Extension Summary
February 2010

Fuel Management Guidance for Wildland-Urban Interface Areas of the Interior Douglas-Fir Biogeoclimatic Zone in the Williams Lake Timber Supply Area

By: Ken Day, MF, RPF, Bruce Blackwell, MSc, RPF, Sarah Wildeman and Cathy Koot, RPBio

Definitions

***Backfire** – A fire purposely lit to burn towards a wildfire and consume fuel such that when the fire fronts meet, fire intensity is reduced.*

***Canopy Base Height** – The lowest height above the ground at which there is sufficient canopy fuel to carry fire vertically. Practically, this includes ladder fuels like dead branches.*

***Cohort** – A group of trees developing after a single disturbance. A major disturbance can lead to an even-aged single cohort stand while a series of minor disturbances can lead to a multi-cohort stand.*

***Crown Fire** – Advances laterally via aerial fuels (all dead and living material not in direct contact with the forest floor).*

Continued Page 2

Introduction

Fuel-reduction treatments in Wildland-Urban Interface (WUI) areas reduce fire suppression costs, improve safety for residents and firefighters, and improve the resilience of forests subjected to fire. Fuel and fire behaviour modelling and a review of relevant literature were conducted to identify Best Management Practices for fuel management activities in stands occurring in the Interior Douglas-Fir biogeoclimatic zone (IDF) and Community Wildfire Protection Plans (CWPP) within the Williams Lake Timber Supply Area (TSA). Thinning and surface fuel reduction in concert with strategic establishment of fuel breaks throughout CWPP wildlands are recommended fuel management strategies.

Forest Management for Fuel Reduction

Community Wildfire Protection, in keeping with forest management principles, requires managers to:

1. Subdivide the area into workable treatment zones (groups of stands).

Subdivide the management area into zones based upon geographic features such as roads, ridges, creeks and private property. The CWPP area should also be zoned according to the proximity that WUI stands have to infrastructure values at risk, and intensity of fuel treatment should be greatest in those stands having closest proximity to values needing protection.

Continued Page 2

> **Goal of Fuel Management:** to reduce potential forest fire intensity (rate of heat released as a fire advances (kW/m)).

B.A. Blackwell & Associates Ltd.

UBC Faculty of Forestry ALEX FRASER RESEARCH FOREST

From Page 1

Definitions

Ladder Fuels *- All fuels (e.g. dead branches and bark on trees, small-diameter live conifers, dead trees, arboreal lichens) above the ground surface and below the upper forest canopy. Broadleaf foliage in this ecosystem does not normally carry fire.*

Surface Fire *– Advances via surface fuels (litter on forest floor, very small trees, ground vegetation, downed wood < 7.6 cm diameter).*

Surface Fuel Loading *– Quantity of surface fuels in kg/m^2.*

Wildland *– Forest stands not immediately adjacent to urban structures and values, but sufficiently close to the interface that aggressive fire behaviour there would threaten communities (generally > 100 m from private property, public access routes or utilities).*

From Page 1

Recommended Zonation (Figure 1)

- **Private Property** – owners responsible for implementing FireSmart recommendations;
- **Urban Interface** - adjacent to private property, public roads or utilities with 30 m fuel free zone, where ladder and surface fuels under 7.6 cm are reduced to near zero, and canopy base height is raised to at least 3 m, and 70 m fuel-reduced zone, where ladder fuels are retained only in canopy gaps and surface fuels under 7.6 cm are less than 4 kg/m^2 and widely dispersed, and crown base height is raised to at least 3 m;
- **Wildland** - greater than 100 m from private property, public roads or utilities, where Forest Stewardship Plans, Woodlot Licence Plans and Community Forest Management Plans should address fuel reduction treatments;
- **Tactical Fuel Breaks** - arranged throughout the landscape at strategic low-fuel zones that provide tactical opportunities during fire suppression.

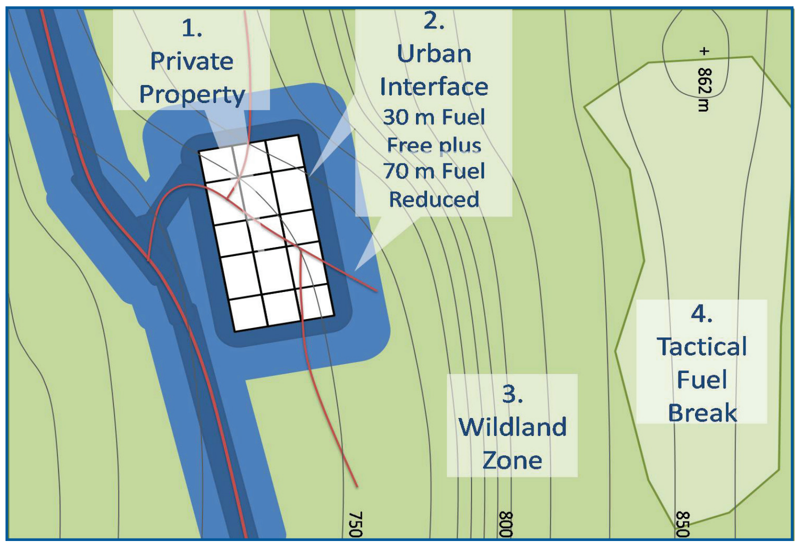

Figure 1: Recommended zonation of the Wildland-Urban Interface

2. Incorporate other resource management objectives.

Important resource management objectives established in the Cariboo Chilcotin Land Use Plan should also be mapped within the CWPP (e.g. Ungulate Winter Range, Wildlife Habitat Areas, Old Growth Management Areas, or Visual Quality), as should other values important to the community. Likewise, important resource features such as cultural and archaeological sites, stick nests, dens, mineral licks and recreation trails should also be identified on maps to the extent their presence is known. By mapping the WUI area according to logical geographic boundaries as well as proximity to infrastructure values, spatially explicit units can then be described in terms of their multiple land management objectives. This will help set silvicultural approaches and treatments.

Forests adjacent to communities contribute to the quality of life for citizens, so it is very important to ensure that fuel treatment activities do not negatively affect elements of the forest that communities value (e.g. trails, viewscapes).

3. Define a target forest structure, acknowledging local forest dynamics.

Past

Historically, the dominant disturbance regime in IDF forests in the Williams Lake Timber Supply Area was stand-maintaining fire. Fire intervals have increased since approximately 1900 due to fire suppression, cattle grazing, and elimination of First Nations burning.

Present

Uneven-aged Douglas-fir stands, in the absence of fire, currently have high densities of slender trees (typically not sawlog sized) with a low canopy base height and close crowns that pose significant risk of crown fires. Accumulations of surface and standing fuels add to this risk.

Veteran Douglas-fir snags and common and Rocky Mountain juniper, being highly flammable, and can lead to the creation of fire brands in the event of a fire. However, large snags have biodiversity values and juniper (particularly Rocky Mountain juniper) is culturally important and relatively rare in the region.

Stands leading in even-aged lodgepole pine contain abundant standing fuel at present, following the recent mountain pine beetle epidemic, and will experience increasing surface fuel loading in the near future as trees fall.

Long Range Target Stand Structure

Since mature, thick-barked Douglas-fir trees are more resilient to fire than other species, the recommended target stand structure for WUI stands is uneven-aged Douglas-fir with components of aspen, lodgepole pine and spruce, and inclusions of grassland and open forest. In areas that have been dominated by lodgepole pine, several entries, plus patience and careful silvicultural practice, may be required to develop this desired structure.

Management Vision

i. Stands are dominated by Douglas-fir, but contain significant components of aspen clumps sufficiently large to create a forest floor dominated by deciduous litterfall. Rocky Mountain juniper is maintained as a frequent component of the stand in those ecosystems where it occurs naturally.

ii. Most trees have present or potential value for forest products, and the timber produced from these stands will be highly desirable for wood products.

iii. Trees are growing in even-aged cohorts that are approximately 300-500 m^2 in area (up to one tree-length across).

iv. Mid-diameter (DBH) cohorts are sufficiently dense to suppress the understory vegetation (hence surface fuel), but large diameter cohorts are open with grass-dominated understory.

v. Large diameter cohorts have a minimum of 3 individuals on 300 m^2.

vi. Open grass and shrub-dominated areas form up to 10% of the area within a stand, and trees gradually regenerate naturally to occupy those areas.

vii. Stand density is dominated by large trees. Minimum average stand density is between 16 and 20 m^2/ha, and maximum tree diameter is between 60 and 70 cm DBH, although larger trees can be reserved for habitat and biodiversity purposes.

viii. Surface fuel loading is generally less than 4 kg/m^2 but in all cases less than 8 kg/m^2. The majority of that surface fuel is discontinuous in pieces larger than 15 cm lying flat on the ground.

ix. Canopy base height is always more than 2 m, and generally more than 3 m. In areas of conifer regeneration, live branches will be pruned to 3 m or half of the live crown depth, whichever is less.

Wildland Stands within Mule Deer Winter Range

Within British Columbia, General Wildlife Measures have the force of regulation under the Forest and Range Practices Act and apply to wildland stands within identified mule deer winter ranges. Those measures are generally in concert with the above vision for wildland stands, but provide specific recommendations for stand density, e.g. post-harvest minimum basal area between 16 and 29 m^2/ha depending on mule deer winter habitat class and biogeoclimatic subzone.

4. Create an operational plan that puts treatment zones into an optimal arrangement across the landscape and over time.

Sites with high surface fuel loading (>8 kg/m^2) of material <7.6 cm diameter in dry site series of dry ecosystems with important values should receive highest priority for fuel management as they are at high wildfire risk. Fuel treatments should increase stand resilience such that treated stands have increased probability of surviving a fire. This is correlated to the fuel management goal of reducing fire intensity, should a wildfire occur. Strategic locations of tactical fuel breaks within the wildland matrix should be identified via spatial analysis, with input from fire specialists (see below). When planning road development and maintenance standards, ensure long-term, dry-weather accessibility to fuel breaks by fire suppression crews and water tanker trucks.

5. Monitor treatment effectiveness and respond adaptively if management targets are not met.

A Gingrich stocking chart calibrated for the IDFdk3 subzone (Day 1998) could be used to describe the pre-treatment stocking status of the stand in comparison to the long-range target stocking. Notations made on the chart before and after each entry can track the progress towards the target. Gingrich stocking charts are means of examining the density of a stand with regard to the range of acceptable stocking, and has an upper limit describing the onset of competition-induced mortality and a lower limit at which a stand is understocked by trees. Metrics like surface fuel loading and canopy base height can be compared with recommended values (below). Monitoring will prompt redesign of management when failure is detected.

Optimal Fuel Loading for Stand Resilience to Fire

Fuel and fire behaviour modelling that included inputs like stand inventory and environmental data (e.g. 90th percentile weather conditions from the IDFdk3 (29°C and 24% Relative Humidity), 15 km/hr wind speed), suggests that the following fuel reduction efforts be taken to reduce risk of wildland fire in the IDF of the Williams Lake TSA:

1. To create **stand resilience** or **fuel break conditions**, maintain surface fuel loadings below **4 kg/m^2**;
2. At surface fuel loading less than 4 kg/m^2:
    i. Where the tolerance for risk is **moderate** (e.g. not within close proximity to infrastructures), the canopy base height should be **greater than or equal to 2 metres**.

    ii. Where the tolerance for risk is **low** (e.g. within close proximity to infrastructures), the canopy base height should be **greater than or equal to 3 metres**.
3. Surface fuel loadings should never exceed **8 kg/m^2**;
4. If surface fuels cannot be maintained below 4 kg/m^2 and are between **4-8 kg/m^2** then the canopy base height must be **greater than or equal to 3 metres**.

Of note:

• Maintaining low levels of surface fuel loading should be a primary management concern.

• Stand density or basal area as a sole measure of canopy fuel loading is not sufficient. Ladder fuels and surface fuels (affecting canopy base height) have large influences on fire behaviour.

• A high basal area or a high number of trees (up to 2000 stems/ha) can be maintained with little risk of crown fire if the advanced regeneration and small diameter class trees are removed, if canopy base height is greater than or equal to 2 metres, and if surface fuels are kept below 4 kg/m^2.

What do Different Levels of Surface Fuel Loading Look Like? (Figure 2)

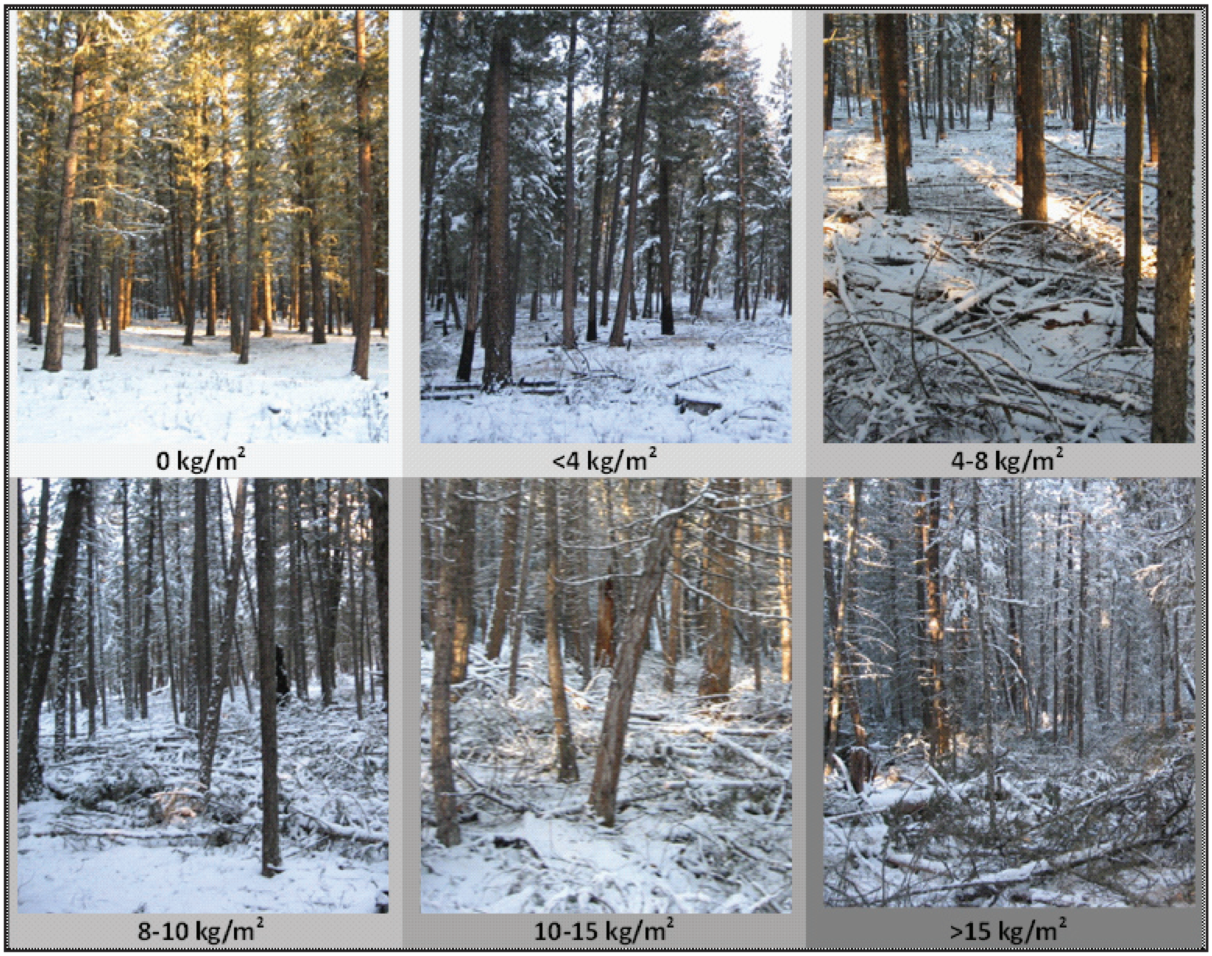

Figure 2: Photo gradient of fuel loadings. These values are observation-based estimates only and field measurements are required for validation

Best Practices for Wildland Fuel Treatment in Community Wildfire Protection Plans

1. Thinning and Surface Fuel Management in the Wildland Matrix

Thinning from below, accompanied by management of the fuel it creates, shifts forest stands from having high crown fire potential to having low surface fire potential (Figure 3). This is accomplished by:

• Reducing stem density to reduce crown closure, and thus the risk of crown fire spread;

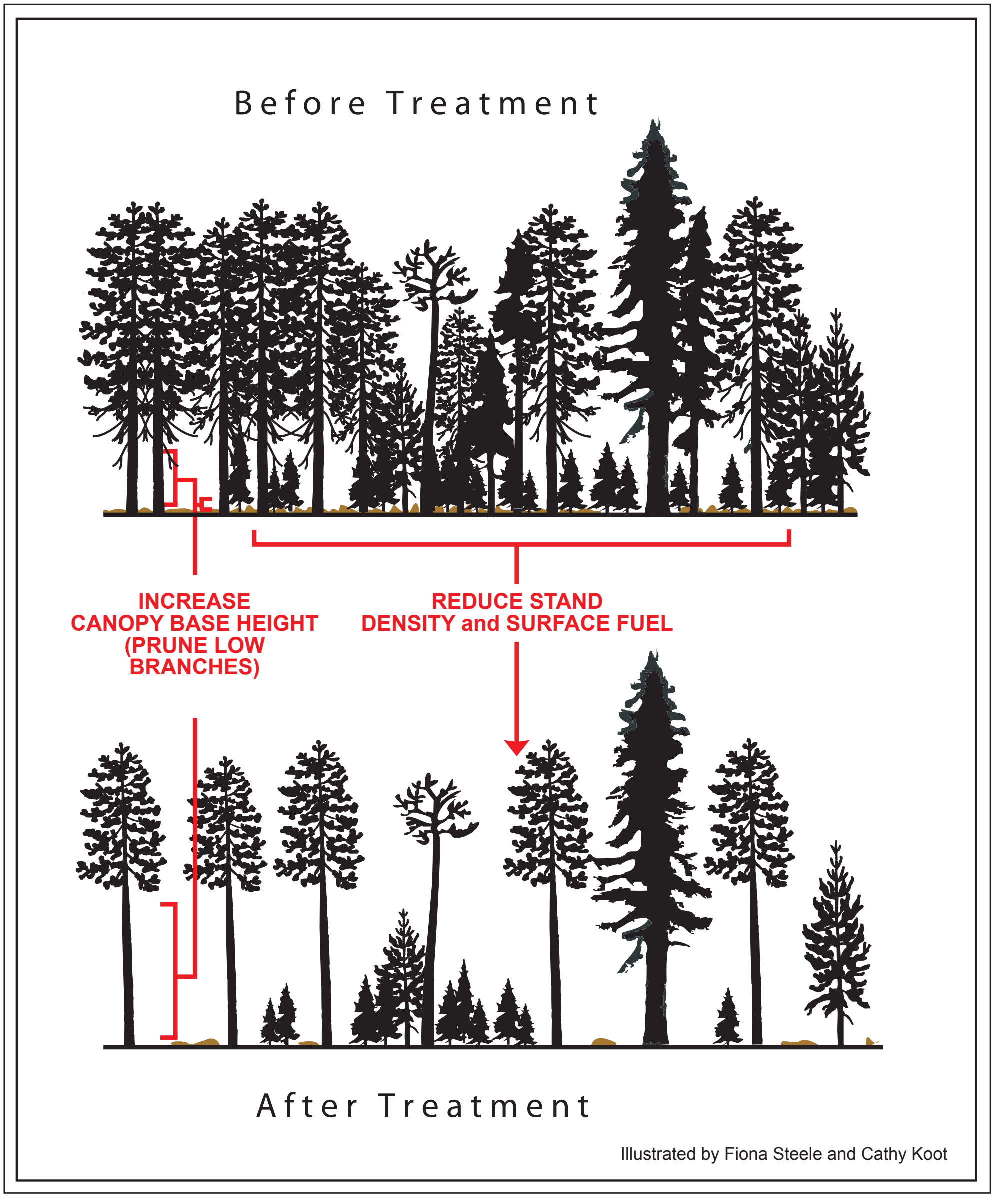

Figure 3: Schematic showing the principles of thinning to reduce stand level hazard

- Increasing the canopy base height through the reduction of ladder fuels via thinning of small-diameter live conifers (both commercial- and pre-commercial-sized) and pruning of branches such that the potential of surface fire spreading into tree crowns is reduced;
- Retaining the most fire resistant trees in the stand. These include the largest specimens of species best adapted to withstand fire – e.g. Douglas-fir, as well as slow-burning trees such as aspen, birch, and cottonwood;
- Removing thinning slash and pre-existing fuels to reduce surface fuel loadings by piling and burning or by removal to roadside for bio-energy use;
- Chipping and distributing the material on the ground surface of a site can increase the decay rate of surface fuels, but does not actually remove the fuel from the site. Chipped fuel can still ignite and sustain slow but intense surface fires.

Guidance for Thinning Treatments

- Thin to cut portions of a stand that are dead or growing inefficiently to free up growing space for the residual stand.
- Large trees that are growing in a clump and sharing a root mass should all be cut or all left because a pair of trees sharing a stump will become unstable if one is cut, and the proximity of the stump will invite bark beetles to the remaining tree.
- Retain the best-formed and most vigourous trees according to the following preference order: Douglas-fir, aspen (birch, cottonwood), spruce (under canopy) or lodgepole pine (open or dry sites). Managing residual trees for timber values may allow future fuel reduction treatments to be supported (at least in part) by timber revenues.
- The spatial distribution of the residual stand should be clumpy. Small trees growing under large trees should be cut because they have no future growing space and create ladder fuels into the crowns of larger trees.

- Residual trees within a cohort or clump will be left at the following spacing depending upon tree size:
    - o Trees less than 1.3 m in height will be left uncut;
    - o Inter-tree distance between trees 1.3 m in height and 7.5 cm DBH should average 2 m, ranging from 1.0 to 2.5 m;
    - o Inter-tree distance between trees 7.5 cm and 12.5 cm DBH should average 3 m, ranging from 1.0 to 3.5 m;
    - o Trees larger than 12.5 cm DBH should be left at the target residual basal area for the stand.
- Employ careful falling and skidding practices to limit damage to residual trees.
- Retain dead standing trees that are not danger trees, existing decayed woody debris, and up to 40 m^3/ha of fresh downed wood in pieces larger than 15 cm and up to 6 m long. Arrange logs so they lie flat on the ground and do not touch each other.
- Remove thinning slash and pre-existing fuels such that there is less than 4kg/m^2 and prune residuals such that the canopy base height is a 2-3 m depending on risk tolerance for the site. If surface fuel loading has to be greater, it must not exceed 8 kg/m^2 and the canopy base height must be at least 3 m.
- While thinning the commercial portion of the stand (greater than 12.5 cm DBH) can precede precommercial thinning and fuel disposal, for efficiency's sake, experience suggests that integrating operations provides the lowest total cost.

Uneven-Aged Douglas-fir Stands

Stands currently dominated by uneven-aged Douglas-fir will generally remain quite closed, with a relatively high density of mid-sized trees remaining. This is because much of the stand density before harvest tends to be concentrated in the size classes between 12.5 and 30 cm DBH.

Even-Aged Lodgepole Pine Stands

Stands currently dominated by dead lodgepole pine will be quite open after treatment, as the majority of pine will be removed.

- Due to shade intolerance, live pine in the understory will be slender with little foliage and may have significant disease or insect damage. Poorly formed or damaged understory pine should be cut during the treatment.
- Slender understory Douglas-fir and spruce, being more shade tolerant, may already be in the process of adapting to the released growing space due to the death of the pine overstory. They will be developing larger crowns and becoming more mechanically stable.
- Overstory Douglas-fir and spruce (and aspen) may be quite exposed to damage by wind after removal of pine. Monitor for wind damage, bark beetle infestation, and salvage opportunities.
- Grasses, shrubs and forbs may be well established in the understory and limit conifer regeneration in the short term. Consider artificial regeneration or let nature take its course.
- Aspen, where present, will regenerate vigorously after treatment and should be an important component of the post-treatment stand. Aspen will, over time, provide suitable nurse-crop conditions to support Douglas-fir regeneration. Preferred species for regeneration include aspen and Douglas-fir, and suitable species are lodgepole pine and spruce.

2. Tactical Fuel Breaks Across the Landscape

Fuel breaks are strategically placed strips of low-volume fuel on the landscape where firefighters can make a stand against fire (e.g. indirect attack via the ignition of backfires) and provide safe access for fire crews in the vicinity of wildfires (Figure 4).

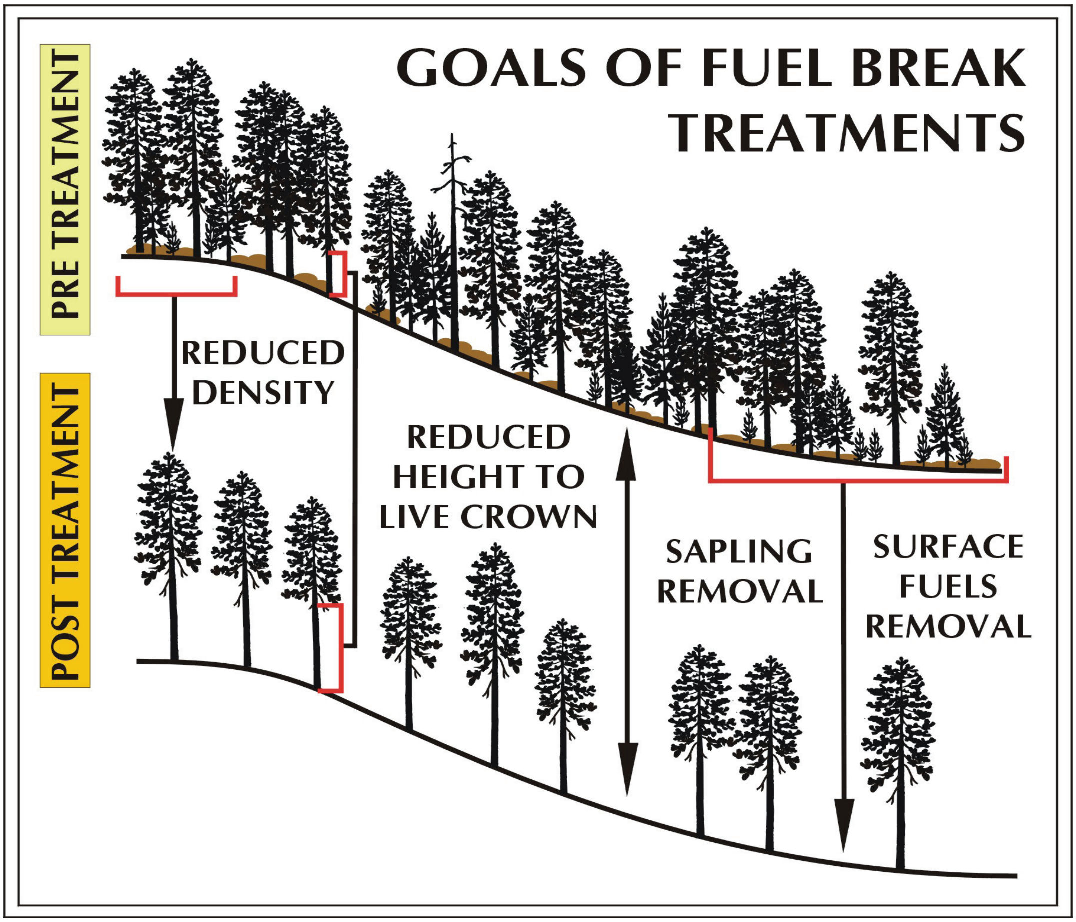

Figure 4: Conceptual diagram of a shaded fuelbreak pre treatment and post treatment

Fuel breaks:

- Are created in strategic locations by reducing surface fuels, increasing canopy base height and aggressively lowering stand density;
- Function most effectively when situated within a wildland matrix that has also experienced fuel reduction.

Guidance for Creating Landscape Fuel Break Treatments

- Consider the direction fire would likely come from due to prevailing winds and prioritize fuel management on areas that present the greatest risk to the urban interface.
- Identify existing fire barriers such as agricultural developments, roads, airports, lakes or other low-fuel areas such as rocky areas, ridges and bare ground.
- Identify stands that enlarge or link these low-fuel conditions and that are located outside of established mule deer winter range, or within areas of low habitat objective within mule deer winter range.
- In consultation with fire specialists, identify candidate fire break areas that could support tactical fire suppression measures or provide fire crews with safe access.
- Thin target stands from below to retain an open stand of the largest Douglas-fir trees, with a target of 16-20 m^2/ha on 300 to 500 stems/ha.
- Canopy base height should be greater than or equal to 3 metres.
- Remove thinning slash and pre-existing surface fuels and maintain surface fuel loadings below 4 kg/m^2 over time.

3. Cost Of Treatment Relative To Value Of Timber Harvest

Fuel treatments are expensive, particularly if there is no commercial harvest value attributed to the project. All-found costs, including planning and supervision, can range from $2,000 to $10,000 per hectare, depending on circumstances and operational methods used. In general, operators favour whole-tree removal of target trees, with piling at roadside for burning or removal as biofuel. Whole trees delivered to roadside containing merchantable logs, should be ideally merchandized for that purpose and not ground or chipped for biofuel. While current government funding disallows the sale of logs generated from interface fuel treatments, there is a very real chance that log sales could support, at least in part, future fuel reduction treatments if program criteria can be adjusted.

Summary

Fuel and fire behaviour modelling, a review of relevant literature and local experience contributed to the identification of Best Management Practices for fuel management activities in stands occurring in the Interior Douglas-Fir biogeoclimatic zone and Community Wildfire Protection Plans (CWPP) within the Williams Lake Timber Supply Area. Thinning and surface fuel reduction, along with strategic establishment of fuel breaks throughout the wildland portions of the CWPP areas are recommended. Modelling suggests that stand resilience to surface fire will occur when surface fuels are less than 4 kg/m^2 and canopy base height is greater than or equal to 2-3 m, depending on risk tolerance for a given stand. Fuel removal must accompany thinning and stand density reduction for fuel treatments to be effective at reducing forest fire intensity should a fire occur. Surface fuel loading should not exceed 8 kg/m^2.

Managers should plan for fuel treatments using forest management principles. The CWPP area should be subdivided into workable treatment zones such that community values and legislated management objectives are recognized. Wildland stands then need to be prioritzed according to proximity to infrastructures. Treatment prescriptions should be planned according to short- and long-term target stand structures and in accordance to General Wildlife Measures if on identified mule deer winter ranges. Operational plans need to put treatment zones into optimal arrangements across the landscape and over time. Monitoring treatment effectiveness will ensure that stands in the Wildland-Urban Interface continue to provide ongoing resilience to fire and opportunities for fire-fighting tactics into the future.

Citation

Day, J.K. 1998. Stocking standards for uneven-aged interior Douglas-fir. *In* Vyse, A., C. Hollstedt, and D. Huggard (editors). Managing the dry Douglas-fir forests of the Southern Interior: Workshop Proceedings April 29 -30, 1997, Kamloops, British Columbia, Canada. Research Branch. B.C. Ministry of Forests, Victoria, B.C. Working Paper 34 /1998.

This extension summary is based on:
Day, K., B. Blackwell and S. Wildeman. 2010. Harvesting and Thinning Guidance for Treatments in Wildland-Urban Interface Areas of TSA 29. FIA Project SOTSA299093008 Contract Report to Tolko Industries, Ltd. Unpubl. report.

UBC Alex Fraser Research Forest: http://www.forestry.ubc.ca/resfor/afrf/index.htm