Fire Management Stocking Standards Guidance Document

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1.0 Stocking Standards

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 requirements. The description of the regeneration requirements includes a list of ecologically 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 biogeoclimatic subzones, variants and site series that produce commercially valuable timber. In addition, stocking standard guidance has been developed for special considerations including: habitat (e.g. grizzly bear habitat), multi-storied 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 by modifying even-aged standards. Likewise, fire management stocking standards are 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[1] 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

[1] **Crown Fire**-A fire that advances through the crown fuel layer, usually in conjunction with the surface fire. Crown fires can be classified according to the degree of dependence on the surface fire phase: (i) Intermittent Crown Fire - A fire in which trees discontinuously torch, but rate of spread is controlled by the surface fire phase. (ii) Active Crown Fire - A fire that advances with a well-defined wall of flame extending from the ground surface to above the crown fuel layer. Probably most crown fires are of this class. Development of an active crown fire requires a substantial surface fire, and thereafter the surface and crown phases spread as a linked unit (CIFFC 2003 Glossary of Forest Fire Management Terms).

changes. For this reason maintenance of forest stands subject to fire management stocking standards should be 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, facilitated migration i.e. western larch, 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 aged 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). 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 provide for reduced risk to, and enhanced protection of values on the landbase - typically human life and safety, property, infrastructure and the delivery of ecosystem goods and services from forests within BC. Fire management stocking standards may also be used to develop landscape level fuel breaks that provide areas where fire behaviour is reduced and provides options for fire suppression that enhance suppression success. Enhanced mitigation and fuel break effectiveness usually results from development of specific stand structural attributes (e.g. inclusion of broadleaf species, fire adapted conifers (e.g. western larch), reduced stand density, etc.) that reduce fire behaviour and improve fire suppression effectiveness.

Where. At the discretion of the designated decision-maker (DDM) fire management stocking standards may be applied in a number of different circumstances including:

1. Within approximately 2 km of the wildland urban interface (WUI)[2]. These areas are identified on maps included as part of resource district fire management plans.
2. Within approximately 2 km of other high value infrastructure or other high resource values on the land base as identified in an approved resource district fire management plan.

[2] **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 area within 2 kilometers of a community with densities of between 6 and 250 structures per square kilometer.

3. Those areas identified as appropriate for a fire management stocking standard within the resource district fire management plan. These areas will most likely be identified based on landscape level fire management objectives (e.g. WUI fuel breaks).

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 Fuel Treatment

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 changes in fuel types 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. 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 are specified in fire management plans and can be described at local and/or landscape scales. Local fire management objectives may seek to reduce fire behavior (fire rank), likelihood

of crown fire, fire intensity or rate of spread, and may also achieve several of these objectives simultaneously.

Landscape scale fire management objectives typically seek to define an acceptable role for fire across broad landscapes. 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 by specifying a desired stand structure 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.

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 (e.g. range and population expansion of western larch) as well. Current Ministry site guides and Chief Forester guidance provide basic ecological suitability information. (See also the discussion on climate change at the end of this section).

Species Selection. 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 and Western larch are less flammable than other 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 competition and reduce surface fuel accumulation, 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 ladder and surface fuels over time. In addition genetics may maximize timber productivity.

Stand Densities. Stand density affects canopy bulk density, canopy base height (due to self-pruning), within-stand environmental parameters (e.g. temperature, humidity, windspeed, fuel moisture levels, understory vegetation, etc.). The fire behavior implications of varying density are species dependent due to different tree silvicultural characteristics that result in different crown characteristics, flammability, and silvics (e.g. shade tolerance, etc.). Implications of a specific density of residual mature trees following a partial cut harvest are very different from the same density (and species) of seedlings being established following a clear-cut harvest. Fire behavior implications will change as the stand grows and develops, and need to be taken into account. Target, minimum, and maximum stocking densities are all key parts of a fire management standard.

Denser stands increase the likelihood of crown fire spread. Denser stands result in increased density dependent mortality leading to more ladder fuels and surface fuels, and a higher likelihood of crown fire initiation. Where denser stands result in increased self-pruning of trees and reduced surface fuels (eg. grasses, herbs, conifer regeneration, etc.) this leads to a lower likelihood of crown fire initiation.

Less dense stands reduce the probability of crown fire spread and provide greater suppression capability as fire retardant can reach fire on the ground more easily, and may allow crews to safely work in the area. More open stands may result in additional surface fuels including grasses which can be very volatile when cured. Designing harvesting to leave a residual stand that functions as a shaded fuelbreak will reduce grass growth and will also reduce windspeed and rate of spread. Potential for increased likelihood of windthrow will depend on species and silvicultural treatment.

In areas with moderate to high fire risk stand density is commonly decreased to reduce crown fire initiation and spread. In areas with low fire risk, 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. Because the fire management objective is to reduce fire behavior 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.

Stand structure characteristics desirable from a fire management perspective typically include all or some combination of relatively low quantities of fuel on the ground, relatively high canopy base heights, relatively low canopy bulk densities and low flammability species. Structures may range from quite open to dense depending upon fire management goals and objectives.

Inter-tree Distance / Inter-crown Distance. Inter-tree distance and inter-crown distance influences the likelihood of fire spreading from crown to crown.

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, enable effective fire suppression and be designed to achieve 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. Additional discussion is included in the tree density section above).

Climate Change Considerations. Climate change considerations may influence the design of the standard particularly choice of species and density, Expansion of western larch into ecologically appropriate sites in seed planning zones LW1 and LW2, is one option identified by the Chief Forester to address climate change, and can be complementary with fire management objectives, and the production of coniferous timber. In dry areas that are expected to have increased moisture deficits in the future, the choice of appropriate species and densities that can be supported on the site over the long term is essential. In drier areas, conversion to non-forest vegetation, open range, or open forest may be appropriate.

Topographic Considerations. 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, and resulting fire behaviour. Hence stocking standards may need to be varied to achieve fire management objectives on steeper slopes and/or warmer aspects.

5.0 Additional Considerations

Additional considerations that are not necessarily directly related to, but are important to the efficacy of a fire management stocking standard include:

Hazard Abatement. Fuel loading pre and post-harvest are very important considerations. Continuity and

loading particularly of fine fuels has a major influence on fire rate of spread as well as intensity. Large fuels contribute to increased fire intensity. 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). Guidance around hazard abatement has been developed by BC Wildfire Service (BCWS). It should be noted that this legislation and guidance applies to forestry operations throughout the Province and was not designed specifically for WUI areas, Under the professional reliance regime, and the principles of due diligence, careful consideration of the implications of fuel-loading post-harvest should be taken into account.

Proximity. The fire management stocking standard should be applied adjacent to the value requiring protection from fire and could 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 in close proximity to the value. It is also critical to consider the proximity of the area being treated in relation to the values at risk (e.g. a sub-division, a community, a windmill farm, etc.). For treatment areas closer to values at risk (e.g. 0 to 600 meters or 0 to 1,000 meters depending on fuel type and spotting potential), a higher standard of fire resiliency should be designed and implemented that reduces the risk of intermittent crown fire well below the 50% used in the examples as the intermittent crown fire will contribute to spotting that can threaten values at risk. The risk of intermittent crown fire can be lowered by a combination of some or all of the following measures: focusing on the most fire resilient species (deciduous, western larch), retaining a residual stand of mature fire resilient trees to create "shaded fuelbreak" conditions (rather than clear-cutting), reducing surface fuels to very low levels, increasing crown base height, decreasing stand densities, and/or increasing inter-tree spacing. The combination of measures chosen should be of a sufficient degree, that in combination, the fire management objectives are met. 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.

Maintenance. Promotion of hazard abated conditions may require further treatments beyond the time frame addressed by the establishment of a free-growing stand 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 over the life of the stand. While a stocking standard does define a "target" stand - the management of the vegetation complex from regeneration to free growing to the next harvest entry all needs to be considered to ensure that the objective is achieved.

Silviculture System Selection. From a silvicultural perspective **w**here practicable, partial cut scenarios with wind-firm, fire resilient species reserved from harvest (i.e. shaded fuel-break) are preferred to clear-cut scenarios, for a number of reasons, including : amelioration of fire weather (wind, relative humidity (RH), etc.), fire resilient tree characteristics have had time to develop (thick bark, high crown base heights (self-pruning during stand development in a closed forest condition), re-vegetation of the site with vegetation and conifers is usually less vigorous due to shading), and the treatment may be more acceptable to the public. That being said, it is recognized that in some stand types, clearcutting may be the only practicable option due to tree silvics disease/insect issues and wind firmness (e.g. mature 100% lodgepole pine stands).

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.

The distribution and arrangement of fuels on the site and on the landscape (partly determined by resource management activities) is a major component of any hazard analysis, since this is the main component that can be managed. Because weather and topography cannot usually be modified, development and achievement of the standard requires the management of fuels. Hence the understanding of the structure, composition and growth of forest stands 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 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 however 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.

Fire management stocking standards should be developed and implemented using professional knowledge of fire management planning, fire behaviour, tree silvics, silviculture and vegetation development including succession. 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 standards for clear-cut and partial cut scenarios are described in the paragraphs below.

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 were 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 Fuelcalc (V 1.2) based canopy bulk densities (CBD) of approximately 0.05-0.07 kg/cubic meter at target age(s) and resulting stands were subjectively evaluated for their ability to achieve fire management objectives. Maximum densities were generally set based on densities that achieved a crown bulk density 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 and is influenced by weather (wind) and slope. As such it is only a general number and needs validation through treatment effectiveness.

For partial cut scenarios Ministry permanent sample plot (PSP) data were used to "create" stands by expansion of plot data to a per hectare basis. These stands were then entered into Fuelcalc 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 V. 4) model to evaluate crown fire potential and rate of spread. The "thinning strategy" generally employed was thinning from below leaving the larger 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 does not account for tree size which has a large influence on canopy bulk density. For PSPs that were under-stocked, tree densities and or species composition in appropriate diameter classes were increased to meet canopy bulk density targets for illustrative purposes.

For "fire weather" inputs into CFIS for the stocking standard examples, 6 years of data – 2010 to 2015 inclusive (June through September) hourly weather records for early to late afternoon (i.e. 13:00-17:00) were queried for one representative weather station for each BEC type example and 97th percentile weather were used for the stocking standard examples. CFIS modelling inputs include: crown base height, 10m open wind speed, estimated fine fuel moisture percentage, estimated fuel consumption, and canopy bulk density. As CFIS requires an estimated fine fuel moisture content (EFFM) it was estimated as 101-FFMC. Fire behaviour specialists may use a more exact calculation for this estimate or the alternate method within CFIS. It is very important to note that there are several ways to decide what weather parameters to use in CFIS to design a standard. For example in the United States it is not uncommon to use the 97th percentile summer weather conditions over a number of years. Local fuels and/or fire behaviour specialists can identify appropriate weather parameters to use. The examples focus on required stocking standard related parameters but some fire related information is included to illustrate integration of stocking standards with fire weather related parameters. The stocking standard examples in this appendix are designed to create a forest stand

structure that does not support active crown fire and reduces the risk of crown fire by more than 50% under 97.5 percentile fire weather conditions

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. As a result caution must be used when applying these example stocking standards to other stands or stand conditions that vary significantly from the example stands used in the modelling. The examples are meant to show what a fire management stocking standard designed for a specific stand with a specific set of condition might look like to achieve the fire management objectives.

Guidance versus Examples

This document is guidance 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.

Example Fire Management Stocking Standards with Rationales

Example 1 – Southern Interior IDF dk Clear-Cut Stocking Standard

The Situation

- BEC Zone – IDF dk site series 01.
- Fire weather analysis indicates an FFMC of 94 and a 10 m wind speed of 22 km/hr for an August afternoon. Avoiding a spacing prior to free-growing declaration is desired.
- The pre-existing stand was primarily conifer with no aspen present.
- The standard must factor in tree species suitability, crop reliability and fire management objectives.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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						Lw[3],Py, Fdi, At[4]	Lw	Clearcut	250	100	150	450		7	Fd – 0.8 Py – 0.6 Lw - 1	2	

[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.
[3]Lw acceptable or potentially preferred when within Seed Planning Zones LW1 or LW2. Seek guidance from regional ecologist.
[4]Accept all aspen as it contributes to fire resistance.

The Rationale

- The intent is to regenerate a stand of fire resilient species at lower than commercial density from planting or natural regeneration that does not require a spacing but does provide an adequate number of trees for any future (post-free growing) stand modifications desired. If however density control is required a spacing treatment will be implemented.
- The fire management objective associated with this particular stocking standard example is to minimize the risk of a continuous crown fire and to reduce the risk of a an intermittent crown fire to less than 50%, given the above parameters CFIS indicates a 47% chance of a crown fire provided canopy base height is 8 m or higher and consumable surface fuel is less than 10 tons per ha.
- Decreasing stocking to density target post free growing to meet fire hazard reduction objectives may require additional slash treatment.
- At is the most fire resilient tree species option and its regeneration should be encouraged where practicable.
- Lw is the next most fire resilient option and is acceptable and potentially preferred in Seed Planning Zones LW1 and LW2 where ecologically suitable following the guidance set out by the Chief Forester.
- Py and Fdi are the next most fire resilient options and so are the preferred species. Mixtures of Fd and Py allow for higher densities than Fd alone however maximum density was modelled 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 to 10 tons per ha or less.
- The spacing should be to the appropriate target low density (e.g. 250 sph) as specified in this standard. Abatement of spacing slash is critical.
- Use high genetic gain (growth) stock to promote growth so as to maintain future management options such as prescribed fire to remove ingrowth.
- If aspen is an option, a standard can be devised that uses aspen stocking as contributing to this standard’s stocking requirements as illustrated.

Example 2 – Southern Interior IDF dk Partial Cut Stocking Standard

The Situation

- BEC Zone- IDF dk1 site series 01.
- Fire weather analysis indicates an FFMC of 94 and a 10 m wind speed of 22 km/hr for an August afternoon.
- The pre-existing stand was primarily conifer with no aspen present.
- 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.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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						At[3], Lw, Py, Fd		Partial Cut	175	150	100	250	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.
[3]Accept all aspen as aspen is fire resistant.

The Rationale

- The fire management objective associated with this particular stocking standard example is to minimize the risk of a continuous crown fire and to reduce the risk of a an intermittent crown fire to less than 50%, and given these parameters CFIS indicates a 47% chance of a crown fire provided canopy base height is 8 m or higher and consumable surface fuel is less than 10 tons per ha.
- 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 larger diameter trees that have well developed fire resilient characteristics (L1 and L2 trees (>7.5 cm DBH)).
- Assumes an intermediate cut that achieves regeneration objectives immediately following harvesting.
- A maximum basal area has been defined to prevent over-stocking of large trees.

- Healthy Fd and Py are more fire resistant coniferous species present and are the preferred species for retention.
- Lw is not currently present in the IDFdk1, so the inclusion of Lw only applies if planting is required and if the area is within Seed Planning Zones LW1 and LW2 where ecologically suitable and following the Chief Forester's guidance.
- Layer 1 trees are trees equal to or greater than 12.5 cm DBH and are modelled 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 modelled based on uniform distribution.
- Resulting stand is somewhat two layered with CBD of no layer exceeding 0.08 kg/cu meter. Canopy base height is 10+ 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.
- Site should have slash hazard abatement.

Example 3 – Southern Interior IDF dm Partial Cut Standard

The Situation

- BEC Zone – IDF dm site series 01.
- Fire weather analysis indicates an FFMC of 95 and a 10 m wind speed of 13 km/hr for an August afternoon.
- The pre-existing stand was primarily conifer with no aspen present.
- Overstocked mixed age stand with very low site quality.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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						At[3], Lw, Py, Fd, Ep		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.
[3]Accept all aspen as aspen is fire resilient.

The Rationale

- The Open Range and Open Forest sites are of very poor site index tend to be overstocked easily with the exclusion of fire, and will tend to unhealthy overstocked stands if left untreated. Densities proposed provide some additional management flexibility (i.e. prescribed fire).
- The fire management objective associated with this particular stocking standard example is to minimize the risk of a continuous crown fire and to reduce the risk of a an intermittent crown fire to less than 50%, and given these parameters CFIS indicates less than a 50% chance of a crown fire provided canopy base height is over 3.2 m and consumable surface fuel are in the less than 10 ton per ha class in CFIS.
- 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 regarded as the transition between open range and open forest as per the Kootenay/ Boundary HLP Order.
- The standard is consistent with ecological restoration objectives for the high end of Open Range and the Low end of Open Forest.
- 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 3 indicated that reducing stocking on these sites would have negligible impact on the Long Run sustainable yield.
- The species selected are fire resilient.
- Canopy bulk densities associated with this stocking standard are very low with near negligible crown fire potential.
- These stocking standards also address interface crown fire concerns (e.g. high intensity crown fire) but there is still a risk of a fast moving surface (grass) fire. Additional management as grazing during the summer before grass curing occurs is recommended to reduce the amount of grass present and reduce this wildfire risk.

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

The Situation

- BEC Zone – CWH dm site series 05.
- Fire weather analysis indicates an FFMC of 90 and a 10 m wind speed of 7 km/hr for an August afternoon.
- Concern that the climate envelope of this part of the CWH may become more warm and dry.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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, Lw[3], Py[3]	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.
[3] 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.

The Rationale

- Objective is to reduce likelihood of crown fire initiation with concurrent reduction in canopy bulk density.
- The fire management objective associated with this particular stocking standard example is to minimize the risk of a continuous crown fire and to reduce the risk of an intermittent crown fire to less than 50%, and given these parameters CFIS indicates a 43% chance of a passive crown fire provide. canopy base height is less than 2 m and consumable surface fuel are in the 10 to 20 ton per ha class in CFIS. Canopy base heights for the standard are well in excess of 1 m.
- Deciduous species options are outlined in the next example. A mixed deciduous / conifer stand would also be an option.
- Fd is fire resilient and Pw reduces canopy bulk density.

- Fd, Pw are complementary – similar growth potential suited to drier conditions.
- White pine blister rust is a major concern. 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 codominant.
- 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 to rely on Cw and Hw as neither are fire resilient and both may die out over time due to climate change.
- 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 (Deciduous Option)

The Situation

- BEC Zone – CWH dm site series 05.
- Fire weather analysis indicates an FFMC of 90 and a 10 m wind speed of 7 km/hr for an August afternoon.
- Rich well-drained site.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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, Act	Clear Cut	1200	500	700			2	Dr, Mb, Ep, Act – 4.0	2	

[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 hence fire behaviour is of little concern.
- 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 mw (Mixed Deciduous / Coniferous Option)

The Situation

- BEC Zone – BWBS mw site series 01.
- Fire weather analysis indicates an FFMC of 92 and a 10 m wind speed of 25 km/hr for an August afternoon.
- Prescription must factor in tree species feasibility, crop reliability and fire management objectives.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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	Pl, Act	Clear Cut	900	500	500	500		2	Sw – 2.5 Pl, At, Acb - 2.0	2	

[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 fire management objective associated with this particular stocking standard example is to minimize the risk of a continuous crown fire and to reduce the risk of a an intermittent crown fire to less than 50%, and given these parameters CFIS indicates a 44% chance of a crown fire provided canopy base height is 9 m or more and consumable surface fuel are in the less than 10ton per ha class in CFIS.
- 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 500 stems per ha in order to maintain CBD below 0.05 by age 100.
- Max density of spruce across standard units is 50 per ha in order to maintain CBD below 0.01 by age 100.
- Density and MITD should be high enough for ingrowth/understory suppression and crown base height lift to free growing at age 20 if pine are planted in groups.
- Site should have had slash hazard abated.

Example 7 – Northern Interior BWBS mw (Deciduous Option)

The Situation

- BEC Zone – BWBS mw site series 01.
- Fire weather analysis indicates an FFMC of 92 and a 10 m wind speed of 25 km/hr for an August afternoon.
- Prescription must factor in tree species feasibility, crop reliability and fire management objectives.
- Fire Management Objectives and specific stocking standards for actual stands will vary based on proximity to values, and the other factors discussed in the main text of this document.

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		Clear Cut	3500	2000	2000			2	Sw – 2.5 Pl, At, Acb - 2.0	2	

[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 because broadleaf species reduce fire behaviour.
- The fire management objective associated with this particular stocking standard example is to minimize the risk of a continuous crown fire and to reduce the risk of a an intermittent crown fire to less than 50%, and given these parameters CFIS indicates a 44% chance of a crown fire provided canopy base height is 9 m or more and consumable surface fuel are in the less than 10ton per ha class in CFIS.
- Any Pl occurring are volunteer and max density of Pl is 50 while only an occasional spruce is acceptable.
- 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 develop full crown closure more quickly and be more capable of suppressing undesirable species than those which have not undergone genetic selection.

Compared to the high fire resistance/resilience coniferous tree species most of the moderate to low fire resistance/resilience species have some or all of the following characteristics: shallow rooting habit, relatively thin to very thin bark, reproduce well in the shade, do not self-prune well, and/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: Lw - Western larch Py - Ponderosa pine Fd - Douglas-fir, and 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 red cedar 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