FUTURE WILDFIRE RISK IN THE HRM WILDLAND-URBAN INTERFACE UNDER CLIMATE CHANGE

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EXECUTIVE SUMMARY

The earth's climate is changing due to anthropogenic emissions of greenhouse gases. The climate is warming, snow and ice are melting, and sea levels are rising as a result of anthropogenic climate change. In Nova Scotia and the HRM climate change is expected to result in steadily warming temperatures and increasing frequency and volume of precipitation. Climate change is expected to have both direct and indirect effects on the HRM Acadian Forest, which surrounds the cities of Halifax and Dartmouth.

Areas where urban development lies alongside and intermingles with wildlands, such as the Acadian Forest stands in the HRM, are defined as wildland-urban interface (WUI). WUI areas have an inherently elevated fire risk as developments and their associated complex fuels, such as decorative landscaping, exist in proximity to wildlands with natural fire regimes. Future climate change will alter the Acadian Forest by changing climate and storm event severity, and altering tree species communities and disturbance regimes, which will also affect the fire risk in the WUI.

This report consolidates and analyses projections for the Acadian Forest under climate change, examining impacts on positive and negative drivers of fire risk. The report builds on previous work for the HRM, which delineated WUI areas in suburban study communities, and made policy recommendations for managing WUI in the HRM in response to evidence that residents are not actively managing wildfire risk. Like that past work, which used the Canadian Forest Fire Behaviour Prediction (FBP) system to model burn probability, the current report also adopts the assumptions of the FBP system. The weather conditions that influence fire behaviour, ignition and suppression, known as fire weather, are understood to be the primary driver of fire risk and behaviour, with vegetation acting as a secondary driver of risk.

Key pathways (or drivers) of fire risk over a hundred-year timescale are explored in this report – fire weather, storm severity, species composition, and pest outbreaks – and their net impacts are qualitatively determined:

- Fire weather is generally projected to increase across Canada. Although climate warming is expected to increase fire risk across Canada, the warming climate projected for the HRM may not result in an overall increase in fire risk, as this warming will be accompanied by a simultaneous increase in frequency and volume of precipitation. The number of days with rain is correlated with burned area in Canada. Despite this general decline in fire-prone weather over time, precipitation increases are projected to differ by season with moderately dry summers and autumns. Precipitation volume is also expected to decline after increases in the 2020s, leading to a warmer, but not consistently wetter future climate. This variability in precipitation is expected to lead to intermediate increases in future fire risk, and a lengthened fall fire season. Our modelling of future fire weather suggests that the severity of fire weather in the HRM will increase.
- Tropical cyclone severity is expected to increase, as is the frequency of severe storms. Tropical cyclones are projected to pass closer to the HRM and these more severe storms may penetrate further inland, resulting in increasing wind throw of tree stands. Wind throw creates coarse woody debris and ladder fuels, which are positive drivers of fire risk. The build up of woody debris may, however, be somewhat mitigated by accelerating decomposition rates.
- The tree species of the Acadian Forest Region will be affected by climate change, leading to an altered future community in this area. Fire prone coniferous species are projected to decline, replaced by pioneer deciduous species. As conifers are a significant factor in fire risk in mixedwood forests, the removal of these species will act as a negative driver of future fire risk. The maladapted species and dead conifer stands will, however, increase woody debris and ladder fuels on the landscape in the short term, acting as a temporary positive driver of risk.
- Future climate change is also expected to increase the severity and duration of insect outbreaks in the HRM. These modelled increases will lead to increased stand mortality, and will also act as a positive driver of future fire risk.

Our modelling projects that fire risk in the HRM will decline over time, associated with the change in tree species composition in this area. This decline in risk will not be linear, and the

HRM will face intermediate periods of elevated fire risk. These intermediate increases in risk are as a result of positive drivers of fire risk, specifically variable precipitation increases and elevated landscape-level fire risk due to increasing fuel loading. These drivers of risk are site-specific.

Although future fire risk in the HRM should decline over the long term (100 years), the HRM must manage intermediate stages of elevated risk, and manage WUI development. The Municipality can manage these risks by introducing fuel management programs on public property and educating private citizens and citizen organizations about fuel loading and landscape-level fire risk. The HRM must try to limit ongoing WUI development, and to identify WUI and manage WUI areas for fire risk. People living in proximity to wildlands with natural fire regimes are at risk from wildfire, even under a future climate with reduced fire risk in the Acadian Forest.

URBAN FORESTS AND HAZARD MANAGEMENT: TRADE-OFFS BETWEEN WILDFIRE RISK AND BENEFITS FROM TREES IN THE HRM WILDLAND-URBAN INTERFACE

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Urban managers must balance trade-offs between benefits from urban forests and the wildfire hazard associated with peri-urban forests. These two priorities are at odds, as urban forest promotion requires the protection and planting of trees, while fuel treatments to reduce wildfire hazard result in the removal of vegetation and reduction of stand density.

The Halifax Regional Municipality (HRM) is located in Nova Scotia, Canada, within the Acadian Forest Region (AFR). Development in central Halifax has spread outward, coming into contact with AFR wildlands, and creating areas of wildland-urban interface (WUI). WUI has an inherently elevated wildfire risk associated with the proximity of residences and complex fuels to wildland with natural wildfire regimes. The AFR has a natural wildfire regime, due to the dominance of fire-prone boreal tree species in this transitional forest region. The tree species composition of the AFR is expected to shift over time under future climate change, leading to a shift towards dominance of broad-leaf deciduous tree species.

Urban forests provide economic, ecosystem and social benefits. Urban forests can reduce cooling costs, reduce noise, filter water and air, and protect human health and mental wellbeing. Protecting existing trees and planting new ones promote these benefits. Conversely, wildfire hazard in peri-urban areas is elevated by the presence of trees. WUI wildfires have both social and economic costs, resulting in property loss and infrastructure damage, response costs, insurance payouts, costs to mental health for affected residents and potentially loss of life. The

risk of structure damage or destruction during wildfire is mitigated through the removal of vegetation and trees.

The HRM has two existing policies that impact the management of the urban forest. Council adopted the Urban Forest Master Plan (UFMP) in 2012 to guide the development of a sustainable urban forest, and to steer decisions around urban forest issues. This document is focused around the HRM urban core and does not examine the peri-urban in detail. The UFMP sets goals for increasing planting of trees and increasing tree canopy, protecting and promoting the HRM urban forests. The HRM also has recommendations for the implementation of fuel treatments to reduce wildfire risk in the WUI. These fuel treatments are similar to those of *FireSmart*, a fuel management program developed in Alberta. *FireSmart* recommends that homeowners remove the majority of fuels and vegetation in the ten metres closest to their home known as "Priority Zone 1", and apply fuel management treatments, such as stand thinning, in the area beyond this zone.

We modelled the application of a modified *FireSmart* treatment in the study communities of Beaver Bank and Spryfield using a detailed forest layer in the ArcGIS program. The detailed, unmodified forest fuel layer and the layer with the simulated fuel management treatment were used in the Burn-P3 model to compare fire susceptibility, representing wildfire hazard, before and after the simulated treatment. Modelling showed that WUI residents in the HRM have not adopted defensible space recommendations, as the simulated fuel treatment removed 171.5 ha of tree canopy in the communities, the majority of which was in the twenty metres beyond Priority Zone 1. This was equivalent to the removal of between 40131 and 2628409 trees, depending on the actual density of tree stands. If these trees are each valued the same as a natural urban street tree in the HRM, this would result in a loss of urban forest benefits from energy conservation, CO_2 removal, air quality improvements, stormwater management and property values of between 2.29 and 150.67 million dollars for the Municipality. Despite these lost benefits the simulated fuel management treatment notably reduced the number of homes that were in contact with areas of elevated wildfire risk and lowered the overall wildfire risk in fringe areas beyond the structures.

Both the benefits and costs associated with urban forests are evident, but it is difficult to determine which should be the priority for management, without proper context. When these are examined over a planning timescale, with consideration of changing wildfire risk in the peri-urban fringe it becomes easier to strike a balance between the two priorities. Trees are rare in

dense urban areas, and are worth less at a distance from the urban core and where there are many trees standing a group. Wildfire hazard also increases with distance from the urban core, following an inverse trend. The priority for management should shift from increasing urban forests within the core, to the management of WUI areas to reduce wildfire risk at the fringe. At present, WUI wildfire risk is high, and modelling suggests that the severity of climate conditions for wildfire will increase in the future. This increase in fire weather will be offset by a shift from high-fire risk species in the AFR to a deciduous, lower-fire risk community. This shift will be gradual, and may include intermediate periods of elevated wildfire risk in the mid-term. In the short-term the reduction of wildfire risk through fuel treatments should be the priority for management, but as wildfire hazard decreases with the changing forest community, priorities should shift towards the promotion of urban forests. To mitigate the removal of trees through fuel treatments, managers can plant low-wildfire risk tree species that are also adaptable to future climate change, under the recommendations of both *FireSmart* and the UFMP. When given a spatial and temporal context the management trade-offs are easily navigated.