regeneration success for both Douglas-fir and ponderosa pine.

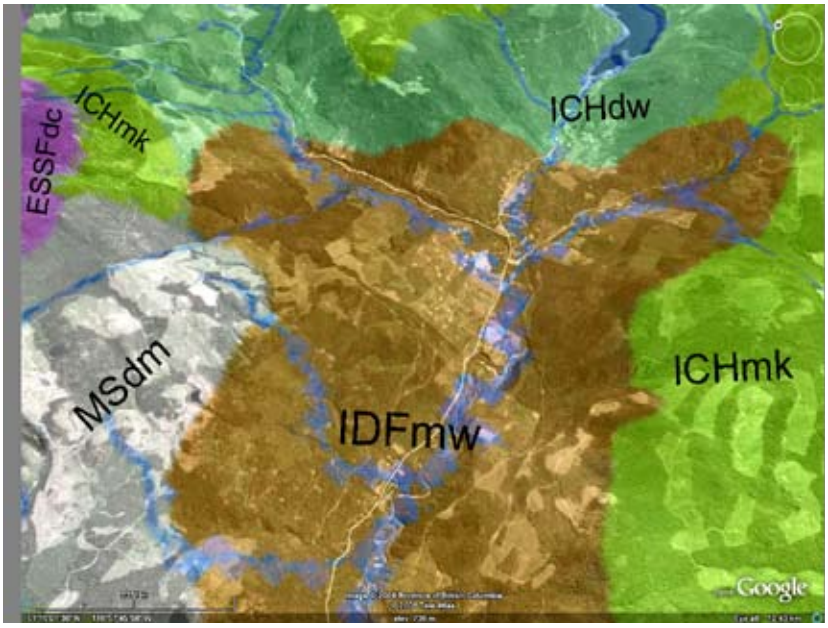
Vulnerability summary

The stands in the IDFmw are likely to see significant changes toward less merchantable types, with significant mortality over the next 40 years, possibly widespread up to 80 years - mostly from a combination of drought stress, insects and disease, and quite possibly large wildfires.

[1] e.g., faller selection, diameter limit harvesting, true single tree selection

CURRENT CONDITIONS

5% of the TSA
5% of the THLB



Barriere River

Sites Naturally Associated with IDFmw	Plant Communities Associated with Current Subzone
Zonal site association	Gentle slopes; closed mixedwood stands Cw, Sxw, Hw, Fd, Pl, Bl, At & Ep; moderate shrub cover of falsebox, spirea, rose, huckleberrry, maple; moderate herb layer of bunchberry, twinflower, prince's pine; moderate cover of feathermosses
Dry site association	Crests and steep south slopes; open Fd, Pl (At) stands; sparse shrub cover of snowberry, saskatoon, falsebox, soopalallie, spirea; moderate herb layer of pinegrass, showy aster, prince's pine; sparse feathermoss, heron's-bill moss and pelt lichens
North slope site association	North slopes; closed mixedwood stands Fd (Pl, Sxw); moderate shrub cover of falsebox, spirea, rose, huckleberrry, maple; moderate herb layer of showy aster, twinflower, prince's pine; dense cover of feathermosses
Wet site association	Dense Cw, Hw, Sxw, Fd, Ep (Act) stands; rich shrub cover of dogwood, alder, devil's club, gooseberry, twinberry, snowberry; moderate herb layer of oak fern, twistedstalk, foamflower; sparse cover of feathermosses

Age Classes	Leading Stand Species	% of IDFmw
<20	Fd67% Pli18% (At Ep)	20
20-60	Fd30% Ep30% Pli10 Cw10% At10%	4
60-120	Fd60 Pli13 At10 Ep12 (Cw)	40
120+	Fd84 (Cw, Pl)	36

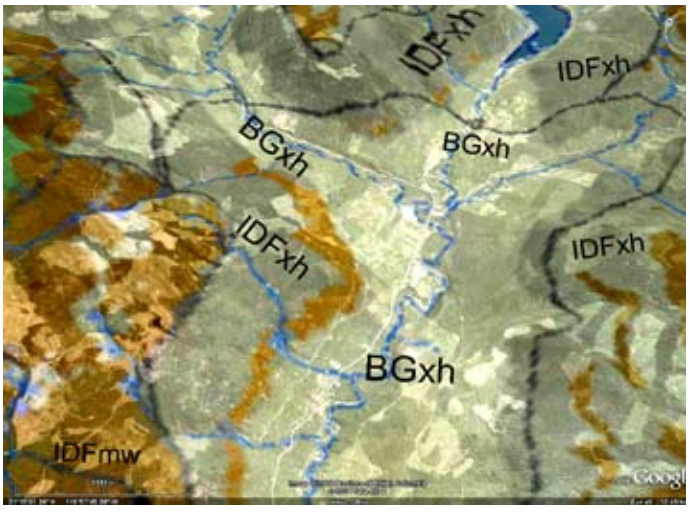
Climate Scenarios

PCM-B1 2050 (least change)

Relative Elevations	Predicted Subzone Climate	% IDFmw
Upper	IDFmw	14
Upper boundary areas may have slightly moister conditions		
Mid	IDFxh	81
Upper boundary areas may have slightly moister conditions		
Lower	PPxh	3
Valley and upper boundary areas may have slightly moister conditions		
Lower	BGxh	1
Almost all areas have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	5.0	6.0	1.0
mean summer temp. (°C)	14.7	16.1	1.4
Mean temp warmest month (°C)	16.4	18.0	1.6
frost free period (days)	105	122	16%
number of frost free days	178	195	10%
mean annual precipitation (mm)	545	568	4%
mean summer precipitation (Jun-Aug) (mm)	242	240	-1%
precipitation as snow (mm)	175	161	-8%
annual heat:moisture index	28	29	3%
mean summer heat: moisture index (May-Sept)	69	77	11%

HAD-A1F1 2050 (most change)



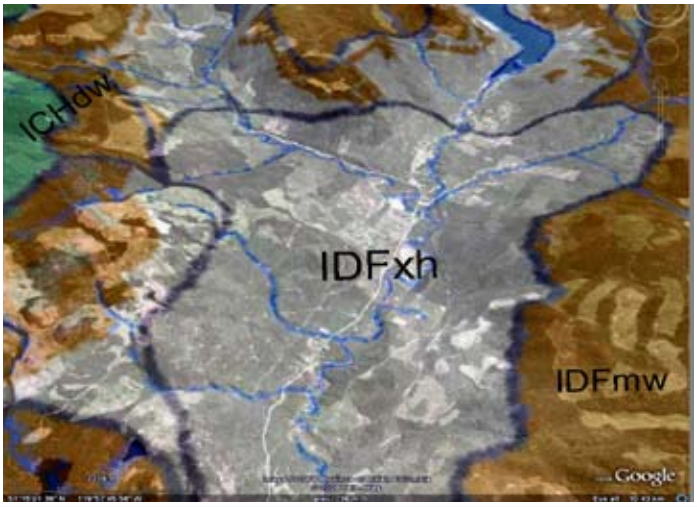
Relative Elevations	Predicted Subzone Climate	% of IDFmw
Upper	IDFmw	3
Rarely, a few areas may have slightly drier conditions		
Upper	IDFxh	29
A few areas may have slightly drier conditions		
Mid	PPxh	6
Rarely, a few areas may have slightly moister conditions		
Lower	BGxh	62
Valley and upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	5.0	8.3	3.3
mean summer temp. (°C)	14.7	19.7	5.0
mean temp warmest month (°C)	16.4	22.0	5.6
frost free period (days)	105	141	35%
number of frost free days	178	228	28%
mean annual precipitation	545	561	3%
mean summer precipitation (Jun-Aug)	242	216	-11%
precipitation as snow (mm)	175	136	-23%
annual heat:moisture index	28	33	19%
mean summer heat: moisture index (May-Sept)	69	104	50%

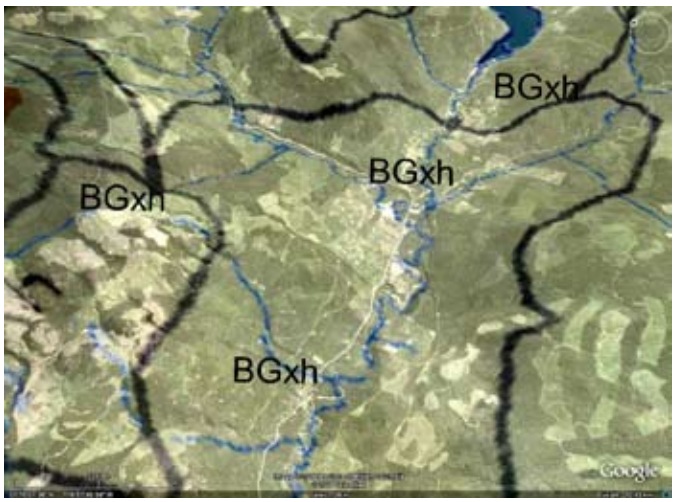
Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate focussing on 2050:

General Description

With the least-change PCM scenario the climate of this subzone will ressemble the ICHxh, however, it will be much less dry. Temperatures go even higher with the most-change HAD scenario, presenting a subzone climate of extremes where lower elevations on south slopes might be closer to PPxh, while north slopes will be a warmer IDFmw. A key point is that the drought index is increasing on average by 19%.

Summary of Ecological Vulnerabilities and Opportunities

INSECTS - More miners and borers can be expected on the broadleaf species. There is also the potential for more damage from Douglas-fir beetle on Douglas-fir stressed from drought and root disease. Spruce budworm may become more of a problem in Douglas-fir, although it tends to be episodic.

ROOT DISEASE – *Phellinus* and *Armillaria* may become more problematic at some sites.

FIRE – More lightning is anticipated here due to the combination of moisture and heat.

Regeneration Vulnerabilities and Opportunities

ALL SITES:

- Douglas-fir remains suitable here and ponderosa pine should be promoted where suitable for initial survival.
- Needle casts like *Dothastroma* may increase in lodgepole pine due to the combination of lack of drought tolerance in pine, high heat, a much hotter temperature but unchanged moisture. Stem rusts will also be more problematic in pine. The use of lodgepole pine over the near term may be suitable if it is planted with other species or at higher densities. Over the long term this approach may be used on northerly, and perhaps easterly, slopes but not at low elevations, especially on southern slopes.
- Ponderosa pine grows alright under this moisture regime. For example, a site near Enderby had SI of 30 for ponderosa pine, Douglas-fir, spruce, western white pine, and western larch, while lodgepole pine was only at 23.

• Western larch may be a good option on sites whereit would notbe prone to frost or too droughty. There is a patch of western larch growing well north of Merritt. It is not known, however, how needle cast and sawfly will respond to it.
• Grand fir seems to respond well to warm temperatures where there is enough moisture so it might be best to try on toe slopes. Success will likely depend on fall rains.
• Western white pine may succeed on some sites although there is still much uncertainty.

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Fd	Mod	Minor for PCM	Armillaria (and Phellinus) root disease will likely be more active especially on moister and cooler slopes. Budworm could increase damage as well (although it will occur in pulses – can manage). Remaining Fd may grow better with more resources as trees from other species die off – see below.
Pli – Mostly 40-60 yr old stands in 2050	Mod	Nil	Not clear if bark beetles will be an issue in 40-60 year old stands at 2050. Rusts and other pests may be a greater challenge in younger stands.
Cw	High	Nil	Hotter temperatures will give drier summers that will be limiting on a wider range of sites. (Currently Cw is excluded from S slopes in this subzone).
Ep	Very High	Nil	Most tend to die out in this subzone by about 80 years right now. Increasing heat and resulting summer drought will increase top dieback and birch-poplar-willow borer damage.
At	High - Mod	Nil	Increased heat and drought in summer will increase problems with needle miner, birch-poplar-willow borer. May persist on northern and eastern slopes.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

IDFxh

Short- term Vulnerability = MOD
Long-term Vulnerability = HIGH

Ecological Narrative for the IDFxh through to 2080:

2008 to 2050

The influence of climate change

This hot and dry subzone will become hotter and subsequently drier, moving away from a tree-dominated subzone to one where grasslands will begin to dominate. Northern exposures and the highest elevations will have less change, while more extreme conditions on southern exposures will result in widespread mortality in many of the mature and maturing stands.

This subzone presently experiences significant summer moisture deficits. Increased summer temperatures and more frequent prolonged summer droughts will lower vigour of established Douglas-fir and Ponderosa pine stands, already under stress from frequent drought. Ponderosa pine currently has high levels of mortality from western and mountain pine beetle epidemics. The result will be more grassy openings and grassland expansion, especially on south slopes, as seed source and suitable shading will limit ponderosa pine re-establishment.

Tussock moth, will remain a significant threat to Douglas-fir in this subzone, and could increase with warmer drier summers. Western spruce budworm, however, may decline, reducing its impact on Douglas-fir stands as the climate warms. Root pathogens, such as *Armillaria* will remain in isolated pockets, at relatively low levels of incidence with the warmer and drier conditions.

An expanded summer drought period, higher mortality, and a high degree of public access will increase the risk of a stand-replacing fire across this subzone. Risk may vary as concentrations of dead trees pass through high risk phases and normal climate cycles, subsiding once fuels are on the ground, and stands are less continuous and more open. Fire disturbance may shift large areas into an early seral / grassland condition. Climatic conditions more severe for establishment could result in an expansion of invasive plant species, many of which have already gained a foothold here. This would be most evident on warmer slopes.

Estimated future forest condition of stands currently mature

Currently, most stands are dominated by Douglas-fir, with dying ponderosa pine mixed in on warmer aspects or ridges. Douglas-fir will remain the dominant species on mesic sites. Increased drought stress will increase risk from Douglas-fir bark beetle and tussock moth when climate cycles and favourable insect conditions converge. This will likely result in more open, discontinuous, possibly uneven stand structures.

From now to 2050 there will be greater summer moisture deficits on all sites. This will likely result in significant stress even on diverse wetter sites (draws and seepage areas) causing mortality in redcedar, spruce and cottonwood. Although impacts may be less for aspen and birch some mortality may occur. While these wetter sites are not used extensively for timber production in this subzone, they do provide significant habitat for wildlife that will be increasingly vulnerable due to increased mortality.

Estimated future forest condition of young stands

Mature trees and regeneration are often intermixed in gappy open stands[1] as a result of harvesting or fire, resulting in abundant Douglas-fir regeneration in gaps on north slopes and relatively open and sparse regeneration on southern exposures. With an increase in severity and length of droughts, there is a likelihood

[1] e.g., faller selection, diameter limit harvesting, true single tree selection

of increased stress in both understory and overstory trees. This stress could result in high levels of periodic mortality due to cyclical spruce budworm and Douglas-fir tussock moth – both insects that thrive in these uneven-aged stand conditions. However as climate continues to warm, spruce budworm impacts may occur less often. As well, large fires may create large patches of grasslands.

Between extreme years, both ponderosa pine and Douglas-fir that are established on mesic to wetter sites will experience similar to slightly slower growth rates than the present due to the reduced period of available moisture. Shade will be a key for early regeneration success for both Douglas-fir and ponderosa pine.

2050 to 2080

The influence of climate change

The longer term outlook for this subzone does not bode well for tree growth or survival. More severe drought will combine with insects to increase mortality and subsequently, fuels and fire risk. The risk of large stand replacing fires may become extreme in drier years. Species presently located on wetter sites will be marginalized as these sites contract, with survivors limited to sheltered north aspects. Wildlife dependent upon the less common tree species will be affected negatively. Snow levels will be low and winter temperatures moderate, reducing the need for snow interception and possibly thermal cover for winter range. Long-term timber management for this subzone will be severely limited by the year 2080 under both scenarios.

Estimated future forest condition of stands currently mature

By 2080 forested landscapes will be limited to patchy stands on north slopes, upper elevations and in seepage areas and draws. Grasslands will dominate warmer aspects with a few surviving trees found in favourable microclimates. Rare remnant ponderosa pine will fair better than Douglas-fir.

Estimated future forest condition of young stands

Surviving open Douglas-fir stands have less favourable conditions for re-establishment of Douglas-fir, due to moisture deficits. Planted or managed ponderosa pine should continue to cope with the changing climatic conditions, unless bark beetles build to epidemic proportions in surrounding stands and subzones (an unclear risk). Overhead shade will be critical for establishment throughout the subzone on mesic or drier sites.

Vulnerability summary

This subzone will experience a trend from a mostly forested condition to a mostly grassland condition from 2008 to 2080.

CURRENT CONDITIONS

7% of the TSA
8% of the THLB

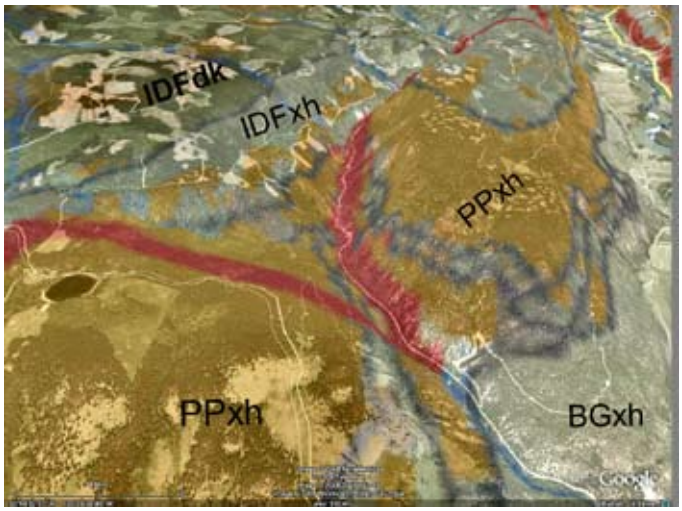
Jamieson Cr.

Sites Naturally Associated with IDFxh	Plant Communities Associated with Current Subzone
Zonal site association	Gentle slopes; closed mixedwood stands Cw, Sxw, Hw, Fd, Pl, Bl, At & Ep; moderate shrub cover of falsebox, spirea, rose, huckleberrry, maple; moderate herb layer of bunchberry, twinflower, prince's pine; moderate cover of feathermosses
Dry site association	Open stands of Py and Fd; sparse shrub cover of saskatoon, spirea, snowberry, juniper, soopalallie; sparse herb layer of pinegrass, bluebunch wheatgrass, kinnikinnick, arrow-leaved balsamroot, showy aster; sparse ragged moss and lichens
North slope site association	Closed stands of Fd (Py); moderate shrub cover of spirea, saskatoon, snowberry, maple; moderate herb layer of pinegrass, arnica, twinflower; moderate to dense feathermosses, ragged moss & pelt lichens
Wet site association	Closed stands of Sxw & Fd (Ep, Act) with Fd, Ep & At in seral; moderate shrub cover of snowberry, maple, rose, dogwood, alder, twinberry; moderate herb layer of sweet cicely, twinflower, violet; sparse feathermoss and ragged moss

Age Classes	Leading Stand Species	% of IDFxh
<20	Fd 90% Py 10%	11
20-60	Fd 75% At 25%	1
60-120	Fd 90% Py 10%	23
120+	Fd 95% (Py)	65

Climate Scenarios

PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% IDFxh
Upper	IDFxh	6
Mid	PPxh	86
Lower	BGxh	8
Valley and upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	4.8	5.9	1.1
mean summer temp. (°C)	15.1	16.4	1.3
Mean temp warmest month (°C)	16.1	17.8	1.7
frost free period (days)	101	118	17%
number of frost free days	174	191	10%
mean annual precipitation (mm)	384	400	4%
mean summer precipitation (Jun-Aug) (mm)	182	181	-1%
precipitation as snow (mm)	124	1115	-7%
annual heat:moisture index	39	40	3%
mean summer heat: moisture index (May-Sept)	90	100	11%

HAD-A1F1 2050 (most change)

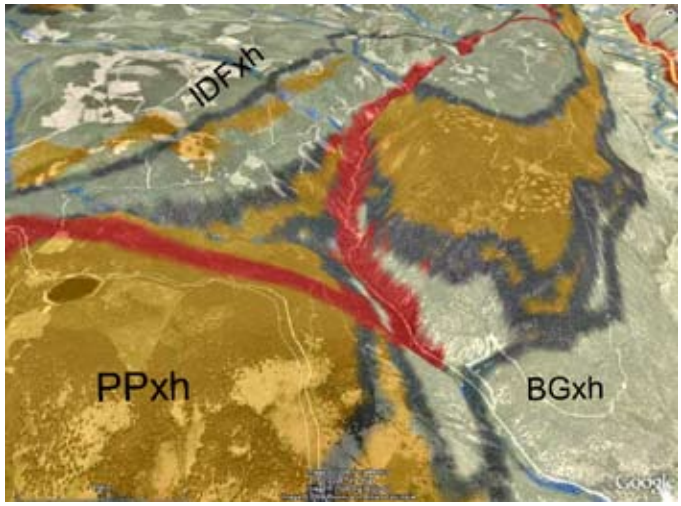
Relative Elevations	Predicted Subzone Climate	% of IDFxh
Upper	PPxh	4
Hills and lower boundary areas may have slightly drier conditions		
Mid	BGxw	1
Hills and lower boundary areas may have slightly drier conditions		
Lower	BGxh	95

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	4.8	8.3	3.5
mean summer temp. (°C)	15.1	20.0	4.9
mean temp warmest month (°C)	16.1	22.1	5.9
frost free period (days)	101	138	36%
number of frost free days	174	224	29%
mean annual precipitation	384	393	2%
mean summer precipitation (Jun-Aug)	182	161	-11%
precipitation as snow (mm)	124	96	-22%
annual heat:moisture index	39	47	20%
mean summer heat: moisture index (May-Sept)	90	139	55%

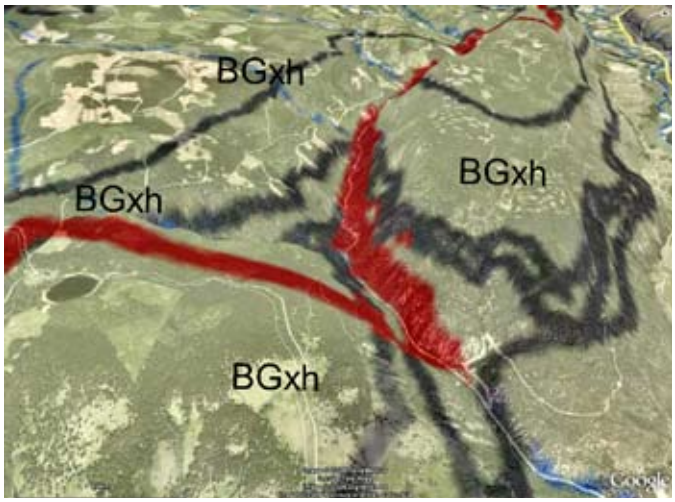
Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate focussing on 2050:

General Description

The precipitation regime and slightly higher temperature gives a similar drought code as the current IDFxh for the least-change PCM scenario. However, hotter temperatures (especially summer) under the most-change HAD scenario brings the drought code up to PPxh levels, except that there will be more precipitaion. The result will be a slightly milder PP. This subzone varies dramatically from north to south slopes. The manner in which climate change will influence the PPxh subzone suggests that ponderosa pine may not necessarily be more resilient than Douglas-fir, even though ponderosa pine can typically withstand more drought. Northerly slopes here will likely continue to look like IDF (with existing timber) but there will likely be some scattered mortality that will thin out the stands and lower timber volumes. South slopes will become very open and dominated by grasses. Grass composition may shift slowly from pinegrass to fescues and bunchgrasses, however, because pinegrass is rhizomatous this is unlikely to occur very quickly. Douglas-fir will be limited to draws.

Summary of Ecological Vulnerabilities and Opportunities

INSECTS - Tussock moth (most likely) and spruce budworm (less likely) will become increasingly problematic. Hemlock looper could be an issue in regenerated stands as it currently attacks precommercially thinned Douglas-fir stands in the IDFxh south of Kamloops.

ROOT DISEASE – There is likely not much *Armillaria* here now. *Phellinus* is patchy and will become less viable in the hotter, drier climate.

FIRE – There will likely be a high degree of mortality on south slopes from drought stress and insects. This could create a considerable short term fire risk with significant fine fuels while the dead trees retain most of their crown branches. This subzone is also often situated relatively close to interface situations.

INVASIVE PLANTS – Invasive species can be expected to quickly establish in any disturbed area in this subzone, as human accessibility is good and ranging cattle are abundant and therefore the probability of introduction is high. It may be advisable to establish some native, long-lived grasses (not domestics)

immediately following disturbances.

Regeneration Vulnerabilities and Opportunities

MESIC SITES:

• With the least change (PCM) scenario it will be necessary to provide shelter in order to get Douglas-fir established. Focus for regeneration should be on north or east facing slopes.

SUBMESIC/SUBXERIC SITES:

• Consider pursuing open grasslands here with an emphasis on maintaining or enhancing native grasses. Where logging occurs, a few clumps of retained ponderosa pine should be left strategically in draws and other moisture recieving microsites so as to provide some shelter for developing regeneration.

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Fd	High possibly VH (S slopes) and M (N slopes)	Nil	Strong divergence with condition differences from north to south slopes. Expected mortality on south slopes will be due to a combination of drought and insects.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

MSdm

Short- term Vulnerability = LOW - MOD
Long-term Vulnerability = HIGH

Ecological Narrative for the MSdm through to 2080:

2008 to 2050

The influence of climate change

The present mountain pine beetle outbreak will reduce the area in mature timber by up to 30%. By 2050 warmer temperatures will mostly promote Douglas-fir. Spruce and especially subalpine fir will experience more stress resulting in increased mortality, due in part to contributing factors such as bark beetle and budworm.

The MSdm already has frequent stand initiating fires (NDT3). Therefore, risk of large wildfires will likely be high for a period due to the warming climate and increased fuel loading from dead pine and other species.

Estimated future forest condition of stands currently mature

Approximately 30% of this subzone will become early seral due to mass mortality of lodgepole pine. This will also result in more open stands of Douglas-fir, spruce and subalpine fir where the pine was a minor component. The Douglas-fir and possibly spruce released by lodgepole pine mortality will increase in size and vigour over the near term. Subalpine fir may survive for the short term, appear well adapted, but will soon show signs of moisture stress on all but the wettest sites resulting in stagnated growth and a limited role as a future overstory species.

By 2050 the mature forest will be a patchy mosaic of scattered fragments of mature or old timber dominated by Douglas-fir, spruce and low vigour or dead subalpine fir. Lower elevations will have more extreme conditions, limiting subalpine fir and spruce even further. Birch and aspen may expand into these gaps from adjacent lower subzones as temperatures moderate.

Estimated future forest condition of young stands

Due to current pine beetle mortality, early seral stands will likely increase to 50% of this subzone by area. A significant portion of these young stands will re-establish with lodgepole pine that may increase growth up to 2050 due to an extended growing season. Comandra blister rust damage will likely remain similar to the present, while western gall rust may decrease due to increased growing season humidity (south slopes and lower elevation sites). Budworm damage on Douglas-fir may increase as climate approaches that of the IDFmw /dk.

Spruce and subalpine fir regeneration will undergo increasing summer drought stress. Terminal weevil will be a greater problem, slowing growth over time. Established Douglas-fir, presently a minor component of regenerated stands, will become more suited for growth and will do well in mid to upper elevations. Lower elevation sites will be suited to Douglas-fir and more towards ponderosa pine nearer to 2050. Patchy, *Armillaria* will increase slightly.

2050 to 2080

The influence of climate change

By 2080 summer temperatures could range between the BGxh and the IDFmw, with precipitation levels and a growing season similar in length to the IDFmw. Subalpine fir will be well outside its ecological tolerance, experiencing extensive mortality throughout the subzone. Spruce will persist on moister draws and upper elevations. Douglas-fir will remain adapted throughout the subzone with possible losses at lower elevations under the warmest, driest scenario. Tussock moth will increase as a significant threat to Douglas-fir in this

subzone, while western spruce budworm may decline. Increased impacts from *Armillaria* are likely except on dry sites.

Increased mortality and associated fine fuels will significantly increase the risk of large wildfires across this subzone in dry cycles. Fire disturbance may shift areas from treed to early seral or even grassland ecosystems, possibly resulting in an expansion of invasive plant species. This will be most evident on warmer slopes.

Estimated future forest condition of mature stands

Lodgepole pine dominated maturing stands established early in the century after the massive beetle epidemic, will be very stressed by heat and drought, with widespread mortality from a number of factors including bark beetles. The highly fragmented remaining mature forest, will be dominated by Douglas-fir in open, gappy stands, with dead pine, spruce and subalpine fir and an understory mix of Douglas-fir, dry shrubs and grass.

Over time, mortality from drought, bark beetles and tussock moth will encourage even more open, discontinuous, or uneven aged stand conditions. Warm aspects may have concentrations of dead timber or open grassy openings. Grasslands could be significantly expanded due to wildfire. Wetter sites could have a greater concentration of broadleaved species such as aspen and birch.

Estimated future forest condition of young stands

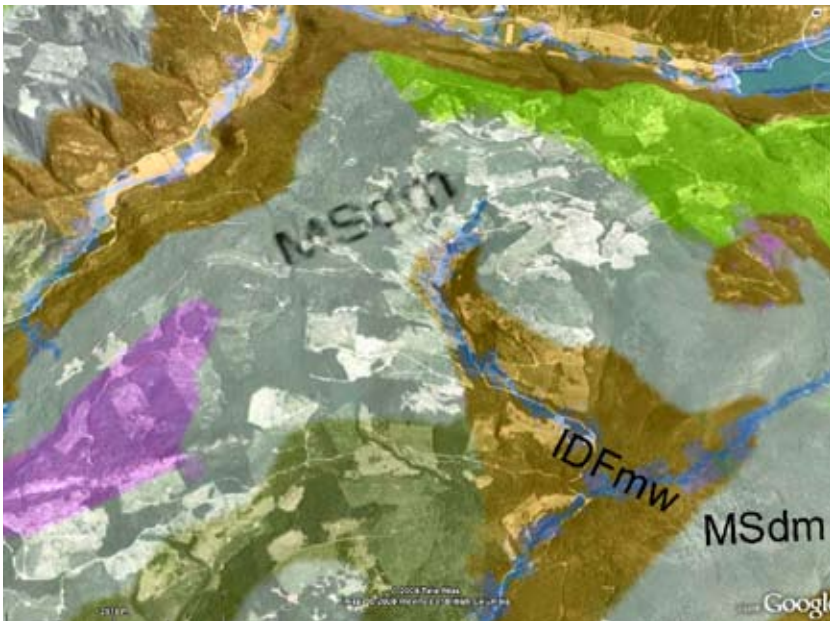
Douglas-fir will establish and grow well on most sites, although it may require shelter for establishment on warmer slopes. Ponderosa pine will similarly thrive, especially on warmer aspects. Regeneration of spruce and subalpine fir will no longer be suitable as they will be outside of their ecological tolerance range. Lodgepole pine, largely outside of its ecological niche, will still likely be suited to cooler northern aspects at higher elevations.

Vulnerability summary

This subzone will change from one where spruce, subalpine fir and lodgepole pine are well adapted to one where Douglas-fir and possibly ponderosa pine will be more suited. The shift will be somewhat gradual up to 2050 with precipitation remaining fairly stable as temperature increases. Changes after 2050 could be more dramatic, though more uncertain, mostly from a combination of drought stress, insects, disease, and large wildfires.

CURRENT CONDITIONS

5% of the TSA
6% of the THLB (141,069 ha)



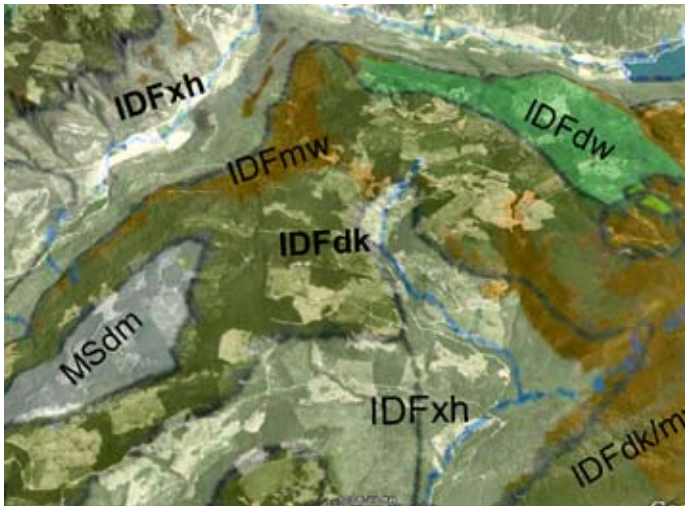
Cicero (Fadear) Ck.

Sites Naturally Associated with MSdm	Plant Communities Associated with Current Subzone
Zonal site association	Closed stands of Sxw & Pl (Bl) with At, Fd & Pl in seral stages; moderate shrub cover of falsebox, spirea, huckleberrryand grouseberry; moderate herb layer of pinegrass, arnica & twinflower; dense cover of feathermosses
Dry site association	Moderately open stands of Fd and Pl; open shrub cover of juniper, spirea, falsebox, grouseberry, and soopalallie; sparse herb layer of pinegrass and kinnikinnick; sparse cover of feathermoss, heron's bill moss and lichens
Cold Air/ Soils association	Closed stands of Sxw on moist sites, and Pl on mesic sites; abundant shrub cover of Trapper's tea, falsebox, grouseberry, huckleberry; moderate herb layer of bunchberry, arnica, bramble; dense feathermosses, heron's bill moss and pelt lichens
Wet site association	Dense stands of Sxw, Bl, Pl, Act (At in seral stages); rich shrub cover of dogwood, alder, devil's club, gooseberry, twinberry; moderate herb layer of oak fern, ladyfern, foamflower, valerian; moderate cover of feathermosses and leafy mosses

Age Classes	Leading Stand Species	% of MSdm
<20	Pli34% Sx12% Bl10% (Fd)	26
20-60	Pli50% Bl30% Sx15% (Fd, At)	12
60-120	Pli50% Fd25% Bl15% Sx10%	22
120+	Pli36 Fd31 Sx25 (Bl)	40

Climate Scenarios

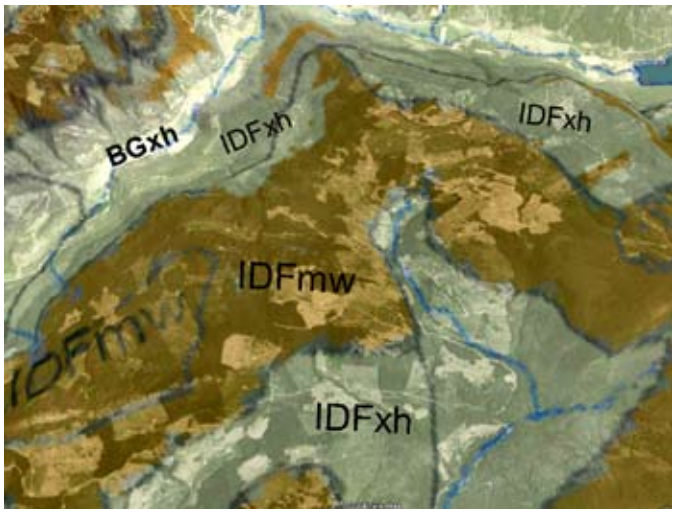
PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% MSdm
Upper	IDFdk	58
Upper boundary areas may have slightly moister conditions		
Mid	IDFmw	38
Upper boundary areas may have slightly moister conditions		
Lower	IDFxh	2
Valley and upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.9	3.9	1.0
mean summer temp. (°C)	13.0	14.3	1.3
mean temp warmest month (°C)	13.8	15.4	1.7
frost free period (days)	73	93	27%
number of frost free days	149	166	11%
mean annual precipitation (mm)	563	585	4%
mean summer precipitation (Jun-Aug) (mm)	263	260	-1%
precipitation as snow (mm)	215	207	-3.5%
annual heat:moisture index	23	24	4%
mean summer heat:moisture index (May-Sept)	53	60	13%

HAD-A1F1 2050 (most change)



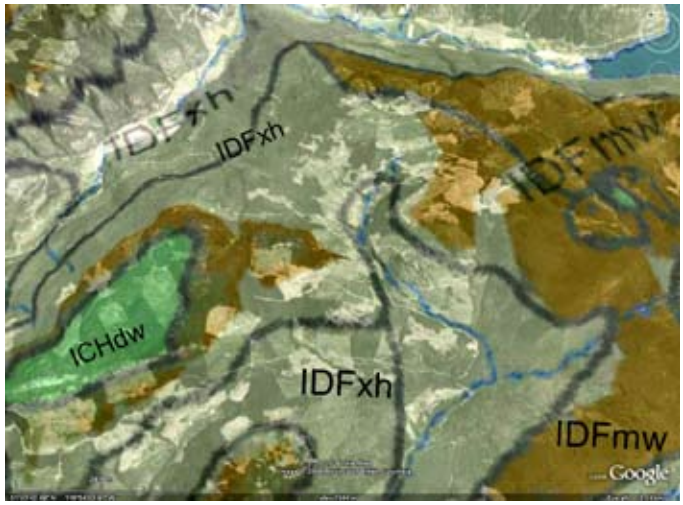
Relative Elevations	Predicted Subzone Climate	% of MSdm
Upper	IDFmw	79
Hills and lower boundary areas may have slightly drier conditions		
Mid	IDFxh	17
Lower	BGxh	4
Upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.9	6.3	3.4
mean summer temp. (°C)	13.0	18.0	5.0
mean temp warmest month (°C)	13.8	19.8	6.1
frost free period (days)	73	113	55%
number of frost free days	149	197	32%
mean annual precipitation	563	575	2%
mean summer precipitation (Jun-Aug)	263	234	-11%
precipitation as snow (mm)	215	171	-20%
annual heat:moisture index	23	29	24%
mean summer heat:moisture index (May-Sept)	53	86	62%

Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)

Overview of Changing Climate focussing on 2050:

General Description

The least-change PCM scenario produces a subzone climate that is best described as a hybrid zone between the IDFdk and the IDFmw, while the most-change HAD scenario should be considerably warmer than the IDFmw with similar precip (except a bit drier in the summer)..

Summary of Ecological Vulnerabilities and Opportunities

INSECTS – Spruce bark beetle is starting to be a bit of a problem for older spruce right now (perhaps two-cycle budworm too). Spruce terminal weevil is also an issue but it is suggested spruce will fight through it.

Regeneration Vulnerabilities and Opportunities

MESIC SITES:

- Promote Fd as suggested on south aspects (right away) and over time more on the north aspects as they gradually warm.
- Over time Fd will be the species of choice on mesic sites.
- Need to de-emphasize Pli in this subzone.
- Consider Lw (again look out for frost), and Py (south slopes).
- Bl is a poor choice here. Bg may have some chance later (beyond 2040 as it warms).
- Some hope for broadleaf species (At) on moister sites (encourage there). Should encourage it in swales (as it occurs in the IDFxh). This will be important for habitat. Also having broadleaf species mixed in will help reduce fire risk.

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Pli – Mostly 40-60 yr old stands in 2050	Mod	Nil	Not clear if bark beetles will be an issue in 40-60 year old stands at 2050. Rusts and other pests may be a greater challenge in younger stands.
Sx	High	Nil	Bark beetle might get considerably worse (check with LM). Also some concern about 2-cycle budworm on older trees.
Fd	Mod	Nil	Ice storms – perhaps problems with breakage. Root disease may become more active. Possible tussock moth.
At	Mod	Nil	Increasing temperature may see some dieback –especially on drier sites.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

MSxk

Short- term Vulnerability = HIGH
Long-term Vulnerability = HIGH

Ecological Narrative for the MSxk through to 2080:

2008 to 2050

The influence of climate change

This subzone is an example of how a single forest health agent can change the timber profile and stand structure over a very short period. The subzone was dominated by stands of lodgepole pine, now either logged or dead. Future forest composition will likely be dominated by lodgepole pine, which is the focus of the present reforestation strategy.

As time progresses with warmer conditions, lodgepole pine will likely move outside of its broad range of ecological tolerance. This will affect vigour and lead to a high risk of future forest health impacts from a range of agents, one of which may be the mountain pine beetle.

Fire is a concern in the current unsalvaged dead pine stands for the next number of years. Once these stands have either been salvaged or they move beyond the most susceptible stages, the threat of fire will be reduced due to the low level of fuels in the newly regenerated forests. This lower fire risk may change soon after 2050.

Estimated future forest condition of stands currently mature

All the lodgepole pine older than 20 years old is either dead or soon to be so. This subzone was dominated by lodgepole pine with only minor amounts of Douglas-fir, spruce, subalpine fir, and aspen (possibly cottonwood on wet sites).

Where it is currently found, Douglas-fir and spruce released by lodgepole pine mortality will increase in size and vigour but will soon show signs of moisture stress on all but the wettest sites. Growth of subalpine fir will stagnate and its role as a future overstory species will be doubtful. The result by 2050 will be a very patchy mosaic of scattered fragments of mature or old timber likely dominated by Douglas-fir, and very small patches of aspen over a landscape mostly covered by young lodgepole pine.

Much of the dead pine has been harvested, yet some will not be salvaged and will remain as a short term fire hazard, especially if lightening storm frequency and intensity increases. As time moves on the risk of large fires diminishes as the hazard declines due to the dominance of young stands.

Estimated future forest condition of young stands

Most of the subzone is located on mesic sites on the Thompson Plateau resulting in similar growing sites and conditions. Young stands are composed primarily of lodgepole pine, with a minor component of spruce, subalpine fir and Douglas-fir. Lodgepole pine was the regeneration species of choice due to its frost tolerance and ability to deal with the cold winters and moderately short, hot summers. Lodgepole pine was planted, or naturally regenerated, where seed was available, over the past 20 years and continues at present.

Up to 2050 it is projected that at least half to the entire subzone will have a climate that it is hotter and drier than the normal range of lodgepole pine, more like the IDFxh where it is not found. Thus, a large proportion of lodgepole pine plantations will be growing in a climate that is not favourable to lodgepole pine. The increase in drought stress will result in lower vigour and increased mortality from a range of potential forest health agents, one of which could be a resurgence of mountain pine beetle.

Conditions will be conducive to increased incidence of tussock moth, potentially impacting young Douglas-fir. Increased spring moisture conditions may offset hotter, drier summers and maintain conditions conducive to comandra and stalactiform rusts. Western gall rust, needlecast, terminal weevil and dwarf mistletoe will likely increase with the overall warmer climate.

Lodgepole pine established on wetter, cooler aspects will have a higher likelihood of prolonged survival. Douglas-fir and ponderosa pine, once established, should be well adapted up to 2050, as will spruce on wetter sites. Subalpine fir will not be well adapted to the future in this subzone. A key element in establishing Douglas-fir will be to avoid frost-induced mortality; trees established beneath overstories of dead pine may have better survival.

2050 to 2080

The influence of climate change

Beyond 2050 and up to 2080, the future within the present MSxk will be one where lodgepole pine is well outside of its ecological tolerances, with much hotter, drier summers, approaching that found in the BGxh.

By 2080 surviving lodgepole pine stands, significantly weakened by drought stress, will be at high risk of mortality, possibly in combination with bark beetles and other forest health agents. The resulting mortality may increase the likelihood of severe fires.

Estimated future forest condition of stands currently mature

At 2080 there will be few old stands, as the subzone will be dominated by 70-90 year old pine. In draws and moisture receiving sites, older Douglas-fir and spruce will be surviving with some difficulty. There will be an increase in open stand conditions on these sites. There will also be concerns regarding control of invasive plants where disturbance from grazing, fire and other activities has occurred.

The dominating pine stands, regenerated after the mountain pine beetle outbreak of the early 2000s, will be declining rapidly and likely experiencing high levels of mortality, in the absence of harvesting or other interventions.

Estimated future forest condition of young stands

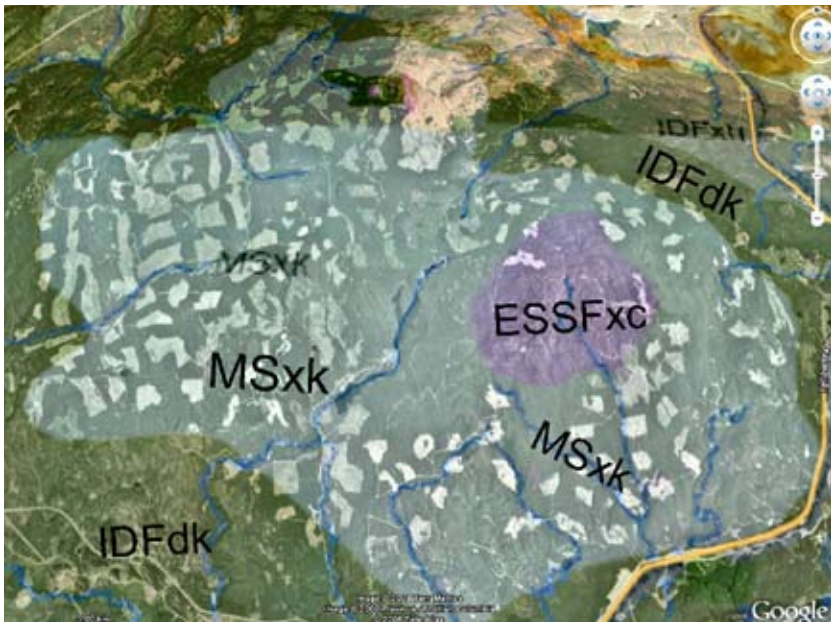
Beyond 2050 to 2080, a number of key parameters for species survival will be impacted. Ponderosa pine will be the lone conifer adapted to drier sites. Douglas-fir will be limited to mesic or moister areas and will require shade for establishment. Lodgepole pine will not be an option as it will be outside of its ecological tolerances.

Vulnerability summary

This subzone will experience a trend away from a lodgepole pine dominated subzone to one suited to ponderosa pine, limited Douglas-fir and an increased proportion of grassland.

CURRENT CONDITIONS

5% of the TSA
11% of the THLB



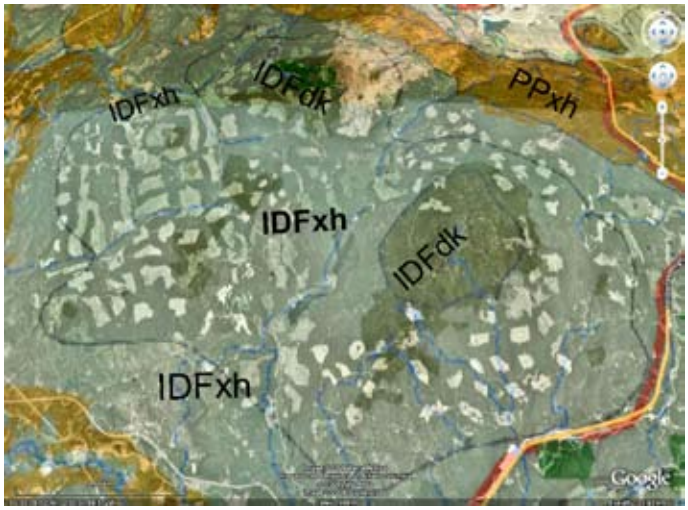
Logan Lk.

Sites Naturally Associated with MSxk	Plant Communities Associated with Current Subzone
Zonal site association	Closed stands of Pl & Sxw (Bl) with At, Pl & Fd in seral stages; moderate shrub cover of soopalallie, utah honeysuckle, spirea, grouseberry; moderate herb layer of pinegrass, arnica, twinflower; dense feathermoss, heron's bill moss and pelt lichens
Dry site association	Moderately open stands of Fd and Pl; open shrub cover of juniper, spirea, grouseberry, and soopalallie; sparse herb layer of pinegrass and kinnikinnick; sparse cover of feathermoss, heron's bill moss and lichens
Cold Air/ Soils association	Closed stands of Sxw on moist sites, and Pl on mesic sites; abundant shrub cover of Trapper's tea, falsebox, grouseberry, huckleberry; moderate herb layer of bunchberry, arnica, bramble; dense feathermosses, heron's bill moss and pelt lichens
Wet site association	Dense stands of Sxw, Pl (Bl, Act) (At in seral stages); rich shrub cover of gooseberry, twinberry, huckleberry, grouseberry, dogwood; moderate herb layer of bunchberry, arnica, twisted stalk, meadowrue; abundant feathermosses, leafy mosses & glow moss

Age Classes	Leading Stand Species	% of MSxk
<20	Pli 85% (Sx, Fd)	14
20-60	Pli 90% (Sx)	7
60-120	Pli 85% (Sx, Fd)	22
120+	Pli 72% Sx 14% Fd 13%	57

Climate Scenarios

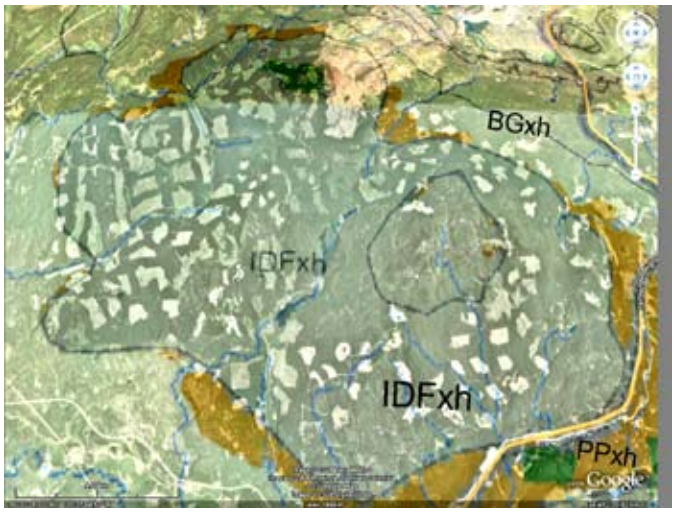
PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% MSxk
Upper	MSxk	2
Mid	IDFdk	52
Valley and upper boundary areas may have slightly moister conditions		
Lower	IDFxh	46
Upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.5	3.5	1.0
mean summer temp. (°C)	12.1	13.4	1.3
mean temp warmest month (°C)	13.2	14.8	1.6
frost free period (days)	73	92	26%
number of frost free days	147	163	11%
mean annual precipitation (mm)	479	499	4%
mean summer precipitation (Jun-Aug) (mm)	224	223	-1%
precipitation as snow (mm)	193	188	-3%
annual heat:moisture index	27	28	4%
mean summer heat:moisture index (May-Sept)	60	68	13%

HAD-A1F1 2050 (most change)



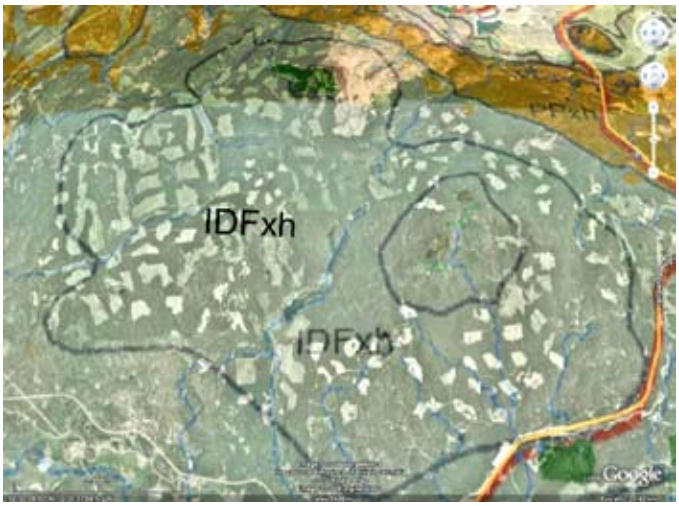
Relative Elevations	Predicted Subzone Climate	% of MSxk
Upper	IDFdk	3
Hills and lower boundary areas may have slightly drier conditions		
Mid	IDFxh	93
Hills and lower boundary areas may have slightly drier conditions		
Lower	BGxh	4

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.5	5.9	3.4
mean summer temp. (°C)	12.1	17.0	4.9
mean temp warmest month (°C)	13.2	19.3	6.1
frost free period (days)	73	113	55%
number of frost free days	147	194	32%
mean annual precipitation	479	491	3%
mean summer precipitation (Jun-Aug)	224	199	-12%
precipitation as snow (mm)	193	155	-20%
annual heat:moisture index	27	33	24%
mean summer heat:moisture index (May-Sept)	60	100	66%

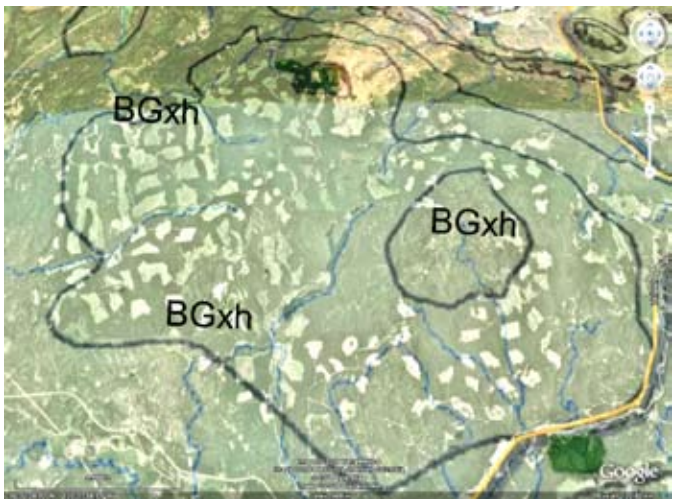
Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate focussing on 2050:

General Description

For the least-change PCM scenario this subzone will be tending toward the IDF, with temperatures slightly closer to the IDFdk than the MSdm (which is also relatively close but slightly cooler in the summer). With the most-change HAD scenario this subzone definitely crosses the line into the IDF climate with temperatures closer to the PP, and moisture similar to the IDFdk in summer but considerably higher in the fall, winter and spring.

Summary of Ecological Vulnerabilities and Opportunities

ROOT DISEASE - Small, fragmented pockets of *Armillaria* continue to exist here but can be delineated and therefore more easily managed. It may become more active here but it is doubtful that increased spread will be a huge problem as this subzone will continue to be dry.

INSECTS - Tussock Moth will increasingly become problematic. Regenerated pine stands may be once again vulnerable to mountain pine beetle in future.

MISTLETOE – It is expected that as the changing climate stresses pine, mistletoe will have significant effects.

RUSTS – Attropellis, western gall and commandra may all increase with the increased moisture forecasted for spring.

FIRE.- As ~90% of the current MSxk is mesic on the plateau, there will soon be much loss of pine due to mountain pine beetle. In the short term there will be significant fire hazard due to the quantity of fines present in pine crowns. Hazard may be high again in fifty years or so when the hotter and drier climate may make subsequent pine stands vulnerable again to pests. At the same time, unsalvaged MPB-killed stems from the current outbreak will be on the ground and present additional fire hazard, although this has not been well quantified.

Regeneration Vulnerabilities and Opportunities

MESIC SITES:

- About half of the beetle-killed stands due to the current outbreak will naturally regenerate to lodgepole pine, especially if salvaged. Pine regeneration will be highly to very highly vulnerable to mortality from a variety of agents as the climate tends toward the IDFxh (lower elevations with PCM or the whole area in HAD). Once it is 40 years old it will likely persist but be stressed.
- With the ongoing loss of pine overwood, there is less chance of natural spruce regeneration. Advanced spruce and subalpine fir regeneration will likely persist, albeit with a struggle.
- The introduction of some ponderosa pine should be attempted on lower slopes (not flats) to avoid frost damage. The susceptibility of ponderosa pine to frost and cold air within this subzone first needs to be determined.
- It is not clear how well western larch would do nor how to best approach it. Low elevation slopes with northern (and perhaps easterly) exposures should provide more moisture, a less harsh climate and a refuge from cold air pooling but this needs to be verified.
- It will be challenging (and risky/potentially costly) to introduce Douglas-fir into this subzone that will soon be dominated by younger pine stands interspersed with minor spruce stands (and a component of dead pine) and where the climate is seen as moving more toward IDFxh. Consider underplanting Douglas-fir into currently fully stocked pine stands that are tall enough to provide some shelter from growing season frosts.

GENERAL STATEMENTS OR CONCERNS FOR REGENERATION:

- Consider western larch (again look out for frost), and ponderosa pine (plant on south slopes).
- Subalpine fir is a poor choice here. Grand fir may have some chance later (beyond 2040 as it warms).
- Aspen should be encouraged in moister sites (as it occurs in the IDFxh) for habitat values and to reduce fire risk.

Maturing / Mature Stand Vulnerabilities

- Management in this subzone will revolve around 40-60 year old pine at 2050 from stands regenerating now after mountain pine beetle. We will have to start logging earlier than normal to start balancing age classes and avoid another catastrophic salvage situation.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

PPxh

Short- term Vulnerability = HIGH
Long-term Vulnerability = HIGH

Ecological Narrative for the PPxh through to 2080:

2008 to 2050

The influence of climate change

This hot and very dry subzone will become hotter and drier in the critical summer months, moving away from a tree - gap dominated mosaic to one where grasslands will dominate. Drought stress will result in widespread mortality in many of the mature and maturing stands over time.

Increased summer temperatures and more frequent prolonged summer droughts will lower vigour of established Douglas-fir and ponderosa pine stands that are already under frequent stress from drought. Mature ponderosa pine are currently disappearing with high levels of mortality from western and mountain pine beetle epidemics. The result will be more grassland ecosystems, especially on south slopes, as seed source and suitable shading will limit ponderosa pine establishment. While wetter sites are not used for timber production in this subzone, they do provide significant habitat for wildlife that will be increasingly vulnerable due to contraction of wet sites and increased mortality in trees and key understory plants.

Fire risk may vary as concentrations of dead trees pass through high risk phases and normal climate cycles continue. However, extended high risk fire seasons may be more common over a period of years. Over time with reduced fuel availability, the risk of forest fires will decrease while the risk of brush or grass fires will remain high, considering proximity to the urban interface. Fire disturbance may hasten the transition to a non-treed ecosystem, possibly encouraging expansion of invasive plant species, many of which are presently established in the subzone.

Estimated future forest condition of stands currently mature

Mature or old tree species diversity in this subzone is currently low, with most sites dominated by Douglas-fir and or dead ponderosa pine. Stands are often open with grassland conditions interspersed as a mosaic. Draws and seepage areas have slightly greater diversity with cottonwood and in some cases aspen mixed with the ponderosa pine and Douglas-fir.

Rare remnant ponderosa pine, surviving the bark beetle epidemic prior to 2010 and some scattered Douglas-fir will remain on mesic and wetter sites. Douglas-fir elsewhere will be very stressed by drought, suffering significant mortality, especially when combined with bark beetle and tussock moth when climate cycles and favourable insect conditions converge. This will result in patchy open, discontinuous, or uneven stand structures on cooler slopes.

Estimated future forest condition of young stands

Young stands have a limited footprint within this subzone as most stands are irregular or multi-aged. With an increase in severity and length of droughts, there is a likelihood of increased stress in both understory and overstory trees.

Between extreme years, both ponderosa pine and Douglas-fir that are established on mesic to wetter sites will experience slower growth rates than the present due to the reduced period of available moisture. Shade will be a key for early regeneration success for both Douglas-fir and ponderosa pine.

2050 to 2080

The influence of climate change

Limiting conditions for tree growth will be exceeded if scenario predictions are met. High stress from drought will increase risk to insects resulting in more dead trees and increased fuel loading which will increase fire risk. Species that are presently located on wetter sites will be marginalized, with survivors limited to sheltered north aspects. Wildlife dependent upon the less common tree species will be affected negatively. Timber management for this subzone will not be an option by the year 2080 under both scenarios.

Estimated future forest condition of stands currently mature

By 2080 forested landscapes will be limited and patchy – found mostly on north slopes, upper elevations and in seepage areas and draws. Grasslands will dominate warm southern and western slopes with isolated surviving trees found in favourable microclimates.

Estimated future forest condition of young stands

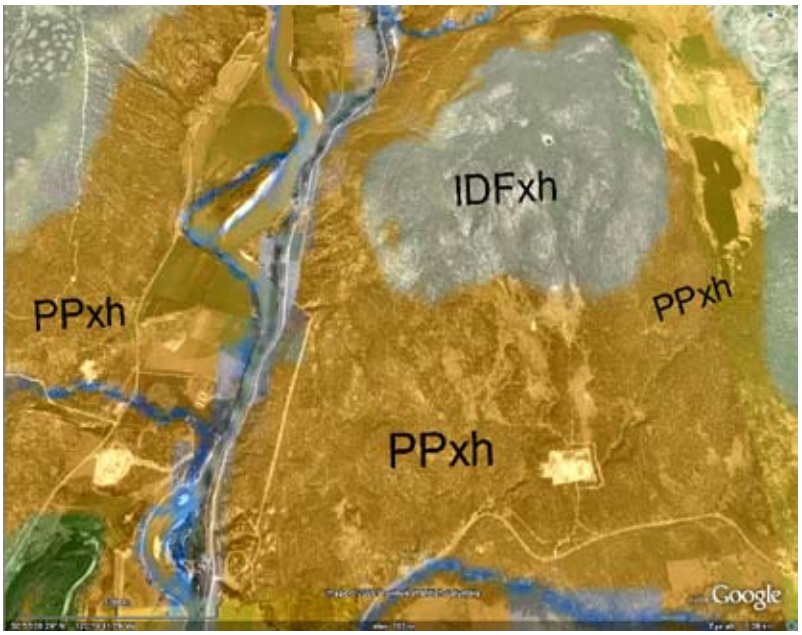
Young stands will not be found, as climate extremes will limit successful establishment. Grasslands will dominate. Proximity to the urban interface will continue to create significant disturbance in these grasslands, contributing to moderate-high levels of invasive plants throughout.

Vulnerability summary

This subzone will experience a trend from a forested condition to a grassland condition from 2008 to 2080.

CURRENT CONDITIONS

3% of the TSA
1% of the THLB



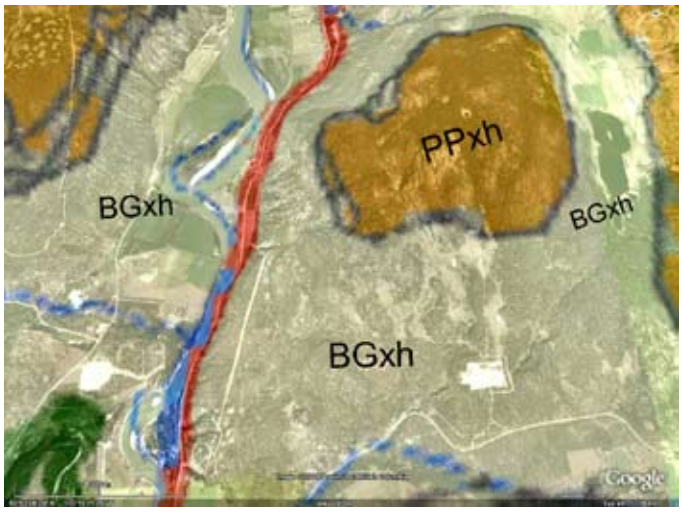
Heffley Cr. / Knouff Lk.

Sites Naturally Associated with PPxh	Plant Communities Associated with Current Subzone
Zonal site association	Open stands of Py (Fd, At); sparse shrub cover of saskatoon, sagebrush or rabbit-brush; sparse herb layer of bluebunch wheatgrass, rough fescue, desert parsley, shrubby penstemon; sparse sidewalk moss and clad lichens
Dry site association	Sparse stands of Py(At); very sparse shrub cover of saskatoon, sagebrush or rabbit-brush; very sparse herb layer of red three-awn, bluebunch wheatgrass, needlegrass, arrow-leaved balsamroot, shrubby penstemon; sparse sidewalk moss and clad lichens
North slope site association	Closed stands of Fd & Py; moderate shrub cover of spirea, saskatoon, oregon grape, snowberry, maple; moderate herb layer of pinegrass, milk-vetch, twinflower; moderate to dense feathermosses, heron's bill moss, ragged moss & pelt lichens
Wet site association	Moderately closed stands of Act, At (Fd); moderate shrub cover of snowberry, maple, rose, dogwood; moderate herb layer of Kentucky bluegrass, pinegrass, wintergreen, twinflower, violet; sparse ragged moss
Grassland sites	Less than 10% tree cover of Py; sparse shrub cover of big sagebrush and rabbit-brush; sparse herb layer of bluebunch wheatgrass, sagewort, balsamroot, silky lupine, rough fescue, pinegrass; very sparse clad lichens and sidewalk moss
Xeric site association	Very open, short Py(Fd); very sparse juniper, spirea, soopalallie, saskatoon; very sparse bluebunch wheatgrass, pinegrass, kinnikinnick, shrubby penstemon, yarrow; sparse sidewalk mosses and clad lichens

Age Classes	Leading Stand Species	% of PPxh
<20	Fd60% Py40%	5
20-60	Fd50% Py50%	1
60-120	Fd60% Py40%	22
120+	Fd60% Py40%	72

Climate Scenarios

PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% PPxh
Upper	PPxh	3
Mid & Lower	BGxh	97
Upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	6.0	7.1	1.1
mean summer temp. (°C)	16.3	17.6	1.3
Mean temp warmest month (°C)	17.6	19.2	1.6
frost free period (days)	119	134	13%
number of frost free days	191	209	9%
mean annual precipitation (mm)	327	342	4%
mean summer precipitation (Jun-Aug) (mm)	156	155	-1%
precipitation as snow (mm)	97	88	-9%
annual heat:moisture index	50	51	2%
mean summer heat: moisture index (May-Sept)	114	126	10%

HAD-A1F1 2050 (most change)

Relative Elevations	Predicted Subzone Climate	% of PPxh
Upper, Mid & Lower	BGxh	100

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	6.0	9.4	3.4
mean summer temp. (°C)	16.3	21.2	4.9
mean temp warmest month (°C)	17.6	23.4	5.9
frost free period (days)	119	156	32%
number of frost free days	191	243	27%
mean annual precipitation	327	335	2%
mean summer precipitation (Jun-Aug)	156	138	-12%
precipitation as snow (mm)	97	74	-24%
annual heat:moisture index	50	59	19%
mean summer heat: moisture index (May-Sept)	114	172	51%

Normal summer heat:moisture index comparisons:
ICHvk – 28; ICHmw – 42; IDFxh – 90; BGxh – 139

Looking Even Farther Ahead:

In 2080 both PCM and the HAD scenarios indicate a climate similar to the BGxh, except even warmer.

Overview of Changing Climate focussing on 2050:

General Description

The temperature will be warmer than the BGxh (at least in the summer) for the bookend scenarios. Precipitation will stay at PPxh levels, except likely a bit higher in spring and fall but less in summer (although still relatively high). With HAD, summer precipitation will drop to 15% less than BGxh (June to Sept.) and the drought index is very close to BG (except it is significantly warmer and fall and spring are a bit moister).

Summary of Ecological Vulnerabilities and Opportunities

DROUGHT – As the average temperature goes up the probability of drought goes up as well. A significant factor for the maintenance of ponderosa pine on grasslands, therefore, will be the timing of summer rains. In southern Mexico, for example, ponderosa pine is maintained by rains in July.

FIRE – There is already a lot of dead ponderosa pine already here, and mortality in Douglas-fir can be expected over time. The fire risk goes up while trees retain dead foliage, then down as the foliage falls off, and up again as trees fall and accumulate on the ground. It is possible that heavier grass cover may result from increased winter and spring rains, which would add more fine fuels. It is unknown whether or not there will be more intense lightning storms in the summers.

Regeneration Vulnerabilities and Opportunities

MESIC SITES and SUBMESIC/SUBXERIC SITES:

- It is not yet known whether ponderosa pine will be able to adapt to anticipated earlier than usual bud flush in spring caused by a warming climate.
- This may be a subzone where we only manage for ponderosa pine on a microsite basis (e.g. moisture receiving ravines) for biodiversity functions and landscape aesthetics. The balance of the area will be grassland.
- The number of adequate growing locations for trees will likely go down. As 30-50% of BC's red and blue listed species occur in this region, this will be a good area to manage for ecological conditions rather than timber. Perhaps consider managing for savannah (scattered trees with grasslands) using introduced pinyon pine or juniper (very hardy).
- Some mixed stands of ponderosa pine and Douglas-fir could be encouraged for wildife habitat purposes.

Maturing / Mature Stand Vulnerabilities

- Ponderosa pine stands are vanishing quickly due to the current mountain pine beetle epidemic. Douglas-fir is found only on the northern and eastern slopes where it is more protected.

ECOLOGICAL SUMMARY AND NARRATIVE for the Kamloops Future Forest Strategy

SBSmm

Short- term Vulnerability = MOD
Long-term Vulnerability = MOD - HIGH

Ecological Narrative for the SBSmm through to 2080:

2008 to 2050

The influence of climate change

This subzone will likely see moderate impacts on existing stands up to 2050. Spruce and established Douglas-fir may see a slight to moderate increase in vigour and growth as climate warms and the growing season lengthens. Summers may be slightly drier, only impacting stands in extreme years. Precipitation as snow will remain relatively stable.

An increase in mature tree growth may occur due to milder temperatures, increased growing season, and continued moderate moisture inputs. This growth increase must be tempered as it carries some uncertainty. Freezing damage to growing tissues may occur as tree phenology becomes desynchronized with climate. Localized storm damage associated with climate extremes, combined with infestations of bark beetles (spruce bark beetle or western balsam bark beetle), may provide localized impacts periodically. Mortality from *Armillaria* will likely increase over time, although the extent of these impacts will be remain fragmented and localized.

The SBSmm has a relatively frequent return interval for stand replacing fires - about 125 years as an NDT3 subzone. As the climate warms, these fire events could be larger and more intense depending on fuels, with some higher risks due to localized periodic mortality. This trend may be especially evident in the lower portion of this subzone. Increased fuels from mortality in mature stands up to 2050 are anticipated to be small to insignificant, except in areas with higher levels of unsalvaged dead pine.

Increased fuel loading due to mortality in this subzone is more likely at lower elevations due to *Armillaria*, bark beetles and other insects in spruce, subalpine fir and to a lesser extent Douglas-fir. Scattered patches of aspen exist throughout in seral stands. While these may expand somewhat, they will have a relatively minor impact on modifying rate of spread should a wildfire occur.

Estimated future forest condition of stands currently mature

Lodgepole pine mortality will now result in more open stands of spruce, subalpine fir and Douglas-fir with brushy gaps. As well, warming temperatures will gradually stress subalpine fir, creating additional gaps from resulting mortality. With overhead seed sources, a multilayered structure may result. Douglas-fir and spruce could see an increase in vigour (and subsequently improved growth), particularly on north and east aspects where current growth is slow. Large wildfires may further increase early seral stands containing lodgepole pine and aspen.

Estimated future forest condition of young stands

Currently, many young stands are in lodgepole pine. These stands should remain vigourous and reasonably healthy up to and beyond 2050, although there will be growth impacts from western gall rust and comandra blister rust in years with higher spring precipitation. Localized mortality gaps from *Armillaria* will increase slightly. Growth and vigour of all young conifer stands may improve up to 2050. However, spruce will see a greater risk from terminal weevil with increasing temperatures, slowing growth throughout this subzone.

2050 to 2080

The influence of climate change

Post 2050 temperatures could be warm enough to favour Douglas-fir and stress established spruce (IDF-like), although precipitation may remain relatively high. Lodgepole pine will remain well-adapted at higher elevations and on cooler aspects, but may struggle with a host of damaging agents on warmer aspects at lower elevations. Subalpine fir will likely be outside of its ecological niche. Mortality events from both weather and insects will likely become less predictable and more severe. *Armillaria* losses may further increase but will remain somewhat fragmented.

Fuels building from mortality in this subzone may keep the risk of intense large wildfires at high levels. Large lightening-caused fire could be more frequent, especially in warm cycles when summer drought is extended. Beyond 2050 warming will reduce the amount of snowpack and length of snow season at lower elevations.

Estimated future forest condition of stands currently mature

Old stands will consist of fragmented remnants of forests impacted by mountain pine beetle and missed by large wildfires. Surviving Douglas-fir will remain vigourous on most sites except those prone to severe drought, such as steep south slopes and ridge tops. Spruce and subalpine fir as a stand component will be under stress from the warmer climate, resulting in reduced growth and increased mortality. The resulting stands will be two storied and gappy with patches of Douglas-fir and spruce (on moister sites) mixed with brush in the understory. Maturing lodgepole pine stands established early in the century will see spreading localized infestations of bark beetles adding to mortality, especially on warmer, drier sites where they will be under increased stress. If larch were previously established it will be well adapted on mesic sites. Ponderosa pine if previously established will be well adapted especially on warmer aspects at lower elevations where grassland patches may start to emerge. Aspen will thrive throughout the subzone while birch may be more prominent on cooler aspects as it moves up from lower elevations.

Estimated future forest condition of young stands

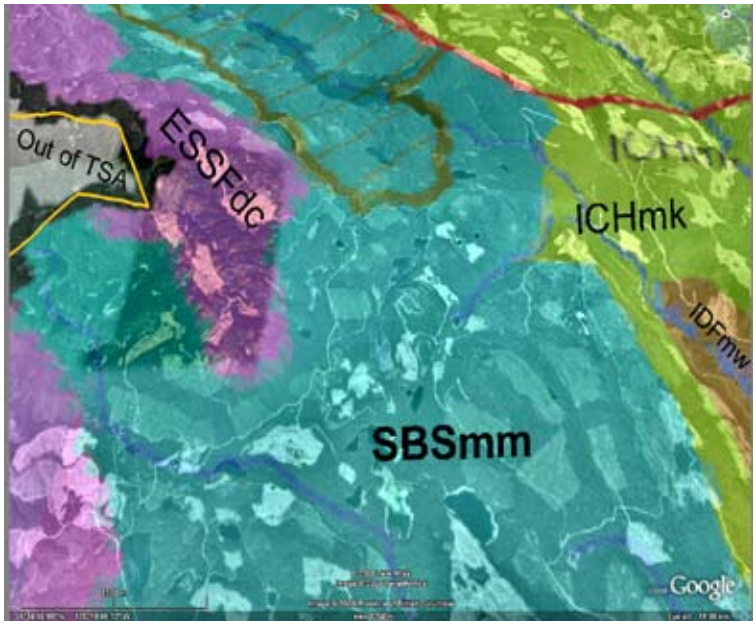
Early seral stands could be quite prominent through this subzone due to large fires. Douglas-fir will grow well on a range of sites, although impacts from *Armillaria* and periodic budworm outbreaks will be evident. On warmer aspects ponderosa pine will establish and grow well and Douglas-fir will require some shelter for establishment. Subalpine fir regeneration will be rare, and spruce will be confined to wetter sites. Young lodgepole pine may see significant mortality due to increased drought stress and a combination of insects and rusts, reducing its prominence in young stands. Aspen will maintain a strong presence in the early seral stands dominating the landscape.

Vulnerability summary

This subzone will change from one where spruce, subalpine fir and lodgepole pine are well adapted to one where Douglas-fir will be more suitable. The shift will be somewhat gradual up to 2050 with precipitation remaining fairly stable as temperature increases. Changes after 2050 will be more dramatic, with increased stress and mortality in mature stands, a higher overall fire risk and challenges for regeneration.

CURRENT CONDITIONS

2% of the TSA
3% of the THLB



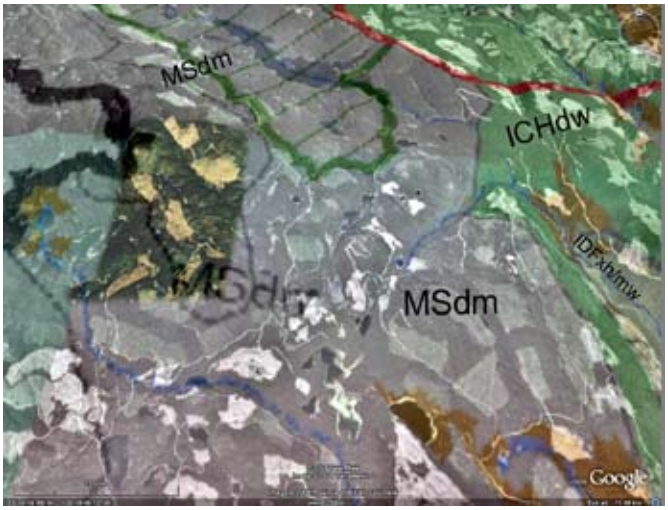
Nehalliston Ck. / Taweel Lk.

Sites Naturally Associated with SBSmm	Plant Communities Associated with Current Subzone
Zonal site association	**Trees:** Sxw, Pl & Bl dominate; At, Pl and minor Swx in seral stages; **Shrubs:** Huckleberry, falsebox, spirea, soopalallie; **Herbs:** twinflower, queen's cup, bramble, bunchberry, one-sided wintergreen: dense feathermosses
South slope site associations	**Trees:** Pl dominates with minor At & Sxw; more At in seral stages; **Shrubs:** Huckleberry falsebox, spirea, rose, saskatoon & soopalallie; **Herbs**: Pinegrass, bunchberry, dwarf blueberry, arctic lupine; sparse feathermoss, heron's bill moss, cladina and pelt lichens
North slope site associations	See Zonal site association
Moist to Wet site association (seepages, streams and fluvial sites)	**Trees:** Swx with minor Bl; Act on floodplains; more Pl & At in seral stages; **Shrubs:** Gooseberry, thinmleberry, twinberry, huckleberry, blueberry, devil's slub, dogwood: **Herbs:** Oak fern, lady fern, foamflower, bramble, twistedstalks: moderate cover of feathermosses

Age Classes	Leading Stand Species	% of SBSmm
<20	Pl60% Sx30% (Bl Fd)	27
20-60	Pl47% Bl47% (Sx)	7
60-120	Pl60% Sx20% Bl10% (Fd, At)	25
120+	Pl43% Sx42% Fd10% (Bl)	41

Climate Scenarios

PCM-B1 2050 (least change)



Relative Elevations	Predicted Subzone Climate	% SBSmm
Upper & Mid	MSdm	80
Rarely, a few areas may have slightly moister conditions		
Lower	IDFmw	20
Most valleys and upper boundary areas may have slightly moister conditions		

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.3	3.3	1.0
mean summer temp. (°C)	12.0	13.3	1.3
mean temp warmest month (°C)	13.0	14.7	1.7
frost free period (days)	63	82	31
number of frost free days	140	157	12
mean annual precipitation (mm)	709	740	4%
mean summer precipitation (Jun-Aug) (mm)	323	320	-1%
precipitation as snow (mm)	284	280	-2%
annual heat:moisture index	18	19	4%
mean summer heat:moisture index (May-Sept)	41	46	14%

HAD-A1F1 2050 (most change)

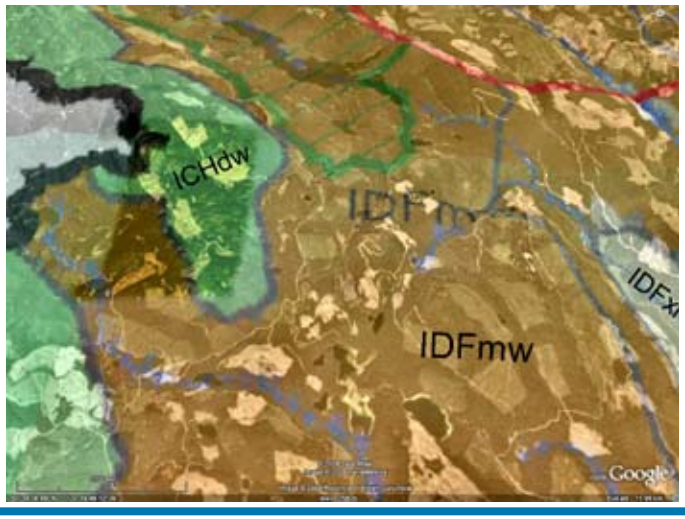
Relative Elevations	Predicted Subzone Climate	% of SBSmm
Upper & Mid	IDFmw	98
Lower	IDFxh	2

Annual Climate Variables	Now	2050	Change
mean annual temp. (°C)	2.3	5.5	3.2
mean summer temp. (°C)	12.0	16.7	4.7
mean temp warmest month (°C)	13.0	18.6	5.5
frost free period (days)	63	104	65
number of frost free days	140	186	33
mean annual precipitation	709	729	3%
mean summer precipitation (Jun-Aug)	323	290	-10%
precipitation as snow (mm)	284	238	-16%
annual heat:moisture index	18	22	23%
mean summer heat:moisture index (May-Sept)	41	65	59%

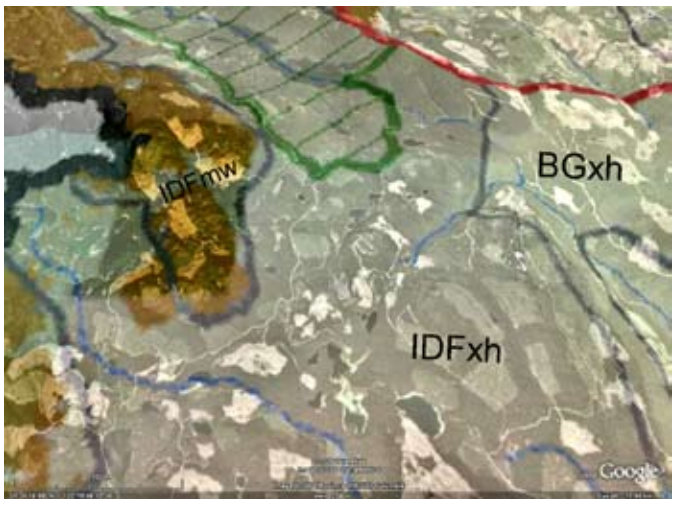
Normal summer heat:moisture index comparisons:
ICHvk – 21-33; ICHmw – 28-56; IDFxh – 76-96; BGxh – 135-139

Looking Even Farther Ahead:

PCM-B1 2080 (least change)



HAD-A1F1 2080 (most change)



Overview of Changing Climate focussing on 2050:

General Description

Higher temperatures push this subzone into a subzone climate that is similar to something between the MSdm and the IDFmw, except that the climate will be moister than either subzone.

Summary of Ecological Vulnerabilities and Opportunities

ROOT DISEASE – Some pockets of *Armillaria* will likely start to show up.

INSECTS – May see increased problems with bark beetles and budworm.

FIRE– Fire risk will not increase appreciably unless insects reach epidemic proportions (to significantly increase fuel loads) which seems less likely than in other subzones.

Regeneration Vulnerabilities and Opportunities

ALL SITES:

- Increased use of Douglas-fir is recommended. Spruce will likely be fine at least up to 2030 when the climate trajectory for the SBSmm will be clearer. Spruce might need to be concentrated on cooler and moister sites after that time.
- Lodgepole pine will be acceptable for continued use but should be balanced with other species.
- Consider planting western larch at lower elevations on warmer aspects with slopes that drain cold air well. Over time ponderosa pine should be considered in a similar manner.

Maturing / Mature Stand Vulnerabilities

Species	Vulnerability Class [1]	Opportunity Class [2]	Rationale
Sx	Low - Mod	Nil - Minor	Possibly an increase in productivity, but at the extreme (most change HAD) the spruce may be slightly stressed and more susceptible to insects – possibly bark beetles.
Fd	Low	Minor - Significant	Fd should likely increase its productivity significantly here over time. This will depend on impacts from insects and disease.
Pli	Low - Mod	Minor - Nil	Likely some increase in productivity, but could be offset by increased losses to a greater range of pests.
At	Low	Minor	At should increase in productivity and possibly quality.

[1] **Vulnerability Classes**
Low – Stands will suffer minor losses due to climate change.
Mod – likely will suffer more than current losses, but will be manageable losses and or secondary risks (fire etc.)
High – likely will suffer signficant losses or incur high secondary risks, but catastrophic losses unlikely.
Very High – likelihood for catastrophic losses are high.

[2] **Opportunity Classes**
Nil – No opportunity to enhance growth.
Minor – Minor growth enhancement likely.
Significant – significant growth enhancement likely.