Summary of Pre-industrial Forest Condition of English River, Caribou, Black Spruce and Dog River-Matawin Forests, Ontario

Version 3
April, 2016

Prepared by: Triin Hart, PhD

resolute
Forest Products

BACKGROUND
This document is a brief summary prepared for the public of a lengthy and comprehensive report. Further information or a copy of the full report is available by contacting Mike Maxfield, Certification Superintendent at: 807-475-2626 or mike.maxfield@resolutefp.com.

The Pre-industrial Forest Condition Report of English River, Caribou, Black Spruce and Dog River-Matawin Forests, Ontario (the PIC report) (Figure 1) was prepared to fulfill FSC National Boreal Standard Criteria 6.1.5 that requires assessment of pre-industrial landscape, including disturbance regimes, and age and compositional structure. The "pre-industrial condition" is defined as the natural landscape condition within the range of natural variability with no human interference. In addition to a historical landscape condition, this definition includes a full range of landscape and stand conditions that existed before the beginning of industrial activity, i.e. natural ranges of variation.

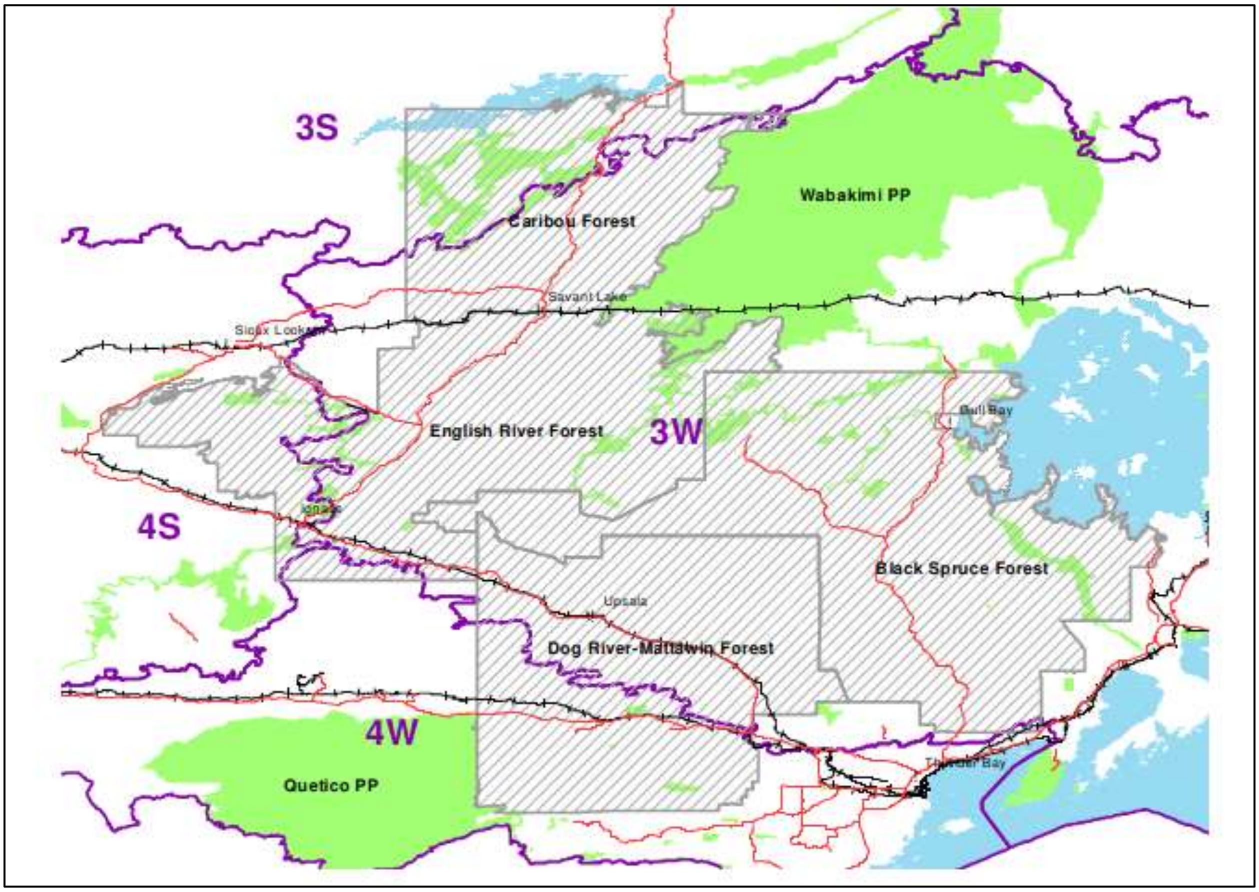

Figure 1. Map of the study area – Caribou Forest, English River Forest, Black Spruce Forest and Dog River-Matawin Forest. The ecoregion classification follows Hill's Site Regions (Hills 1961).

The first PIC report was prepared for the Caribou Forest in 2009 and was peer-reviewed by Dr. Kevin Kemball and Dr. Norm Kenkel. A joint PIC report was prepared for the Black Spruce and Dog River-Matawin Forests in 2012 and peer-reviewed by Dr. David Andison and Dr. Daniel

Kneeshaw. The current version of the PIC report combines the analysis of four Resolute Forest Products Sustainable Forest Licence areas (Caribou, English River, Black Spruce and Dog River-Matawin) and was peer-reviewed by Dr. Juha Metsaranta and Dr. Norm Kenkel in 2013. The report consists 150 pages, 90 figures, 6 tables and 2 appendices.

METHODS

The natural landscape condition was reconstructed using a combination of empirical and simulation modeling and literature synthesis approaches. Description of historic landscape composition, structure and dominant disturbances was obtained from historical survey records, forest inventories, management plans and scientific literature. In addition, simulation models Strategic Forest Management Model (SFMM) (Kloss 2002) and Boreal Forest Landscape Dynamics Simulator (BFOLDS) were used (Perera et al. 2008).

NATURAL DISTURBANCES

Landscape patterns in Northwestern Ontario are driven by the relatively dry climate resulting in frequent and large-scale fires. Spruce budworm, wind, forest tent caterpillar and jack pine budworm are common secondary natural disturbance agents. However, their impact on the landscape can be considered low compared to fire. Therefore, forest management in the area is adjusted to emulate mainly fire effects in terms of frequency, spatial occurrence and size distribution.

Fire

Fire is the only natural disturbance agent in the boreal forest that can cause extremely severe disturbances to forest vegetation, resulting in nearly complete mortality of overstory trees, understory vegetation and consumption of soil organic layers (Johnson 1992). Fire is the main agent that can set succession back to conditions where seral stages are distinguishable and where the first tree cohort is usually established by same-aged fire adapted tree species.

A natural fire regime has a high degree of variability related to fire size distribution and the estimations of the length of fire (Li 2002). A review of fire cycle literature showed that fire frequency in the Northwestern Ontario boreal forest has either increased or remained stable during the late Holocene (ca. 4000-0 years BP), depending on the site examined (Genries et al. 2012; Senici, Chen, and Bergeron 2015; Senici et al. 2013). Recent studies demonstrate a strong influence of soils, vegetation, and landscape connectivity in influencing the average fire return intervals at different sites (Senici, Chen, and Bergeron 2015; Senici et al. 2013). Average fire cycles varied significantly throughout the Holocene (~10000-0 years BP) with average fire cycles of approximately 260 years in the early Holocene (10,000-4,000 years BP) compared to average fire cycles of 120 years during the late Holocene (ca. 4000-0 years BP) (Senici et al. 2013). This increased fire frequency during the late Holocene was attributed to the onset of cooler and moister climatic conditions, which led to a decline of white pine (*Pinus strobus*) populations and increase of relatively more flammable vegetation types including black spruce (*Picea mariana*) and jack pine (*Pinus banksiana*) (Genries et al. 2012).

In contrast to the relatively long fire cycles estimated by Holocene charcoal studies, average fire cycles of ~100 years have been estimated by fire record reconstruction, dendroecological studies, and natural disturbance simulations (i.e. BFOLDS). The difference in fire cycles between these types of studies is explained by their difference in temporal scale. Holocene charcoal record studies generally span timescales of ~10000 years, which includes periods of relatively very high and low fire activity. In contrast, studies that use historical fire records and/or dendroecological sampling generally cover time periods of approximately 300 years, due to the inavailability of data for older time periods. These differences in temporal scale among the different types of fire studies affect the fire cycle estimate. In practical terms, this means that the long time period of Holocene charcoal studies may not accurately reflect recent increases or decreases in fire activity. Indeed, one recent study found that fire activity has increased significantly in Northwestern Ontario over the last century, likely due to warming temperatures since the end of the little ice age (ca 1850) (Senici et al. 2010). This result is also in agreement with a number of other studies from other areas of the boreal forest that report significant increases in fire activity over recent decades due to warming temperatures (Calder et al. 2016; Girardin et al. 2013; Kelly et al. 2013; Marlon et al. 2012) . This shorter fire cycle length is also supported by natural disturbance simulation studies which find average fire cycles of ~100 years for Resolute's northwestern Ontario forests (Elkie et al. 2013).

Natural fire size distribution is characterized in northwestern Ontario forests by a large number of small fires and small number of large fires. The number of large infrequent fire events is decreased in current landscape compared to historic conditions and this is attributable to fire suppression, harvesting and stochastic nature of fire regime. Boreal fires create variability in the landscape patterns through fire shapes, sizes and severity and this variability needs to be taken account when planning for harvesting, residual management and silviculture. The southern part of the study area is influenced by milder and more humid climate and is characterized by lower fire intensity and a higher number of smaller fires.

Other disturbances

Spruce Budworm (SBW) is the second most common disturbance agent in the study area. In every 20¬100 years, the SBW population reaches epidemic levels, causing severe and extensive defoliation of stands dominated by balsam fir and white spruce and in the epidemic years also black spruce. The other common disturbance agents in the Forests are wind, forest tent caterpillar (FTC), jack pine budworm, yellow-headed spruce sawfly and several root rots and stem rots. However compared to fire and spruce budworm, their influence on landscape composition and structure is relatively low. All these disturbances "weed out" most susceptible individuals either by species or age or by combination of both (Dyer and Baird 1997).

IMPACTS OF INDUSTRIAL HARVESTING

Industrial harvesting started around the 1930's and was initially confined to the Dog River-Matawin and southern and eastern parts of Black Spruce Forest due to proximity of towns and water access. These areas are reflective of logging history that used to concentrate only economically feasible species. In addition, the adaptation of the Timber Management Guidelines for the Provision of Moose Habitat in 1980's required establishment of small harvest blocks with residual hardwood patches. As a result, the area contains a substantial proportion of mixedwoods with bimodal structure. These stands are uncommon in a natural landscape driven by stand-replacing fires and fail to provide habitat for the endangered umbrella species woodland caribou.

In addition, the well-established network of roads has enhanced the fragmentation of the forest landscape.

The English River Forest has been industrially harvested since the 1960's and the northern proportion of the Black Spruce Forest since the 1970's, with clear cutting the dominant harvesting method. The resulting landscape structure resembles a fire disturbed landscape consisting of large patches of even-aged forests. Nevertheless, the insufficient silviculture practices until the 1980's have increased the conifer-hardwood mixed species stands at the expense of pure conifer stands.

The harvesting history in the Caribou Forest started in the mid-1970s with harvesting activities limited to a relatively small area of the Forest, leaving the majority of the Forest in its natural state. The Caribou Forest has a large area of forest older than would be expected under a natural disturbance regime. This is due in large part to the combined influence of fires associated with settlement and railways in the early 1900s, fire suppression activities since, and industrial harvesting activities being limited to a relatively small portion of the forest area over a relatively short time period. Computer simulated forecasts show that these areas of old forest will decline over time due to natural succession and planned harvesting activities. But the amount of older forest cover is expected to remain within the range of values consistent with natural disturbance processes for most cover types.

FOREST PATTERNS

Vegetation patterns reflect gradual change in climate and disturbance regimes from north to south as well as the harvesting history. Relative importance of black spruce decreases from north to south, whereas the proportions of jack pine and hardwoods increase. The proportion of jack pine and black spruce dominated stands has decreased as a result of historical industrial species preferences and pre-1980 insufficient silviculture in the area, with the magnitude of the decrease being in accordance with the length of the industrial harvesting history. In addition, historically, the southern parts of the study area supported abundant red pine and white pine found in pure and mixed stands. The abundance of these two species has decreased as a result of historical high grading for these species starting late 1800's.

Boreal ecosystems are by nature very dynamic with one large fire or spruce budworm outbreak potentially resulting in a large shift in landscape composition and structure. This can be well observed in the Caribou Forest where mature and old stands currently compose nearly 55% of the forested land which is considerably higher than expected under the scenario of average fire cycle. This was caused by the large fire of 1918 that burned nearly half of the Caribou Forest; and due to lack of large fires in former Caribou East. Spruce dominated or mixed conifer stand types in mature age class contribute most to the increase of mature and old conifer stands compared to natural ranges. Similar patterns can be observed among hardwood dominated forests, where the proportion of forest in mature age classes is higher than expected according to the historic data and simulated natural ranges of variation.

There has been a decrease in the abundance of old-growth forests in both the Black Spruce and Dog River-Matawin Forests. The decrease has been especially large in the Dog River-Matawin Forests, where the proportion of old-growth stands is currently only 2.9% (compared to

BFOLDS ranges of 5-42.3%). In the Caribou and English River Forests, the proportion of old-growth appears to be within the ranges of natural variation.

Projections made by forest management plans for all four SFLs move forest composition and structure towards their natural state. Fire cycle estimations align with those found in the current report for the Black Spruce (110 years) and English River Forests (113 years), but seem to be on the lower range of natural variation for Caribou (70 years) and Dog River-Matawin Forests (80 years). However, given the high impact of historical forest harvesting in the Dog River-Matawin Forest that has significantly increased the proportion of un-even aged mixed stands, the application of higher cut levels may be desirable to help convert these stands back to even-aged conifer dominated forests as characteristic of a stand-replacing fire regime.

REFERENCES

Calder, W J et al. 2016. "Medieval Warming Initiated Exceptionally Large Wildfire Outbreaks in the Rocky Mountains." PNAS 112(43): 13261–66.

Dyer, J.M. and Baird, P.R. 1997. Wind disturbance in remnant forest stands along the prairie-forest ecotone, Minnesota, USA. Plant Ecology 129(2): 121-134.

Elkie, P et al. 2013. Science and Information in Support of Ontario's Forest Management Guides for Landscapes: Science Package – Series A: Simulations, Rationale and Inputs. Ontario Ministry of Natural Resources. Forest Policy Section.

Genries, A et al. 2012. "Local versus Regional Processes: Can Soil Characteristics Overcome Climate and Fire Regimes by Modifying Vegetation Trajectories?" Journal of Quarternary Science 27(7): 745–56.

Girardin, M P et al. 2013. "Vegetation Limits the Impact of a Warm Climate on Boreal Wildfires." New Phytologist 199: 1001–11.

Johnson, E.A. 1992. Fire and vegetation dynamics: studies from the North American boreal forest. Cambridge University Press.

Kelly, R et al. 2013. "Recent Burning of Boreal Forests Exceeds Fire Regime Limits of the Past 10,000 Years." PNAS 110(32): 13055–60.

Kloss, D. 2002. Strategic Forest Management Model, Version 2.0 user guide. Ontario Ministry of Natural Resources, Forest Management Branch, Forest Management Planning section., Toronto, ON.

Li, C. 2002. Estimation of fire frequency and fire cycle: a computational perspective. Ecological Modelling 154 (1¬2): 103-120.

Marlon, Jennifer R et al. 2012. "Long-Term Perspective on Wildfires in the Western USA." PNAS: 535–43.

Metsaranta, J.M. 2010. Potentially limited detectability of short-term changes in boreal fire regimes: a simulation study. International Journal of Wildland Fire 19(8): 1140-1146.

Perera, A.H., Ouellette, M., Cui, W., Dresher, M., and Boychuk, D. 2008. A spatial simulation model for exploring large scale fire regimes and succession in boreal forest landscapes. Forest Research Report 152.

Perera, A.H. and Cui, W. 2010. Emulating natural disturbances as a forest management goal: lessons from fire regime simulations. Forest Ecology and Management 259(7): 1328-1337.

Seidl, Rupert, Paulo M. Fernandes, Teresa F. Fonseca, François Gillet, Anna Maria Jönsson, Katarína Merganičová, Sigrid Netherer et al. 2011. Modelling natural disturbances in forest ecosystems: a review. Ecological Modelling 222, no. 4: 903-924.

Senici, D et al. 2013. "Multi-Millennial Fire Frequency and Tree Abundance Differ between Xeric and Mesic Boreal Forests in Central Canada." Journal of Ecology 101: 356–67.

Senici, D, H Y H Chen, and Y Bergeron. 2015. "The Effects of Forest Fuel Connectivity on Spatiotemporal Dynamics of Holocene Fire Regimes in the Central Boreal Forest of North America." Journal of Quarternary Science 30(4): 365–75.

Senici, D, Han Y H Chen, Y Bergeron, and D Cyr. 2010. "Spatiotemporal Variations of Fire Frequency in Central Boreal Forest." Ecosystems 13: 1227–38.