Fire Management Stocking Standards Guidance Document

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Contents

1.0 Stocking Standards Generally

Stocking standards provide the basic linkage between the harvest of a forest stand and the regeneration of a new stand and are a required element of forest stewardship plans under the *Forest and Range Practices Act* (FRPA). In the context of reforestation in British Columbia (BC):

"Stocking Standards means the tree stocking standards that apply when (a) establishing a free growing stand or (b) meeting the requirements of *Forest Planning and Practices Regulation* (FPPR) section 44 - covers commercial thinning, intermediate cuts and harvesting for special forest products".

As such stocking standards typically describe two key elements including:

1. A description of the regeneration. The description of the regeneration includes a list of ecological suitable species, stand density (target number and minimum number per hectare), minimum inter-tree distance, free growing height and height to brush (i.e. competition) ratio.

2. A description of the remaining overstory if it is intended to contribute to stocking (e.g., partial harvest, standard under FPPR 44). This typically includes description of residual density (e.g., maximum and minimum basal area), a listing of ecologically suitable species and appropriate leave tree criteria.

Stocking standards also include a description of where and when the standard would be applied (e.g., situations and circumstances).

Stocking standard guidance for even-aged management has been developed for subzones and site series within the biogeoclimatic ecosystem classification (BEC) system used within BC for those BEC types that produced commercially valuable timber. In addition, stocking standard guidance has been developed for special considerations including; habitat (e.g. grizzly bear habitat), multistoried stands (e.g., single tree selection), single entry dispersed retention, broadleaf management and different harvest strategies. Standards for these different purposes have been developed independently or from modified even-aged standards. Likewise, fire management stocking standard(s) will be developed as a modification of existing even-aged or multistoried standards with an appropriate rationale.

The *Forest Planning and Practices Regulation* (FPPR) section 26 (5) allows the Minister to approve stocking standards provided the regeneration date and stocking standards are reasonable with respect to future timber supply from the area.

2.0 The Fire Management Stocking Standard

The purpose of a fire management stocking standard is to develop and maintain forest stand conditions that achieve fire management objectives. This commonly means reducing fire behaviour by reducing **likelihood of crown fire and/or fast-moving high intensity ground fire**. Forest stands are not static and fire management stocking standards seek to enable or achieve fire management objectives as the forest stand changes. For this reason maintenance of fire management stocking standards is linked to silvicultural activities by industry or government planned through time for a particular stand.

A resulting fire management stocking standard combines in an effective way a number of sometimes complimentary (e.g. broadleaf management and reduced fire behaviour) and sometimes competing (e.g. maximizing timber volume and reduced fire behaviour) objectives within an ecologically, socially and economically compatible framework. In this light a fire management stocking standard then becomes a combination of:

1. Fire management objectives (see below).
2. Other compatible objectives (e.g. acceptable timber production, ecosystem restoration, broadleaf management, etc.).
3. Stand structural considerations.

2.1 Stocking Standard Rationale

Fire management stocking standards are to be developed as designated decision maker (DDM) approved variations on existing, even or uneven age standards. Fire management stocking standards do need to consider all the current requirements of a stocking standard (e.g. ecologically suitable species, density, minimum inter-tree distance (MITD), minimum height(s), competition ratio, acceptable variation, etc) and in addition to describing the standard itself a stocking standard rationale needs to address a number of fundamental issues including – why is the standard needed; where will the standard be applied and when will the standard be applied (i.e., the situations and circumstances).

Why. Fire management stocking standards are used to promote the development of stand structural conditions that may provide for enhanced protection of values on the landbase, typically infrastructure and the delivery of ecosystem goods and services from forests within BC. Fire management stocking standards may also be used to develop landscape scale fuel breaks that provide area where fire behaviour may be reduced to enhance suppression success. Enhanced protection and fuel break effectiveness usually results from development of specific stand structural attributes (e.g. inclusion of broadleaf species, reduced stand density, less flammable species, etc.) that reduce fire behaviour and improve fire suppression effectiveness.

Where. Fire management stocking standards may be applied in a number of different circumstances including:

1. Within approximately 2 km of interface[1]. These areas are identified on maps included as part of District fire management plans.
2. Within approximately 2 km of other high value infrastructure or other high resource value on the land base as identified on approved Fire management plan values maps.
3. Those areas identified as appropriate for a fire management stocking standard within the District fire management plan. These areas will most likely be identified based on landscape scale fire management objectives.

[1] **Wildland Urban Interface** (WUI) means any area where combustible wildland fuels (vegetation) are found adjacent to homes, farm structures or other outbuildings. For the purpose of the Strategic Wildfire Prevention Initiative, the wildland urban interface is the areas within 2 kilometers of a community with densities of between 6 and 250 structures per square kilometer.

4. Fire management stocking standards may be developed at several different scales ranging from the scale of the cutblock to that of the landscape. Multi-block fire management stocking standards could also be developed.

Figure 1: Pollock Terrace Summerland BC Before and After

Fire management stocking standards are intended to be used in specific circumstances and locations to achieve specific fire management objectives (see below). These stocking standards would most likely be applied adjacent to or within a short distance of a value at risk from fire or may be applied as a linear feature when being used to implement a fuel break. Fire management stocking standards could also be used to diversify fuel types in a limited area thus reducing fire behaviour over an area through the provision of "speed bumps" areas where fire behaviour is altered. The standards are not necessarily intended for broad implementation across large areas (e.g. one would not likely implement a fire management stocking standard across an entire Forest Development Unit or Timber Supply Area).

When. Fire management stocking standards may apply at a number of points during the life cycle of a stand including the regeneration (i.e. following harvest)/free-growing stage, an intermediate cut (i.e. commercial thinning) stage and at a partial harvest with regeneration objectives stage. The fire management stocking standard may also apply when identified within a fire management plan as appropriate based on identified landscape or fuel management objectives.

Within BC those who harvest forest stands generally have a reforestation obligation described through stocking standards to achieve. Once that obligation is achieved the province then assumes responsibility for incremental silviculture within those stands until again harvested. Fire management stocking standards do not alter this fundamental relationship. These standards simply describe desired stand structural characteristics at whatever stage in the life of a stand they are applied to.

3.0 Fire Management Objectives

Fire management objectives may be described at either local and/or landscape scales. Fire management plans will identify objectives at a landscape scale while fire threat mitigation plans – including fuel management – will identify those objectives at a more local scale. Local fire management objectives may

seek to reduce: fire behaviour (fire rank), likelihood of crown fire, fire intensity or rate of spread and may also achieve several of these objectives simultaneously.

Landscape scale objectives typically seek to define an acceptable role for fire across broad landscapes. These objectives may include a desire to reduce fire size, reduce fire behaviour (e.g. reduce fire intensity over the landscape) or encourage the use/application of fire for various ecological purposes. Landscape scale objectives are achieved through the combined implementation of local (i. e. stand level) fire management objectives. Whether landscape or local, objectives typically seek to reduce the impact of fire on values on the landbase while usually also seeking to enhance fire suppression effectiveness and success as an over-riding objective.

Fire management stocking standards contribute to fire management objectives through being a primary means whereby a desired stand structure is specified that will help achieve identified fire management objectives. As such fire management stocking standards are one of the tools used to implement local and/or landscape scale fire management objectives.

4.0 Stand Structure and Composition Considerations

The following is a brief discussion about several stocking standard stand structure considerations relative to fire and fuel concerns. Note that this is not a complete discussion but highlights ways in which these factors interact **for consideration in the development of a fire management stocking standard**. Those developing these stocking standards are encouraged to consult further references such as those listed in the appendix (particularly Agee and Skinner 2005 and/or Graham et al. 2004) and/or consult qualified professionals or both.

Ecological Suitability. Tree species selected do need to be ecologically suited. Use of mal-adapted species, within a fire management stocking standard, because of their desirable fire characteristics is not likely to result in achieving the desired fire and other forest management objectives. In a similar fashion use of species that tend to be subject to multiple forest health issues may also not meet fire management or other objectives. Suitability should consider longer term issues like climate change as well. Current Ministry site guides and chief forester guidance provide basic ecological suitability information.

Species. Different tree species have different characteristics with respect to fire. Species differ with respect to canopy characteristics (e.g. canopy density, crown width, etc), flammability and fire resistance and resilience. Generally broadleaf species are less flammable than coniferous species and as a result may reduce fire behaviour. Canopy bulk density is a key variable driving the development of crown fire and species with less dense crowns may be less likely to initiate or propagate crown fire. Dense stands however tend to increase the likelihood of crown fire over less dense stands. Crown base height is an additional variable driving crown fire. Species with a greater tendency to self-prune thus increasing canopy base height may be less likely to promote crown fire. Species that do not self-prune well at desired densities (i.e. increased density increases self-pruning) may require pruning treatments in order to achieve fire management objectives. Different species also contribute variably to ground fuels which may enhance ground or crown fire. As a result of differences in bark characteristics tree species have differing ability to withstand the effects of fire. Also enhancing resilience are different reproduction strategies whether it be sprouting or fire enhanced regeneration

from seed. Practitioners can use these differences to achieve different fire related fire management stocking standard objectives. See Appendix 2 for general guidance on tree species within BC related to fire and more species based information. Also see the tree selection tool at: http://www.for.gov.bc.ca/hfp/silviculture/TSS/tss.htm. The USFS fire effects information system is also an excellent source for fire related information by species. It is located at: http://www.fs.fed.us/database/feis/ .

Genetics. Genetic considerations in tree selection for stocking may be a key factor. Planted species selected for height growth may be able to grow rapidly enough to suppress understory and competition thus achieving one or more of the fire management related objectives. Use of genetically improved stock from a forest health perspective will result in healthier trees better able to survive forest health issues and are less likely to suffer mortality and become fuel. In addition genetics may maximize timber productivity.

Stand Densities. Because a typical objective of a partial cut fire management stocking standard is to alter fire behaviour and dense forest commonly encourages extreme fire behaviour target stocking densities may need to be specified as part of a fire management standard. Due primarily to differences in crown characteristics and crown based fire management objectives, maximum densities may vary as a result of species, species combinations and/or different tree layers (i.e. layer 1 layer 2, etc from BC Silviculture Survey Procedures Manual – April 2009). In some environments stand density may decrease due to concerns about the inability to control crown fire initiation thus necessitating control of crown fire rate of spread while in other environments stand density may remain at current stocking standard levels or increase to reduce ingrowth and promote self-pruning which also can reduce crown fire – particularly when combined with a reduction in ground fuels. In a complementary fashion the density of partial cut standards may be constructed so as to enhance timber flow or provide habitat or increase diversity while meeting fire management objectives.

Stand structure. Fire management stocking standards usually include species desirable from a fire management perspective. These species may or may not always be the very best adapted species for a site from a growth and yield perspective and may or may not be competitive with other species during the seedling and early sapling stages of stand development.

Inter-tree Distance. Inter-tree distance influences stand density and hence influences canopy bulk density, canopy base height and within stand environmental parameters (e.g. temperature, humidity, etc.) and moisture relations. The effects of density are species dependent due to different crown characteristics and silvics (e.g. shade tolerance, etc.). Denser stands may increase the probability of crown fire while less dense stands may reduce the probability and provide greater suppression capability as fire retardant can reach fire on the ground more easily. Denser stands may also result in increased density dependent mortality which may increase fire potential through dead trees acting as ladder fuels. Denser stands may increase self-pruning of trees and reduce surface and ground fuels while more open stands may result in additional surface and ground fuels and increased likelihood of windthrow depending upon species and silvicultural treatment.

Tree/Competition Height Ratios. Opportunistic use of conifer/broadleaf tree competition height ratios or increasing the number of acceptable broadleaves may also enhance the ability to achieve fire related objectives in a stocking standard by increasing the number of broadleaf trees in a stand.

Promoting the use of indigenous broadleaf species, that typically reduce fire behaviour, may also contribute to achieving fire management objectives.

Partial Cut Stocking Standard Considerations. Partial cut stocking standards require consideration as to species, density, tree characteristics (e.g. health, size, etc), regeneration, pattern on both the area under consideration and the landscape and the ability to achieve fire management and other objectives. Effective partial cut fire management standards should contribute to reducing fire behaviour enabling fire to be more likely to be controlled/suppressed or achieving management objectives.

Forest Succession and In-Growth Including Understory. Professionals need to consider the vegetation response of a site post- treatment or activity. The response may enhance or hinder the ability of a standard to achieve fire management objectives. The rate at which the response occurs may also impact the design of the stocking standard. Depending upon circumstance the stocking standard may need to address maximum density (see above).

Climate Change Considerations. Climate change considerations may influence the design of the standard particularly choice of species but might also impact the assessment of what the fire management objectives are or should be.

Topographic. Stands located on steep slopes have different risks than stands on flat sites. Heat and fire generally readily move uphill hence a stocking standard may be altered to account for different fire behaviour on slopes compared to flat sites. Aspect influences site heat and moisture relationships and as a result commonly has an impact on fuel moisture and humidity. Stocking standards may be varied to achieve different fire management objectives as a result of these factors.

5.0 Additional Considerations

Additional considerations not necessarily directly related to the standard developed are important to the efficacy of a fire management stocking standard. These include:

i. Hazard abatement. Hazard abatement following an industrial activity (i. e. harvesting, thinning, etc.) is required under the *Wildfire Act* and associated regulations (see: http://bcwildfire.ca/Industry_Stakeholders/industry/Assessment_Abatement.htm). Fuel loading pre- and post-harvest are important considerations. Continuity and loading particularly of fine fuels has a major influence on fire rate of spread as well as intensity. Guidance around hazard abatement has been developed by BC Wildfire Service (BCWS)..

ii. The fire management stocking standard should be applied adjacent to the value requiring protection from fire and should be applied on other appropriate standard units within the harvest area. In essence the objective is to both protect the value and create diversity in fuel types by incorporating fuel types with reduced fire behaviour potential within the local landscape. The standard need not be uniformly applied but can be intermixed with other resultant fuel types resulting from other stocking standards within the unit. It is important that due consideration be given to resultant and remaining fuel types (likely fire behaviour and spotting potential) as well as their spatial arrangement on the local landscape.

iii. Maintenance or promotion of hazard abated conditions may require further treatments beyond the time frame addressed by the establishment of free-growing stocking standards and the return of the area to the crown. Development of a stocking standard needs to consider changes in vegetation and fuels as a result of succession during the prescription development stage. While a stocking standard does define a "target" stand - what occurs or is done or not done to the vegetation complex from the starting point to the point at which the standard applies and beyond is aimed may reduce the effectiveness of achieving the standard.

6.0 Assessment for Development and Use of a Fire Management Stocking Standard

The development and use of a fire management stocking standard fundamentally requires an understanding of the interactions between fire and fuel (live and dead) within a given environment (weather and topography). Understanding and assessment of this interplay is critical to the successful implementation and efficacy of a fire management stocking standard. Accounting for some but not all fire, fuel, weather and topography related factors in this assessment may result in a standard that does not achieve the fire management or other objectives of the standard.

Fuels are generally the factor that can be manipulated to achieve the fire management stocking standard objectives. Because weather and topography cannot usually be modified development and achievement of the standard requires adapting the standard to the fuels where a standard is desired. Hence the understanding of the structure, composition and growth of forest stands (aka fuels) existing and desired within the area where the standard is to be applied is the beginning point for assessment and development of a fire management stocking standard.

The development and proposal of a fire management stocking standard does require a description of stocking within an objective driven plan. As a result it may consist of a proposal to plant seedlings but may also allow for natural regeneration provided a standard is described and met. For example using expected natural regeneration of aspen as the standard is acceptable provided a standard (i.e. density, height, etc.) is described. It is not the intent of a fire management stocking standard to in effect create areas devoid of trees. That said densities may be very low as illustrated in the example(s) for open forests in Appendix One: General Approach to Creating the Example Fire Management Stocking Standards.

As a best practice, fire management stocking standards should be developed and implemented using the expertise of a professional knowledgeable about fire management planning in combination with those knowledgeable in silvics and silviculture. Professional reliance and seeking out the expertise of those knowledgeable in conducting an assessment in light of objectives for the development and implementation of a fire management stocking standard for either assistance and or review of a proposed standard is highly recommended.

7.0 References

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Appendix One: General Approach to Creating the Example Fire Management Stocking Standards

The general approach to generating fire management stocking standard targets for clear-cut and partial cut scenarios were as follows.

For clear-cut scenarios, stands of appropriate species composition and characteristics were regenerated within TIPSY and evaluated at "free-growing" – generally age 20 – or beyond for canopy bulk density and canopy base height. Resulting canopy bulk densities and base heights could then be used as an input for the Crown Fire Initiation and Spread (CFIS) model to evaluate crown fire potential at free growing and/or later ages. Plantation densities and species composition were varied to achieve canopy bulk densities (CBD) of around 0.05-0.07 kg/cubic meter at target age(s) and resulting stands subjectively evaluated for ability to achieve fire management objectives. Maximum densities were generally set based on densities that achieved a target number of approximately 0.10 kg/cu meter that has been suggested as a threshold for crowning in forests and plantations (see Agee 1996, Alexander 1998 and Cruz et al. 2005) but has not been extensively tested or evaluated in natural forest stands. As such it is only a general number and needs validation through treatment effectiveness.

For partial cut scenarios Ministry permanent sample plot (PSP) data was used to "create" stands by expansion of plot data to a per hectare basis. Sample plots were selected based upon a geographic information system (GIS) analysis of biogeoclimatic (BEC) zones to a subzones level intersected with interface area within the Province of BC. By knowing which subzones were most prevalent within BC interface areas PSPs were used to generate representative interface "stands". These stands were then entered into Fuelcalc (ver 1.2) and "thinned" to appropriate species and densities and resulting canopy base heights and bulk densities noted. Resulting canopy base heights and bulk densities could then be used as an input for the Crown Fire Initiation and Spread (CFIS) model to evaluate crown fire potential and rate of spread. The "thinning strategy" generally employed was thinning from below leaving suitable species to achieve a target canopy bulk density of less than 0.10 and resulting stands subjectively evaluated for ability to achieve fire management objectives. In some examples maximum density is expressed as both a density and a basal area limit because density alone does not account for tree size and hence canopy bulk density. For PSPs that were deemed under-stocked tree densities and or species composition in appropriate diameter classes were arbitrarily increased to meet canopy bulk density targets for illustrative purposes.

This guidance is designed to address the considerations important in creating fire management stocking standards. The following are examples of stocking standards that could be developed using the principles and considerations within the guidance. These are not necessarily appropriate stocking standards for a particular BEC site series. They are examples of the rationale and resulting stocking standard that could be proposed within Forest Stewardship Plans (FSPs) as fire management stocking standards. That said the examples are intended to represent realistic conditions that may be encountered. As suggested within the guidance document practitioners should consult appropriate expertise in developing fire management stocking standards.

Assumptions and Limitations

The use of modeling tools such as FuelCalc and TASS/TIPSY and CFIS to provide illustrative stocking standard examples does not constitute "approval" of the use of these tools to define a rationale for stocking standards that meet fire management objectives. These tools have not been extensively tested and validated and as such only provide an initial "target" that experience and model improvement may change. Consultation with appropriate expertise about the acceptability or modification of the standard developed using these tools is essential. That said these tools provide information for example standards and a rational for fire management stocking standards given different starting conditions that professionals can modify as necessary. At this point in time, it is not recommended that any of the following stocking standards be implemented "carte blanche" as a "formula" stocking standard.

Example Fire Management Stocking Standards with Rationales

Example 1 – Southern Interior IDF dk ss1 BEC Subzone Clear Cut Stocking Standard

The Situation

- ⊡ This stocking standard is for stands that occur within 500 metres of designated interface boundary as identified on provincial strategic threat analysis maps or within fire management plans.
- ⊡ BEC Zone – IDF dk1 ss1.
- ⊡ Avoiding a spacing prior to free-growing declaration is desired.
- ⊡ The standard must factor in tree species suitability, crop reliability, maximum sustainable productivity and fire management objectives.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	Broadleaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
IDF - Current FDP Standard	Fd, Pl	Py	Lw, Sx	At		Fd, Pl	Py	Clearcut	1000	400	500			7	Pl – 1 Fd – 0.8 Py – 0.6	2	150
IDF - Fire Management Standard						Fd, Py	Lw	Clearcut	250	100	150	450		7	Fd – 0.8 Py – 0.6 Lw - 1	2	80

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of conifers greater than 50 % of the specified minimum tree height for the primary species with the highest minimum tree height.

The Rationale

- ⊡ The intent is to regenerate a stand at low density from planting that does not require a spacing, however if density control is required a spacing treatment will be implemented.
- ⊡ Decreasing stocking to density target post free growing to meet fire hazard reduction objectives may require additional slash treatment.
- ⊡ Fd and Py are more fire resistant and so are the preferred species. Lw is also fire resistant and so is acceptable.
- ⊡ Mixtures of Fd and Py allow for higher densities than Fd alone however maximum density is based upon Fd alone.

- Reduced competition ratio to promote broadleaf - less flammable and beneficial in reducing fire behaviour.
- Site should have slash hazard abatement post-harvest.
- As a variation on this standard, if a spacing treatment is planned due to anticipated natural regeneration ingrowth it may be appropriate for professionals to prescribe a short term target density of consistent with the current FDP stocking standard (e.g., 1000 stems per hectare) modified for species composition, through planting in order to suppress ingrowth and competing vegetation.
- The spacing should be to the appropriate target low density (e.g., 250 sph) as specified in this standard.
- Use high genetic gain (growth) stock to promote growth so as to maintain future management options such as prescribed fire to remove ingrowth.

Example 2 – Southern Interior IDF dk1 BEC Subzone Intermediate Cut Stocking Standard

The Situation

- ⊡ These stands occur within 500 metres of designated interface boundary as identified on provincial strategic threat analysis map or identified within the fire management plan.
- ⊡ BEC Zone- IDF dk1 ss1.
- ⊡ Stands currently consist of overstocked multilayered stand with in excess of 2500 stems/ha. Overstory of Fd and Pl, numerous dead Pl and some dead Fd.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	BroadLeaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
IDF - Current FDP Standard	Fd, Pl	Py	Lw, Sx	At		Fd, Pl	Py	Partial Cut	400	200	200						
IDF - Fire Management Standard						Fd, Py	Lw	Partial Cut	300	150	100	450	10				

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of Layer 1 and Layer 2 conifers.

The Rationale

- ⊡ Stand management objectives and desired future forest structure including fire management objectives are key considerations in establishing this stocking standard.
- ⊡ The residual stand is to be primarily composed of large diameter L1 and L2 trees (>7.5 cm DBH).
- ⊡ Assumes an intermediate cut without regeneration objectives.
- ⊡ A maximum basal area has been defined to prevent over-stocking of large trees.
- ⊡ Healthy Fd and Py are more fire resistant and so are the preferred species for retention.
- ⊡ Layer 1 are trees equal to or greater than 12.5 cm DBH and are based upon uniform distribution. Higher densities would be appropriate under a patchy or aggregate distribution pattern. Layer two trees are greater than 7.5 cm in diameter and are also relatively evenly spaced.
- ⊡ Resulting stand is somewhat two layered with CBD of no layer exceeding 0.08 kg/cu meter. Canopy base height is approximately 9 meters.

- ⊡ Stand will likely grow and develop CBDs in excess of 0.1 kg/ cu meter and may or may not require additional treatment due to high canopy base height.
- ⊡ Any occurring aspen may be retained to reduce fire behaviour and does not count toward stocking targets.
- ⊡ Site should have slash hazard abatement.

Example 3 – Southern Interior IDF dm1 BEC Subzone Partial Cut Standard

The Situation

- ⊡ These stands occur within 500 metres of designated interface boundary as identified on provincial strategic threat analysis map or identified within the fire management plan.
- ⊡ BEC Zone – IDF dm1 ss1.
- ⊡ Overstocked mixed age stand with very low site quality.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	Broad Leaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
IDF - Current FDP Standard	Fd, Pl, Lw	Py	Bl, Sx	At, Ep		Fd, Pl	Lw, Py	Partial Cut	1000	500	450						
IDF - Fire Management Standard						Fd, Py, Lw	Pl	Partial Cut	70	35	50	75					

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of Layer 1 and Layer 2 conifers.

The Rationale

- ⊡ The Open Range and Open Forest sites are of very poor site index, tend to be overstocked easily and will tend to unhealthy overstocked stands if left untreated. Densities proposed provide some additional management flexibility (i.e. prescribed fire).
- ⊡ The objective is to recreate the open range stands that once existed on these poor quality sites.
- ⊡ The maximum density of 75 stems per ha is commonly regarded as the “division” between open range and open forest. It is recognized within the Kootenai Boundary LRMP as such.
- ⊡ The standard is consistent with ecological restoration objectives.
- ⊡ The above mentioned stocking standards should meet the conditions of FPPR s. 26(3 and 4) in that these tree species are ecologically suited for these sites and that analysis and sensitivities conducted as part of Timber Supply 2 indicated that reducing stocking on these sites would improve the mid-term timber supply and have negligible impact on the long run sustainable yield.
- ⊡ The species selected are highly fire resistant.

- ⊡ Canopy bulk densities associated with this stocking standard are very low with near negligible crown fire potential.
- ⊡ These stocking standards also address interface wildfire concerns (e.g. high intensity crown fire) that wildfire management branch has raised with these stands.

Example 4 – Lower Mainland South Coast CWH dm Subzone (Option 1)

The Situation

- ⊡ Within 2 km of interface.
- ⊡ BEC Zone – CWH dm ss1.
- ⊡ Somewhat rich site.
- ⊡ Concern that the climate envelope of this part of the CWH may become more warm and dry.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	Broadleaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
CWH - Current FDP Standard	Fd	Hw	Pw, Cw	Act, Dr, Ep, Mb, Ra	Py, Lw	Fd,	Hw, Cw	Clear Cut	900	400	500			3	Fd/Hw – 3.0 Pw – 2.5 others – 1.5	2	150
CWH - Fire Management Standard						Fd, Pw	Cw, Py, Lw, Hw	Clear Cut	900	600	700	1000		2	Fw/Hw – 3.0 Pw – 2.5 Cw/Lw – 1.5 Py – 0.6	2	100

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of conifers greater than 50 % of the specified minimum tree height for the primary species with the highest minimum tree height.

The Rationale

- ⊡ Objective is to reduce likelihood of crown fire initiation with concurrent reduction in canopy bulk density.
- ⊡ Fd , Pw are both fire resistant and Pw reduces canopy bulk density.
- ⊡ Fd, Pw are complementary – similar growth potential suited to drier conditions.
- ⊡ Use high genetic gain stock to reduce rust, suppress ingrowth and bracken fern.
- ⊡ Relax competition ratio to allow some broadleaf species if they occur which would reduce fire behaviour.
- ⊡ Reduce regen delay for fast site occupancy reducing competition and hazard.
- ⊡ Density and MITD should be high and low enough respectively for ingrowth/understory suppression and crown base height lift to free growing at age 20.
- ⊡ May still be a period of 2 or 3 years of hazard as trees establish and grow – crown closure by age 6 at the earliest.

- This density (900/ha) at free growing may be carried through to harvest.
- Plant 1200 to account for mortality.
- Maximum density to be 1000/ha where trees that contribute to maximum are either dominant or co-dominant.
- Py, Lw are considered tertiary species in the eastern portion of the subzone at low elevations as a climate change adaptation strategy given their resilience to fire and relatively low canopy bulk density, but are limited to a maximum of 200 stems per ha.
- Could consider increasing density target at free growing to 1200 sph to increase the rate of site occupancy, however this may result in a stand requiring spacing and slash treatment
- Do not want overly stocked Cw and Hw may die out over time.
- Site should have had slash hazard abated.
- One can easily create a mixed wood standard using standard stocking or fire management stocking standard for stratified units within a standard (harvest) unit.

Example 5 – Lower Mainland South Coast CWH dm BEC Subzone (Option 2)

The Situation

- ⊡ Within 2 km of interface.
- ⊡ BEC Zone – CWH dm ss5.
- ⊡ Rich well-drained site.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	BroadLeaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
CWH - Current FDP Standard	Cw, Fd		Pw, Hw	Act, Dr, Ep, Mb		Fd, Cw	Hw	Clear Cut	900	400	500			3	Fd/Hw – 3.0 Pw- 2.5 Others 1.5	2	150
CWH - Fire Management Standard						Dr	Mb, Ep	Clear Cut	1200	500	700			2	Dr, Mb, Ep – 4.0	2	150

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of conifers greater than 50 % of the specified minimum tree height for the primary species with the highest minimum tree height.

The Rationale

- ⊡ Intend to compliment Coast Hardwood Strategy and produce short rotation red alder and associated broadleaf species.
- ⊡ Broadleaf species reduce fire behaviour.
- ⊡ Reduce regeneration delay for fast site occupancy reducing competition and hazard.
- ⊡ May still be a period of 2 or 3 years of hazard as trees establish and grow.
- ⊡ Density and MITD should be high enough for ingrowth/understory suppression and crown base height lift to free growing at age 20.
- ⊡ Under an intensive management regime designed to reduce rotation length stands can be spaced to between 600 and 800 sph when the height to live crown ration is 50 % (approximate stand height 10 meters).
- ⊡ Plant 1400 stems/ha.
- ⊡ Crown closure in 3 or 4 years.

- ⊡ Site should have had slash hazard abated.
- ⊡ One can easily create a mixed wood standard using standard stocking or fire management stocking standard for stratified units within a standard (harvest) unit.

Example 6 – Northern Interior BWBS mw1 (Option 1)

The Situation

- These units are generally within 500 metres of designated interface boundary.
- BEC Zone – BWBS mw1.
- Prescription must factor in tree species feasibility, crop reliability, maximum sustainable productivity and fire management objectives.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	Broadleaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
BWBS - Current FDP Standard	Pl, Sw			At, Act		Pl	Sw	Clear Cut	1200	600	700			4	Sw – 2.5 Pl, At, Acb - 2.0	2	150
BWBS - Fire Management Standard						Pl	Sw	Clear Cut	900	700	600	1000		2	Sw – 2.5 Pl, At, Acb - 2.0	2	100

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of conifers greater than 50 % of the specified minimum tree height for the primary species with the highest minimum tree height.

The Rationale

- Intent is to produce a mixedwood stand of lodgepole pine and aspen in which aspen cover generally exceeds cover of pine. The pattern of species should reflect a mixture in which clonal aspen tends to be more predominate near interface.
- Broadleaf species reduce fire behaviour.
- At is from clonal sprouting while Pl are planted and any Sw occurring are volunteer.
- The competition ratio is based upon competition with lodgepole pine not aspen.
- Max density of pine in pine standard units is 1000 stems per ha in order to maintain CBD below 0.08 by age 100.
- Max density of spruce across standard units is 500 per ha in order to maintain CBD below 0.08 by age 100.
- May still be a period of 2 or 3 years of hazard as trees establish and grow.
- Density and MITD should be high enough for ingrowth/understory suppression and crown base height lift to free growing at age 20.

- ⊡ Crown closure in 3 or 4 years.
- ⊡ Site should have had slash hazard abated.

Example 7 – Northern Interior BWBS mw1 (Option 2)

The Situation

- ⊡ These units are within 500 metres of designated interface boundary.
- ⊡ BEC Zone – BWBS.
- ⊡ Prescription must factor in tree species feasibility, crop reliability, maximum sustainable productivity and fire management objectives.

The Standard

BCG Zone	Suitable Species					Proposed Stocking Standard Species		Silviculture System	Target (sph)	Min P (sph)	Min PA (sph)	Max Density (sph)[2]	Max Basal Area (m^2)	Regen Delay (yrs)	Min Ht (m)	MITD (m)	Broadleaf Comp Ratio (%)
	Primary	Secondary	Tertiary	Broadleaf	Fire Management Appropriate[1]	Preferred (P)	Acceptable (A)										
BWBS - Current FDP Standard	Pl, Sw			At, Act		Pl	Sw	Clear Cut	1200	600	700			4	Sw – 2.5 Pl, At, Acb - 2.0	2	150
BWBS - Fire Management Standard						At, Act	Sw, Pl	Clear Cut	3500	1700	2000			2	Sw – 2.5 Pl, At, Acb - 2.0	2	100

[1] - Fire management appropriate suitable species are additional species ecologically adapted to the site that do not generally maximize timber production which may be used as part of the fire management stocking standard.
[2] - Represents the total density of conifers greater than 50 % of the specified minimum tree height for the primary species with the highest minimum tree height.

The Rationale

- ⊡ Intend to produce a broadleaf stand dominated by aspen.
- ⊡ Broadleaf species reduce fire behaviour.
- ⊡ Any Sw or Pl occurring are volunteer and max density of Pl is 1000 while max density of Sw is 500 in order to maintain CBD less than 0.08 kg per cubic meter should only conifers dominate these sites.
- ⊡ May still be a period of 2 or 3 years of hazard as trees establish and grow.
- ⊡ Density and MITD should be high enough for ingrowth/understory suppression and crown base height lift to free growing at age 20.
- ⊡ Crown closure in 3 or 4 years.
- ⊡ Site should have had slash hazard abated.

Appendix Two: Fire Management Rating and Fire Resistance/Resilience Characteristics of Common Tree Species Used for Reforestation In British Columbia

Fire Resistance/Resilience of Coniferous Tree Species in British Columbia

Coniferous tree species with high fire resistance/resilience typically possess the following characteristics. They tend to be deep rooted thus increasing wind-firmness and ability to access soil moisture. This allows for thinning stands to wider spacing without windthrow concerns and these species tend to maintain higher foliar moisture content during summer dry periods. Fire resistant/resilient species tend to not accumulate large amounts of litter beneath their canopy. Those species that do accumulate litter usually tend to have thick bark and or self-prune relatively well to reduce tree mortality and/or crown fire potential. They tend to have open crowns of relatively low canopy bulk density and often have the ability to "self-prune" under low light conditions. Tree species highly resistant/resilient to fire typically have thick bark when mature and are not high in volatile and/or resinous chemical compounds. Species that do not regenerate well in shade generally result in more fire resistant stands as there is less likelihood of ladder fuels developing. Tree species which had undergone some genetic improvement may be more capable of suppressing undesirable species than those which have not undergone genetic selection.

Compared to the description of high fire resistance/resilience coniferous tree species note that most of these species in the moderate to low fire resistance/resilience categories have either singly or in combination(s) shallow rooting habit, relatively thin to very thin bark, reproduce well in the shade, do not self-prune well or are high in volatile oils that add to flammability – see appendix table 1 below for specifics. The following is a rating of coniferous tree species commonly used within British Columbia.

- Coniferous species highly fire resistant/resilient include: Fd - Douglas-fir Py - Ponderosa pine Lw - Western larch Pa - Whitebark pine
- Coniferous tree species with moderate fire resistance/resilience include: Pw - Western white pine Pl – Lodgepole pine Pj - Jack pine Bg - Grand fir
- Coniferous tree species with moderate to low fire resistance/resilience include: Se - Engelmann spruce Sw - White spruce Ss - Sitka spruce Hw - Western hemlock Hm - Mountain hemlock Cw - Western redcedar Yc - Yellow cedar
- Coniferous tree species with low fire resistance/resilience include: Ba – Amabilis fir Bl - Subalpine fir Lt – Tamarack La - Alpine larch Sb - Black spruce Tw - Western yew

Fire Resistance/Resilience of Broadleaf Tree Species in British Columbia

Broadleaf tree species as a group generally are not as flammable as coniferous species due to increased moisture content and a general lack of highly volatile oils and as a result exhibit reduced fire behaviour (i.e. rate of spread, fire intensity) compared to coniferous species. However with respect to fire resistance/resilience broadleaf species are impacted by the same factors (e.g.

rooting depth, bark thickness, etc) that affect coniferous species. As in the case of coniferous species deep rooting depth, thick bark, self-pruning ability, reduced low light regeneration and genetic improvement typically contribute to fire resistance/resilience.

Compared to the description of high fire resistance/resilience broadleaf tree species note that most of these species in the moderate to low fire resistance/resilience categories have either singly or in combination(s) shallow rooting habit, relatively thin to very thin bark, reproduce well in the shade, do not self prune well or are high in volatile oils that add to flammability – see appendix table 1 below for specifics. The following is a rating of deciduous tree species commonly used within British Columbia.

- Broadleaf tree species with high fire resistance/resilience include: Acb - Balsam poplar Act - Black cottonwood
- Broadleaf tree species with high to moderate fire resistance/resilience include: Qg - Garry oak Mb - Bigleaf maple
- Broadleaf tree species with moderate fire resistance/resilience include: At - Trembling aspen Dr - Red alder Ep - Paper birch
- Broadleaf tree species with low fire resistance/resilience include: Ra – Arbutus

Table 1. Fire related characteristics for tree species commonly used for reforestation in BC.

	Rooting Habit	Conifer or Broadleaf	Litter Accumulation Associated Understory	Crown Density	Self Pruning Ability	Bark Characteristics	Chemical Composition	Genetic Improvement	Low light Regeneration Potential	Fire Resistance/Resilience Rating
Fire Effect / Species	Moisture content of deep rooted species tends to be higher throughout any summer dry period reducing flammability. Deep rooted species tend to be less susceptible to windthrow.	Deciduous species are generally less flammable than coniferous species due commonly to higher moisture contents, often less dense crowns and usually a lack of volatile chemical compounds.	Species which tend not to accumulate large amounts of litter beneath them tend to resist crown fire and be more fire resistant depending on bark thickness. Species associated with abundant understories may experience more fire and may be more prone to crown fire.	Species with more open crowns and sparse foliage tend to resist active crown fires more than species with dense crowns. Canopy bulk density figures provide a relative ranking of species. Stand canopy characteristics are often density dependent as well.	Self pruning ability is usually density dependent however species which are more shade tolerant generally do not self prune well. Increased canopy base height as a result of self pruning reduces the likelihood of crown fire.	Species with thick bark tend to resist (survive) fire better than species with thin bark. Most species have relatively thin bark when young which tends to reduce survival in the face of fire.	Species high in volatile and or resinous compounds tend to be more flammable than species low in these compounds. Highly lignified species often tend to produce more smoke and burn for longer periods than those with less lignin content.	Species that have been genetically improved in, for example, height growth may help suppress understory vegetation and ladder fuels as well as self prune sooner assuming sufficient density. Blister rust resistance may enhance the use of western white pine.	Species with high low light regeneration capacity may provide a source of ladder fuels thus encouraging crown fires.	Categorical Rating
Ba – Amabilis fir	Moderate	Conifer		Medium	High	Thin	Medium-Low	None	High	Low
Bg - Grand fir	Moderate	Conifer		Medium	High	Medium	Medium-Low?	None	Medium-Low	Moderate
Bl - Subalpine fir	Moderate	Conifer		Low	High	Thin	Medium-Low	None	High	Low
Fd - Douglas-fir	Deep	Conifer		High	High	Thick	Medium-Low	Growth	Low-High	High
Lt – Tamarack	Deep-Shallow	Conifer		Low	Low	Thin	Low	None	Low	Low
La - Alpine larch	Deep	Conifer		Low	N/A	Thin	Low	None	Low	Low

	Rooting Habit	Conifer or Broadleaf	Litter Accumulation Associated Understory	Crown Density	Self Pruning Ability	Bark Characteristics	Chemical Composition	Genetic Improvement	Low light Regeneration Potential	Fire Resistance/Resilience Rating
Lw - Western larch	Deep	Conifer		Low	High	Thick	Low	Growth	Low	High
Se - Engelmann spruce	Shallow	Conifer		Medium	Medium	Thin	Low?	Growth	Low	Moderate - Low
Sw - White spruce	Shallow	Conifer		High	High	Medium	Medium?	Growth	Low	Moderate - Low
Sb - Black spruce	Shallow	Conifer		Medium?	Medium	Thin	Medium-High	None	High	Low
Ss - Sitka spruce	Shallow	Conifer		High	High	Thin	Medium-Low?	Growth / Weevil	Low	Moderate - Low
Pa - Whitebark pine	Deep	Conifer		Low	N/A	Medium	Medium-High?	None	Low	High
Pj - Jack pine	Deep	Conifer		Low	Medium	Medium	Medium	None	Low	Moderate
Pl – lodgepole pine	Deep	Conifer		Low	High	Medium	Medium	Growth	Low	Moderate
Pw - Western white pine	Moderate	Conifer	Litter	Low	High	Medium	Medium-High	Growth / Rust	Low	Moderate
Py - Ponderosa pine	Deep	Conifer	Litter	Low	Medium	Thick	High	Growth	Low	High
Hw - Western hemlock	Shallow	Conifer		Medium	High	Medium	Low	Growth	High	Moderate-Low
Hm - Mountain hemlock	Shallow	Conifer		Medium	High	Medium	Low	None	Low	Moderate-Low
Yc - Yellow cedar	Shallow	Conifer		High	High	Medium	High	Growth	Medium	Moderate-Low

	Rooting Habit	Conifer or Broadleaf	Litter Accumulation Associated Understory	Crown Density	Self Pruning Ability	Bark Characteristics	Chemical Composition	Genetic Improvement	Low light Regeneration Potential	Fire Resistance/Resilience Rating
Cw - Western redcedar	Shallow	Conifer		High	High	Thin	High	Growth / Browsing	Medium-High	Moderate-Low
Tw - Western yew	Deep	Conifer		Medium	N/A	Thin	Low?	None	High	Low
Acb - Balsam poplar	Moderate-Shallow	Broadleaf		N/A	High	Thick	Low	None	Low	High
At - Trembling aspen	Moderate-Deep	Broadleaf		N/A	High	Thin	Low	None	Low	Moderate
Act - Black cottonwood	Deep	Broadleaf		N/A	High	Thick	Low	None	Low	High
Dr - Red alder	Moderate-Deep	Broadleaf		N/A	High	Thin	Low	None	Low	Moderate
Ep - Paper birch	Moderate	Broadleaf		N/A	Medium	Thin	Low	None	Low	Moderate
Qg - Garry oak	Deep	Broadleaf		N/A	Low	Medium	Low	None	Low	High-Moderate
Mb - Bigleaf maple	Deep	Broadleaf		N/A	Medium	Medium	Low	None	Low-Medium	High-Moderate
Ra – Arbutus	Deep	Broadleaf		N/A	Low	Thin	Low	None	Low-Medium	Low