Ecologically based decision matrix for determining response[1] to fire in the Northern Interior Forest Region

All information required in the decision matrix is found on the attached map.

1. Identify the BEC (Biogeoclimatic Ecosystem Classification) subzone in which the fire is located using the accompanying Decision Matrix Map. The website: http://www.for.gov.bc.ca/HRE/becweb/resources/classificationreports/subzones/index.html contains descriptions of each BEC subzone. Refer to Appendix 1 for the descriptive subzone name.

2. Determine Natural Disturbance Type (NDT):

Table 1: Natural Disturbance Type categories for the northern British Columbia and the BEC subzones contained within each type. NDT 4 is not included in this list as no ecosystems in the Northern Interior Forest Region fall within this disturbance type.

NDT 1: Rare stand initiating events				
CWHvh2	CWHvm	CWHvm1	CWHvm2	CWHwm
ESSFwc3	ESSFwk1	ESSFwk2	ESSFwv	
ICHvc	ICHvk2	ICHwk3	ICHwk4	
MHmm1	MHmm2	MHun	MHwh1	
NDT 2: Infrequent stand initiating events				
CWHws1	CWHws2			
ESSFmc	ESSFmk	ESSFmm1	ESSFmv1	ESSFmv2
ESSFmv3	ESSFmv4	ESSFxv1		
ICHmc1	ICHmc1a	ICHmc2	ICHwc2	
SBSvk2	SBSwk1	SBSwk2		
SWBdk2	SWBmk	SWBmks	SWBun	SWBvk
NDT 3: Frequent stand initiating events				
BWBSdk1	BWBSdk2	BWBSmw1	BWBSmw2	BWBSun
BWBSvk	BWBSwk1	BWBSwk2	BWBSwk3	
MSxv				
SBPSdc	SBPSmc	SBPSmk		
SBSdk	SBSdw1	SBSdw2	SBSdw3	SBSmc2
SBSmc3	SBSmh	SBSmk1	SBSmk2	SBSmw
SBSun	SBSwk3	SBSwk3a		
NDT 5: Alpine tundra and subalpine parkland				
BAFAun	BAFAunp			

[1] This Decision Matrix is based only on broad ecological factors, it does not consider or relate to other values on the landscape (example: Timber Supply, Wildlife Habitat, Species at Risk, or Human Improvements). All other values must be considered in making a response decision.

CMAun	CMAunp			
ESSFmkp	ESSFmmp	ESSFmvp	ESSFwcp	ESSFwvp
ESSFmcp				
IMAun				
MHmmp				

3. Is the stand in NDT 5?
   a. Yes - Modified Response
   b. No – move on to Step 4
4. Area in Mature and Old Forest:
   a. Identify the landscape unit within which the fire is located (refer to the Decision Matrix map).
   b. Determine the current percent of mature and old forest remaining within the BEC subzone in the landscape unit in which the fire is located (refer to the table on the Decision Matrix map).
   c. Assess the age of the stands within which the fire is expected to burn. Table 2 contains the age criteria for mature and old forest by NDT type.

Table 2. Age criteria for mature and old forest.

NDT	Age Criteria for Mature and Old Forest
1	greater than 140yr old (age class 8 or older)
2	greater than 140yr old (age class 8 or older)
3	greater than 120yr old (age class 7 or older)

   d. Is the fire likely to reduce the amount of mature and old forest on the landscape below the minimum level*?
      i. Yes – Suppression
      ii. No – Modified Response

*Refer to Tables 3 through 5 to identify the minimum proportion of mature and old forest for the given NDT Type and BEC subzone that the fire is located within. Compare this value to the proportion currently existing within the landscape unit (found on the attached map).

Table 3. NDT 1 Ecosystems with rare stand-initiating events

Subzone	Average Fire Size (ha)[2]	Maximum Fire Size (ha)[2]	Mean event interval (yrs)	Recommended minimum proportion of mature and old forest (older than 140yr)
CWHvh2, CWHvm, CWHvm1, CWHvm2, CWHwm	50 – 500	>500	250[3]	29%
ICHvc, ICHwk4	150 – 500	> 25 000	250[3]	29%
MHmm1, MHmm2, MHun, MHwh1	50 – 150	150 – 500	350[3]	34%
ESSFwv	50 – 500	10 000	350[3]	34%
ESSFwc3	50 – 500	10 000	800-900[4]	42%
ESSFwk1	50 – 500	10 000	800[4]	42%
ESSFwk2	50 – 500	10 000	800-900[4]	42%
ICHvk2, ICHwk3	150 – 500	> 25 000	600[4]	40%

Table 4. NDT 2 Ecosystems with infrequent stand-initiating events

Subzone	Average Fire Size (ha)[2]	Maximum Fire Size (ha)[2]	Mean event interval (yrs)	Recommended minimum proportion of mature and old forest (older than 140yr)
CWHws1, CWHws2	50 - 500	>500	200[3]	25%
ICHmc1, ICHmc1a, ICHmc2, ICHwc	150 - 500	> 25 000	200[3]	25%
ESSFmk, ESSFxv1	50 – 500	10 000	200[3]	25%
ESSFmc	50 – 500	10 000	300[4]	31%
ESSFmm1	50 – 500	10 000	300[4]	31%
ESSFmv1	50 – 500	10 000	200[4]	25%
ESSFmv2	50 – 500	10 000	150[4]	20%
ESSFmv3	50 – 500	10 000	200-300[4]	29%
ESSFmv4	50 – 500	10 000	300[4]	31%
SBSvk	50 – 500	15 000	600-900[4]	41%

[2] Based on "Typical Historic Patterns of Wildfire Disturbance by Biogeoclimatic Zone." A one page addition to the biogeoclimatic zones of B.C. map, published by Protection Branch, Ministry of Forests, Victoria, B.C. in 1992. Original source: a table contributed by John Parminter to "Old-growth forests: problem analysis" by Evelyn Hamilton and Alison Nicholson. Published by Research Branch, Ministry of Forests, Victoria, B.C. in 1990. vi + 104 p.
[3] Biodiversity Guidebook British Columbia Ministry of Forests and British Columbia Ministry of Environment, Lands and Parks. 1995
[4] DeLong. 1998.

SBSwk1	50 – 500	15 000	220-400[4]	32%
SBSwk2	50 – 500	15 000	120[4]	16%
All SWB subzones except SWBmk	150 – 2000	> 5000	200[3]	25%
SWBmk	150 – 2000	> 5000	180[4]	23%

Table 5. NDT 3 Ecosystems with frequent stand-initiating events

Subzone	Average Fire Size (ha)[2]	Maximum Fire Size (ha)[2]	Mean event interval (yrs)	Recommended minimum proportion of mature and old forest (older than 120yr)
BWBSdk1	3000 – 10 000	200 000	120-180[4]	22%
BWBSdk2	3000 – 10 000	200 000	180[4]	26%
BWBSmw1	3000 – 10 000	200 000	100[4]	15%
BWBSmw2	3000 – 10 000	200 000	100-200[4]	22%
BWBSun, BWBSvk, BWBSwk3	3000 – 10 000	200 000	100[3]	15%
BWBSwk1, BWBSwk2	3000 – 10 000	200 000	120[4]	18%
MSxv	50 – 500	> 5000	150[3]	22%
All SBPS subzones	50 – 500	> 1000	100[3]	15%
SBSdh	50 – 500	15 000	150[4]	22%
SBSdk, SBSdw2, SBSdw3, SBSmc2, SBSmc3, SBSmw, SBSwk3a	50 – 500	15 000	100[4]	15%
SBSdw1, SBSmh, SBSun	50 – 500	15 000	125[3]	19%
SBSmk1	50 – 500	15 000	100-120[4]	17%
SBSmk2, SBSwk3	50 – 500	15 000	120[4]	18%

Rationale for the Decision Criteria

Developing a concrete definition or decision matrix to determine where fire is ecologically 'good' is challenging and requires applies a human value to a naturally occurring ecological process. Key to conserving and maintaining functioning and productive ecosystems is to maintain the components and processes that make up these ecosystems (Jensen and McPherson 2008, Campbell et al. 2009, Banner pers. comm. 2010). Since nearly all ecosystems in northern British Columbia have developed with fire as a key component and ecosystem process (Parminter 1991), maintaining fire is critical from an ecological perspective. In the majority of cases wildfire is beneficial to the ecosystem and should be maintained wherever possible and in some instances encouraged (i.e. fire dependent ecosystems such as grasslands). However, in northern British Columbia, there is one primary situation in which ecologists agree that risks to the ecosystem posed by fire may outweigh the benefits. This is the case where a limited amount of mature and old forest remains on the landscape and the wildfire threatens this forest. This forms the primary decision criterion in the matrix: an assessment of the potential of the wildfire to reduce the total amount of old and mature forest on the landscape below a minimum threshold. Other sensitive components of the ecosystem such as species at risk and critical wildlife habitat may also be threatened by fire. However, these aspects of the ecosystem are considered through other processes within fire management planning.

The following sections present the rationale behind the decision matrix and discuss ecological factors considered in the development of the matrix.

Minimum requirement for Mature and Old Forests

A basic assumption behind ecosystem management is that the further an ecosystem is altered from the natural range of conditions to which it has adapted and developed, the higher the risk to biodiversity (BC MSRM 2004). There are different measures that may be used in ecosystem management to assess whether the current state of an ecosystem falls within the natural range of variability (NRV) of that ecosystem or conversely, that there is a risk to biodiversity. One that has been used in Timber Supply reviews and by the ecosystem-based management approach developed for the Great Bear Rainforest is a comparison of the amount of old forest remaining on a landscape to the amount of old forest that would naturally occur on that landscape without human intervention. These processes have established targets for the minimum amount of old forest to be retained on a landscape as a percentage of that which would naturally occur (BCMSRM 2004, Price et al. 2009). This decision matrix utilizes a similar application of a minimum threshold for the amount of mature and old forest to be maintained on a landscape scale.

There is abundant evidence in the literature that thresholds exist for the amount of habitat required to support certain ecosystem components. However, there is limited consensus on how much habitat is required to avoid crossing a threshold, beyond an agreement that the amount will vary among organisms and across ecosystems (Price et al. 2009). Price et al. 2007 conducted a review of studies on ecological thresholds. In general the results from this review and other work suggest that above a threshold of 70% of the minimum range of natural variation, risk to biodiversity is low. When retention of old forest falls below 30% of the minimum range of natural variation, risk to biodiversity is high. For the purpose of developing this decision matrix, the average threshold value of 50% was used as the guideline for determining the desired minimum level of mature and old forest for a given area of biogeoclimatic subzone located within a landscape unit. If the amount of old and mature forest within the area of the subzone located within the landscape unit, falls below this threshold value, it is recommended to strive to maintain the remaining mature and old forest and suppress fires that threaten further loss of old forest.

The amount of old and mature forest that would naturally occur on a landscape, given a specific fire return interval, was calculated using the negative exponential equation presented by Johnson and Van Wagner (1985). This equation uses the fire cycle to directly calculate the area of forest remaining at a given time.

Natural Disturbance Type 5 - Alpine tundra and subalpine parkland

Natural Disturbance Type 5 encompasses alpine and subalpine parkland ecosystems. Major stand initiating events such as wildfire are rare in this disturbance type. Prior to early settlement it was expected that the majority of the landscape encompassed by this disturbance type was in a climax community. The ecosystems in this disturbance type occur above or immediately below treeline, and the minimal vegetation experiences very harsh environmental conditions. Therefore, although wildfire is rare, when fire occurs, the effect on the local vegetation communities can be dramatic and cause long-tem shifts in the position of the tree line and vegetation communities (Ministry of Forests and Ministry of Environment, Lands, and Parks 1995). However at a landscape scale, wildfire in this disturbance type is not considered a response priority due to the rare occurrence of fire and isolated local effect (Hicks, Banner pers. comm.)

Climate Change and Carbon Emissions

Wildfire is an ecological process that is key to maintaining ecosystem health, function and productivity. Weighing the importance of maintaining fire within the ecosystem against the impact of carbon emissions from fire that could contribute to climate change and thereby threaten or change the ecosystem is complicated. In order to minimize the impact of carbon emissions from fire, local ecologists have emphasized the importance of maintaining two forest types with high carbon storage implications (Pojar, Haeussler, Banner pers. comm.). These are: young, rapidly growing forests and moist, rich, high productivity forest types. Young forests grow rapidly and sequester considerable amounts of carbon. Moist, rich, high productivity forests have the capacity to store large quantities carbon at all stand ages.

Young rapidly growing forests will generally be given high priority for protection due to timber values considered in other aspects of the fire response decision process . Although the protection of moist, high productivity forest types is not explicitly stated, these forest types tend to be ecosystems with long fire return intervals (NDT 1 and some areas of NDT 2) which reflect the low risk of fire occurring in these types. Therefore the occurrence of fire in these ecosystems is generally minimal to infrequent, fire size is small, and the emission of carbon is reflected similarly. Fire occurrence and area burned in these types should be monitored over time. If fire frequency or area burned increases substantially, a greater degree of protection of these forest types should be considered.

Mountain Pine Beetle

The mountain pine beetle (MPB) has affected vast areas of northern British Columbia's forests. However, the mortality of pine is not currently reflected in the provincial VRI inventory mapping. Therefore, when considering how much mature and old forest remains on a landscape with considerable MPB attack (Step 5), the amount of live old forest may appear to be greater than actually present as the current mapping uses VRI data. Without considerable study and surveying effort, it is difficult to assign an age class or comparable value to MPB attacked stands. A significant portion of stands with MPB attack may still contain a significant proportion of live trees of other species both in the canopy and the subcanopy (secondary structure). Depending upon the degree of MPB attack and the amount of live trees remaining, these stands may or may not provide the same ecosystem function and services as old live stands.

An solution may be to work with GIS analysts to incorporate MPB impact mapping from the Forest Analysis and Inventory Branch (updated annually) to the decision matrix map. This may allow the differentiation of live and dead stands on the landscape. As this project moves forward and the decision matrix is applied to the entire Northern Interior Forest Region and areas where MPB attack is greater, the MPB impact mapping should be used in the development of the attached Decision Matrix map. The impact map could overlay the VRI data so that all pine stands within the MPB impact zone would be removed from the mature and old age classes. This would allow fire managers to estimate the remaining amount and location of live mature and old forest on the landscape and determine whether this could be protected through fire suppression.

Appendix 1

BAFA	**Boreal Altai Fescue Alpine**
un	Undifferentiated
unp	Undifferentiated and Parkland
BWBS	**Boreal White and Black Spruce**
dk1	Stikine Dry Cool
dk2	Liard Dry Cool
mw1	Peace Moist Warm
mw2	Fort Nelson Moist Warm
un	Undifferentiated
vk	Very Wet Cool
wk1	Murray Wet Cool
wk2	Graham Wet Cool
wk3	Kledo Wet Cool
CMA	**Coastal Mountain-heather Alpine**
un	Undifferentiated
unp	Undifferentiated and Parkland
CWH	**Coastal Western Hemlock**
vh2	Central Very Wet Hypermaritime
vm	Very Wet Maritime

ICH	**Interior Cedar – Hemlock**
mc1	Nass Moist Cold
mc1a	Nass Moist Cold - Amabilis fir phase
mc2	Hazelton Moist Cold
vc	Very Wet Cold
vk2	Slim Very Wet Cool
wc	Wet Cold
wk3	Goat Wet Cool
wk4	Cariboo Wet Cool
IMA	**Interior Mountain-heather Alpine**
Un	Undifferentiated
MH	**Mountain Hemlock**
mm1	Windward Moist Maritime
mm2	Leeward Moist Maritime
mmp	Moist Maritime Parkland
un	Undifferentiated
wh1	Windward Wet Hypermaritime
MS	**Montane Spruce**
xv	Very Dry Very Cold

vm1	Submontane Very Wet Maritime
vm2	Montane Very Wet Maritime
wm	Wet Maritime
ws1	Submontane Wet Submaritime
ws2	Montane Wet Submaritime
ESSF	**Engelmann Spruce -- Subalpine Fir**
mc	Moist Cold
mcp	Moist Cold Parkland
mk	Moist Cool
mkp	Moist Cool Parkland
mm1	Raush Moist Mild
mmp	Moist Mild Parkland
mv1	Nechako Moist Very Cold
mv2	Bullmoose Moist Very Cold
mv3	Omineca Moist Very Cold
mv4	Graham Moist Very Cold
mvp	Moist Very Cold Parkland
wc3	Cariboo Wet Cold
wcp	Wet Cold Parkland
wk1	Cariboo Wet Cool
wk2	Misinchinka Wet Cool
wv	Wet Very Cold
wvp	Wet Very Cold Parkland
xv1	West Chilcotin Very Dry Very Cold

SBPS	**Sub-Boreal Pine -- Spruce**
dc	Dry Cold
mc	Moist Cold
mk	Moist Cool
SBS	**Sub-Boreal Spruce**
dk	Dry Cool
dw1	Horsefly Dry Warm
dw2	Blackwater Dry Warm
dw3	Stuart Dry Warm
mc2	Babine Moist Cold
mc3	Kluskus Moist Cold
mh	Moist Hot
mk1	Mossvale Moist Cool
mk2	Williston Moist Cool
mw	Moist Warm
un	Undifferentiated
vk	Very Wet Cool
wk1	Willow Wet Cool
wk2	Finlay-Peace Wet Cool
wk3	Takla Wet Cool
wk3a	Takla Wet Cool - Douglas-fir phase
SWB	**Spruce -- Willow – Birch**
dk	Dry Cool
mk	Moist Cool
mks	Moist Cool Scrub
un	Undifferentiated
vk	Very Wet Cool