Forests Canada

Forest Restoration After Wildfire

Knowledge Gaps and Future Needs Analysis

Cover: Obstacle planting in North Shuswap, British Columbia, 2025.
Above: Cariboo Carbon Solutions, 2026. Photo: MacKendrick Hallworth.
Back Cover: Planting operations in the Ogoki Forest after 2023 wildfire, Northwestern Ontario, 2025. Photo: Integrity Reforestation.

Contents

Executive Summary

Increasing attention has been placed on wildfires and their impact on forested ecosystems across Canada since 2017 when the "mega-fires" began. Over the years, significant effort has gone into wildfire research and improving forest management practices on the ground. To this end, much of the conversation has been centred around anticipating reactive resource needs across key regions (i.e., firefighting), and the evaluation and mitigation of wildfire risk. Missing from the conversation has been silvicultural activities *after* wildfire where trees are being added to the landscape. This artificial regeneration of forests—when natural regeneration is insufficient—can have unknown implications in the forest recovery story.

To better understand the decisions and approaches for post-wildfire forest restoration in Canada, Forests Canada surveyed and interviewed a sample of forest managers and tree planting practitioners, resulting in a response from eighty survey respondents and eight individuals interviewed. The results from the survey together with highlights from interviews are presented here with the aim to explore: decision-making processes that guide artificial regeneration of forests after wildfire through tree planting; the techniques being practiced on the ground to maximize the successful establishment of forests; and how future fire risk is being considered in forest recovery after wildfire.

In general, forest managers appear to be taking a cautious and patient approach when planting trees after wildfire. Regeneration surveys, resource allocation, permitting regulations, environmental and wildlife benefits, alignment with community, and access logistics are among the primary considerations for the forest managers who are pursuing reforestation activities on sites that experienced wildfire.

Findings reveal a notable shift in field practices for post-wildfire forest restoration when compared with traditional operations, but the specifics of these shifts are inconsistent across respondents. The clearest adjustments in technical approach are related to tree spacing, microsite selection, operational costs, enhanced policies on occupational health and safety, and calculated future fire risk. While changes in species selection, tree nursery stock types, and salvage logging practices were also noted, they are being applied to a lesser degree. However, these shifts are slowly gaining traction as practitioners share knowledge and adopt new practices based on learned and shared experiences among peers.

The outcomes of this study culminate in seven key knowledge gaps for future efforts on the topic:
1) The prioritization of reforestation efforts, 2) Shifts in species selection, 3) Indigenous stewardship pathways, 4) Strategic review of tree planting standards, 5) Site preparation and salvage logging, 6) Understanding the true cost of artificial regeneration, and 7) Occupational health and safety.

Above: Red pine germinant following 2022 Central Fires Complex, Grand Falls-Windsor, Newfoundland, 2024. Photo: Dr. Lucas Brehaut, Research Scientist – Wildfire Resilience, Natural Resources Canada.
Inset: Zanzibar Holdings Ltd., 2026

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Introduction

Researchers, Indigenous communities, and forestry professionals across North America are noting a shift in the recovery of forests after wildfire. Fire suppression (Parisien et al. 2020), leading to high fuel loads, combined with drought conditions (Wang et al. 2025) and higher global temperatures, have contributed to the onset of wildfires that are more frequent, affect larger areas, and with higher severity than ever before (Jain et al. 2024). However, it remains unclear whether these increases exceed the historical range of variability in boreal fire regimes (Danneyrolles et al. 2025). Nevertheless, the 2023 wildfire season in Québec alone burned over 4.5 million hectares under extreme warm and dry conditions, highlighting the accelerating influence of climate change on fire regimes (Boulanger et al. 2024). Researchers are also noting that past fires lead to climate change feedback loops that can put forests at risk for future fires (Kirchmeier-Young et al. 2024); we can thus expect similar wildfire patterns in the future if interventions and mitigation efforts are not in place. Other factors to consider are historical fire exclusion policies, warmer climate and increasing development into the Wildland Urban Interface (WUI), the area between human settlements and forested lands (Sánchez-Guisández et al. 2002).

Wildfire is not always destructive; it can be a chance for renewal and trajectory changes for ecosystems. An essential component of forest dynamics, wildfire plays a vital role in the boreal forest where certain tree species such as *Pinus banksiana* (jack pine) rely on wildfire for their life cycle and persistence on the landscape (Briand et al. 2015). Before colonization of Turtle Island by Europeans, Indigenous communities practiced cultural burning for millennia, using fire to reduce fuel loads for ease of transportation, hunting, and to promote the growth of plant medicines (Christianson et al. 2022). Since then, fire suppression took precedence as a means to subjugate Indigenous communities through the restriction of cultural practices and ceremony, as well as to protect lumber supply, homes, and people in settlements.

The lasting impact of wildfires on forest ecosystems has been noted for several years. Knowledge on the effects of high temperatures and water deficits on post-fire recruitment processes of major boreal tree species in Canada suggest that forests are at risk of becoming less productive than they currently are (Boucher et al. 2020). Research indeed suggests that forest recovery after wildfire has been declining worldwide since 2001 as fire severity has increased (Lv et al. 2025). Researchers, government staff, and Indigenous communities are still collecting data on how these mega-fires have affected natural forest establishment in recent years, how newly planted trees are responding to these harsher conditions, and where efforts would be best placed to try and recover the landscapes that are not following the historical trajectory of natural forest establishment following disturbances (Oeggerli et al. 2026).

While wildfires continue to intensify, trees are still being planted on schedule, to traditional specifications and standards in the form of harvest renewals, reclamation of sites for the energy sector, and through public and private investment for forest restoration on sites with and without silvicultural obligations (Natural Resources Canada, 2024). The Canadian Council of Forest Ministers (2021) claims that “suppression activities alone (for example firefighting) will not be adequate to address the increasing challenges posed by wildland fires”, and that a new interconnected adaptive strategy is needed on a massive scale (Canadian Council of Forest Ministers, 2024).

We are now at a crucial point in the story, where enough time has passed since the mega-fires started, to see some forest regeneration failure—so much so that we can start taking corrective action to ensure the successful recovery of these forests—while also enhancing their resilience to wildfire in the future. However, it is still unclear how reforestation decisions following wildfires are being made by forest managers, and which strategies and techniques are currently being used to restore the forest cover. Making the decision

Rhododendron groenlandicum (bog Labrador tea) and *Vaccinium* (blueberry) growing in the understory of a burned site in northeastern Quebec. Photo: Dr. Nelson Thiffault, Natural Resources Canada.

to artificially regenerate a site after wildfire through tree planting requires careful consideration—given the scale of the wildfires, limited resources, and competing priorities. This knowledge would enable forest professionals and stewards to approach tree planting after wildfire in a way that results in forest recovery that is cost-effective, ecologically sound, and meets the needs of surrounding communities and land stewards.

The Reforest Canada Collective, a division of Forests Canada, hosted a three-part webinar series in early 2025 (Forests Canada, 2025), to highlight current ground-level approaches and research related to post-wildfire tree planting practices. Compelling questions raised by webinar attendees required additional input from industry and, in part, formed the basis of this report. The objective of this report is to provide an overview of the science, policy, and efforts being made on the ground for tree planting after wildfire, while noting emerging trends to identify a pathway forward for forest recovery priorities. As such, the report is divided into the following three questions presented to forest managers and tree planting professionals across Canada:

1. Decision making: What are the decision-making processes that guide artificial regeneration of forests after wildfire through tree planting?
2. Techniques: What are the techniques being practiced on the ground in tree planting operations to maximize the successful establishment of forests?
3. Future fire risk: How is future fire risk being considered in forest recovery after wildfire?

To better understand the complexity of post-wildfire forest restoration, Forests Canada conducted and published an online survey from May 26 to October 31, 2025, aimed at two distinct but occasionally overlapping target groups in Canada: forest managers and tree planting professionals who have experienced wildfire in their operations. Organizations and individuals active in forest management across Canada (provincial and territorial departments, tree planting companies, silviculturalists, etc.) were contacted and invited to complete the survey. Responses from individuals and companies outside of this target group (researchers, industry, academics, etc.) were also captured in the survey in a third respondent pool to gain insights into desired topics for future knowledge mobilization and training opportunities. Participants were invited to respond to questions spread over four sections aimed at the different target groups, for a total of 49 possible questions, some of which enabled open-style responses (see Appendix 1: Methodology and Appendix 2: Survey Questions). Data were compiled and analyzed, with select responses reported here. Where relevant, the synthesis of survey responses is complemented by short summaries of current scientific knowledge ("What the Science Tells Us" boxes), which help place respondents' views in context.

Results

Industry Insights on Post-fire Forest Restoration

A total of eighty individuals responded: thirty-five representing the two target groups across multiple regions of Canada (Figure 1; Table 1), with the remaining respondents representing the third pool who provided feedback on topics of interest for continued learning opportunities.

Breakdown of Survey Respondents

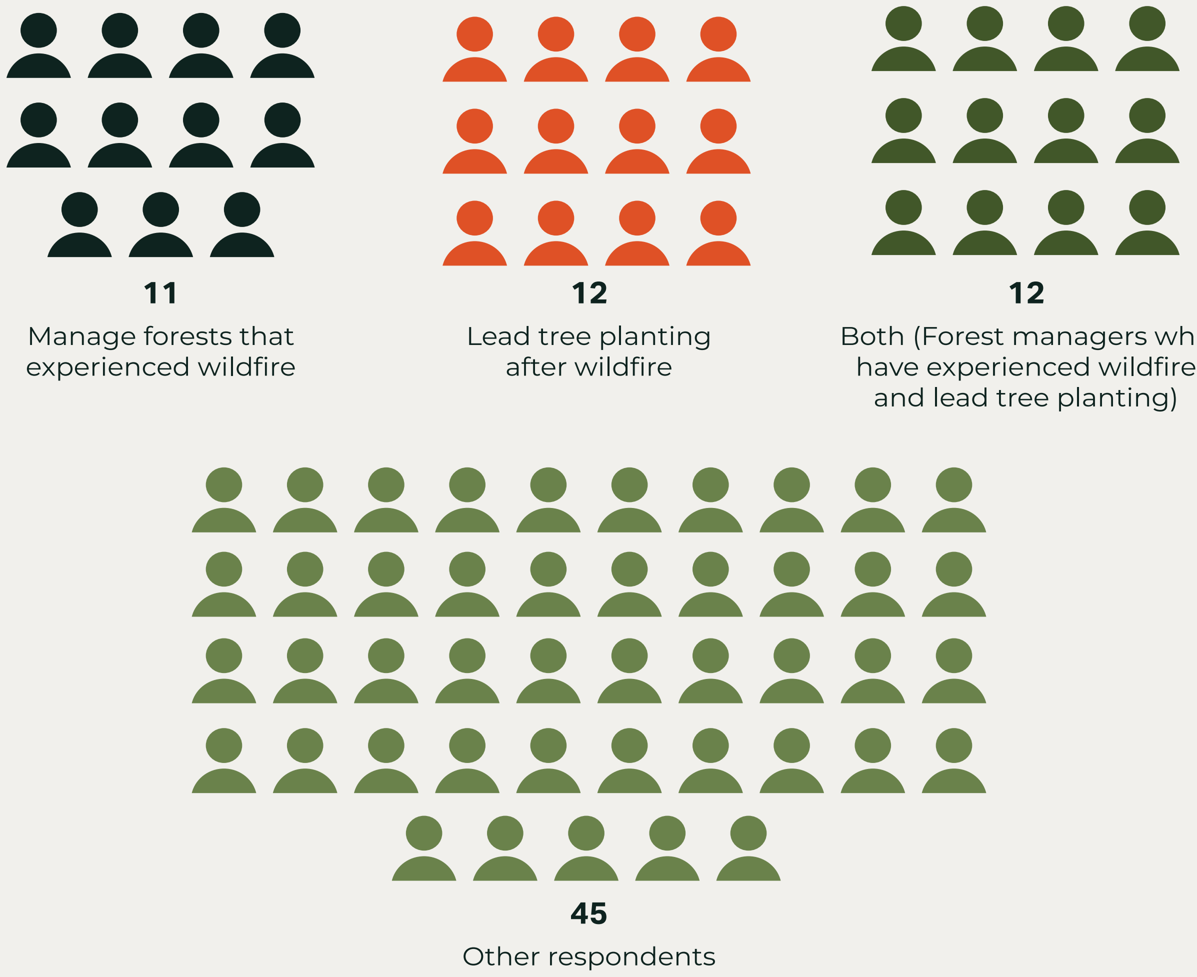

Figure 1: Breakdown of survey respondents.

Photo: Integrity Reforestation

Table 1: Regional representation of target groups

Province	Forest managers who have experienced wildfire but do not plant trees (n=11)	Tree planting organizations who have planted after wildfire but do not manage forests (n=12)	Forest managers who have experienced wildfire and plant trees (n=12)	Other response (n=45)
ON	1	1		19
BC	5	10	9	15
AB	4	8	4	6
MB	1	2	1	6
SK		2	1	7
QC	1	1		9
YT	1			2
NWT		1		2
NB		1		5
NS		1		5
NFLD		1		2
PEI		1		1
USA				2
INTL				3

Decision Making

Land Stewardship and Management Planning

The driver for forest restoration after disturbance depends on many factors, but management responsibility and land stewardship leads the way for subsequent decision-making. In this section of the report, we summarize the results from survey respondents for question 1 in our objectives surrounding decision-making for prioritization of forest recovery after wildfire.

The Decision to Artificially Regenerate

Based on results from the survey, of the forest managers who have experienced wildfire on their lands, trees have only been planted on just under twenty per cent of the sites affected by wildfire in their management area (Figure 2). Where they chose not to plant trees, the leading reason to support that decision was that natural regeneration was occurring on its own, followed by budget or resource constraints (Figure 3). Sites with silvicultural obligations must be replanted under provincial regulations if natural regeneration is not taking place, but there are millions of hectares across the country that have burned and are not under such obligations. In those cases, trees are not being replanted if resources are not in place that support the efforts.

In the forested areas affected by wildfire in your jurisdiction, approximately what percentage of the land has been and/or will be artificially regenerated with trees?

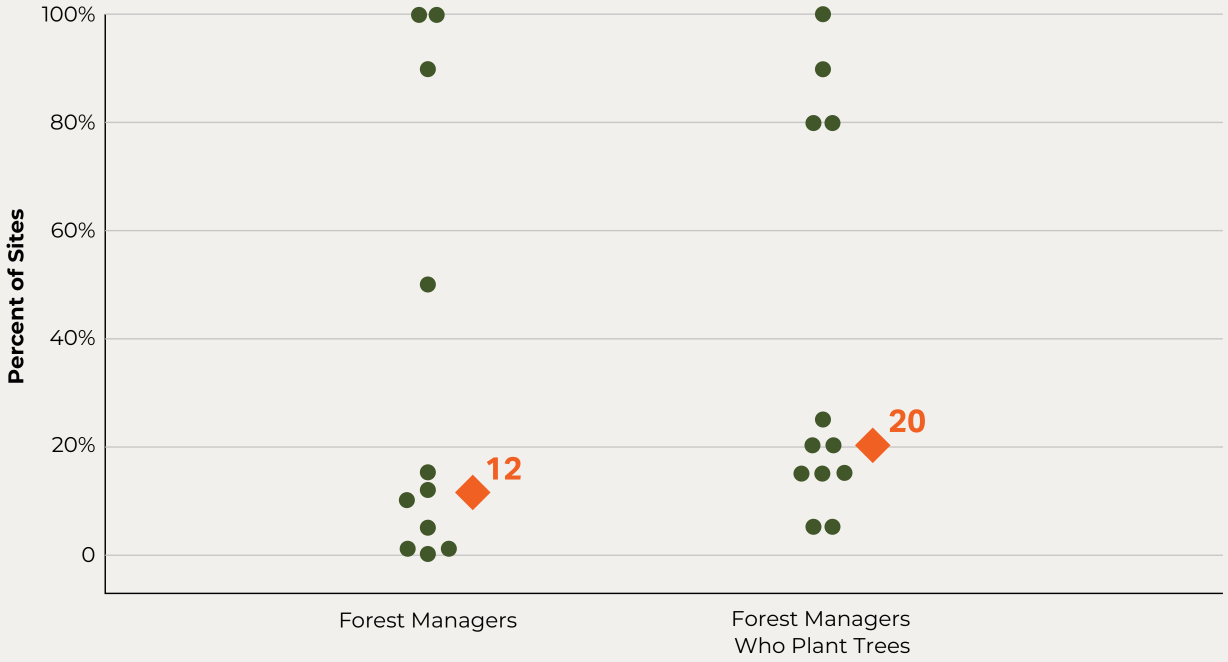

Figure 2: Percentage of sites being replanted after wildfire as reported by forest managers (n=11) and forest managers who plant trees (n=12). Dots represent individual respondents; orange diamonds represent the median value.

For the areas where you are not artificially regenerating with trees, what are the reasons?

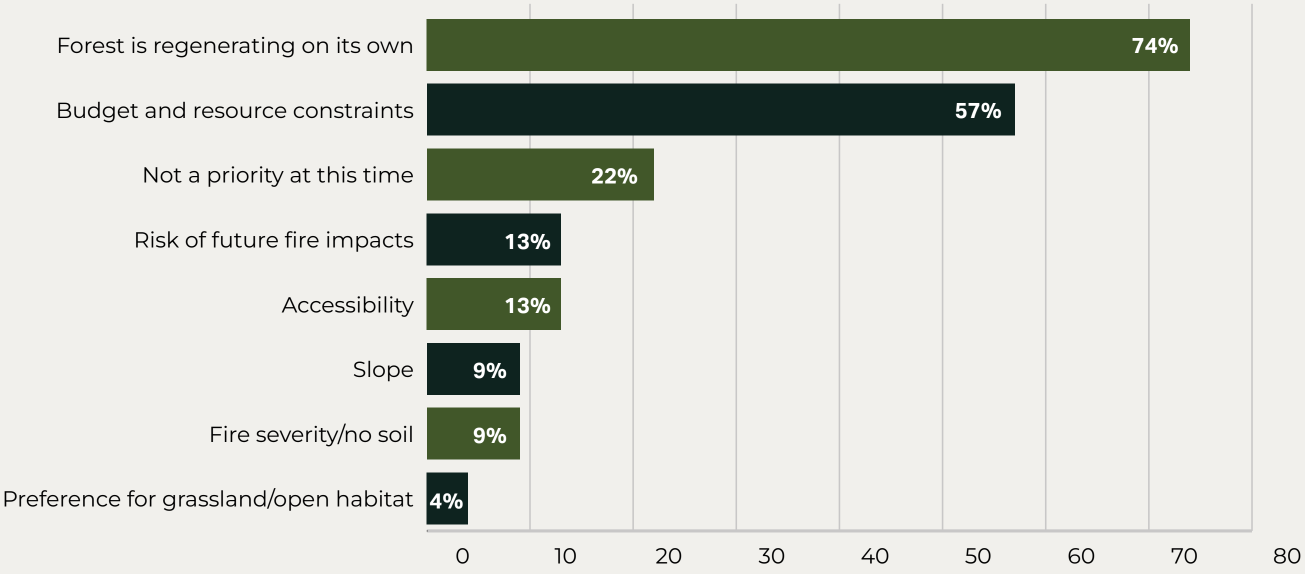

Figure 3: Reasons provided by forest manager survey respondents for not planting trees in select sites after wildfire (n=23).

Public forest land is managed using different approaches across Canada, and this variability is consistent with tree planting efforts. In Canadian national parks, forest restoration following disturbance is guided by conservation-focused principles such as those outlined in the IUCN-WCPA's Best Practice Protected Area Guidelines (Parks Canada Agency, 2018; Keenleyside et al. 2012). According to Marcia DeWandel with Parks Canada (personal communication, August 26, 2025), the 2024 wildfires in Jasper National Park left an abundance of bare ground in areas of high human use (trails, day use areas, etc.). Due to the increased potential for invasive alien plant spread, and to lessen the effects of wind and water erosion, restoration efforts are focusing on areas of high human use (vectors for invasive spread) within the montane valley bottom. *Pseudotsuga menziesii* (Douglas fir) seedlings, less abundant and more fire-resistant than *Pinus* spp. (pine) and *Picea* spp. (spruce), are being planted in many of these locations. Douglas fir seeds are being collected in the Jasper montane region, grown out in nurseries, and planted back into their ecotypic habitat.

Prioritization of Reforestation: Regional versus Site-level Decision Factors

Once the decision has been made to reforest an area after wildfire at the regional level, further subdivision of sites is needed since planting trees after wildfire requires an investment of resources and access can be difficult in many instances. Regional-level prioritization is largely shaped by governance and economic considerations. At this scale, reforestation decisions depend on factors such as land ownership and management responsibility, the presence of silvicultural obligations to replant, and whether salvage logging can be integrated with planting operations to recover value from remaining timber. These considerations help determine whether and where reforestation efforts are feasible and justified across the broader landscape.

At the local site level, prioritization focuses on biophysical and operational characteristics. Survey responses indicate that wildfire intensity is the highest-ranked site-level factor influencing prioritization, followed closely by economic investment (Table 2). Forest managers also reported that having permits or agreements already

Planting trees in Jasper National Park after the 2024 wildfires. Photo: Marcia DeWandel, Parks Canada.

in place can accelerate decisions about which sites to address first (Figure 4). Additional factors influencing site-level prioritization include seed source distance, fire size, and local ecological conditions, consistent with the Integrated Post-Fire Resilience Strategy published by American Forests (2023). Physical site attributes such as site size, the level of vegetative competition, and seed source availability further shape planting decisions.

Planter safety was also identified as an important consideration when determining whether to proceed with operations on a given site.

Table 2: Ranking for prioritization of reforestation after wildfire as reported by forest manager survey respondents. In the weighted score, 5 points were awarded to 1st place priorities and 1 point for 5th place priorities, tallied up to a total score.

How do you prioritize choosing regions to plant trees after wildfire?

Rank	Priority Category	Weighted Score (n=23)
1st	Intensity of wildfire	78
2nd	Economic investment	73
3rd	Ease of access	70
4th	Environmental benefits	64
5th	Wildlife habitat	60

Other variables used in prioritization systems when choosing areas to reforest after wildfire

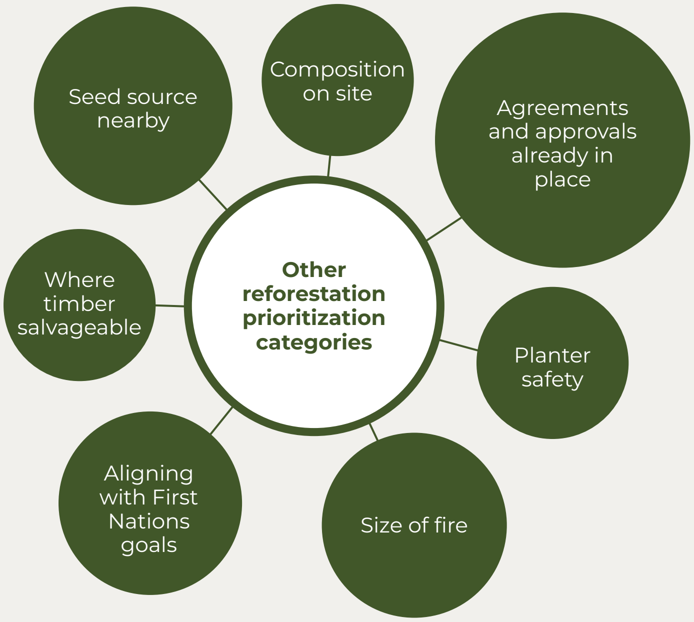

Figure 4: Open-ended prioritization categories for localized efforts for reforestation after wildfire, grouped by similar responses from forest managers survey respondents (n=23). Bubble size represents frequency of repeated categories.

Techniques

Approaches and Decisions for Tree Planting After Wildfire

Planting trees after wildfire isn't new in Canada, but with the change in patterns of wildfire, coupled with post-wildfire forest recovery receiving more attention and funding in recent years, this highlights a need to evaluate the operational angle of this practice: what is happening on the ground? In this section of the report, we summarize the trends in techniques for forest recovery after wildfire.

Time Since Fire

Generally, sites cannot be planted with trees immediately after fire for various reasons: ensuring site access, ordering seedling stock, acquiring permits if applicable, and organizing the planting crew, can take a long time. However, nine per cent of the forest manager respondents in the survey have been able to reforest the areas within one year (Figure 5), likely opportunistically with seedlings that were able to be deployed on short notice. More than thirty-five per cent of the respondents are waiting three or more years after the fire, which is ideal for observing natural regeneration patterns to determine if there is, in fact, a need to reforest. However, there is a trade-off between allowing enough time for regeneration surveys and beginning early enough to overcome vegetative competition as more non-target species enter the site, such as ericaceous shrubs (Thiffault et al. 2015). This is relevant only for forest lands managed under silvicultural obligations where non-target species are controlled in the site to promote the successful establishment of target species. For this reason, going beyond three years is likely more difficult for re-establishing forests artificially through tree planting, depending on the level of vegetative competition. Further research is needed on the variable of "time since fire" and is likely very region- and site-dependent.

How long after the fire are you waiting to plant trees?

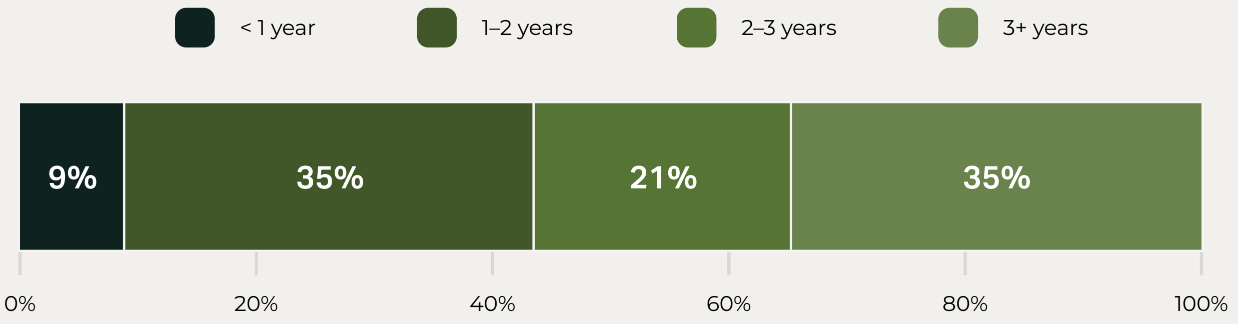

Figure 5: Proportion of time taken after fire to begin planting trees, as reported by forest manager survey respondents (n=23).

What the Science Tells Us

Time Since Fire

Published literature indicates that time since wildfire is a key determinant of post-fire forest recovery and the effectiveness of reforestation interventions in boreal forests. The early post-fire recovery phase (approximately five years) is particularly influential, as it largely determines future stand composition, structure, and resilience (White et al. 2023; Waldron et al. 2023). During this period, most natural regeneration of fire-adapted species occurs. When regeneration is limited early on, subsequent recruitment is often weak, increasing the risk of long-term regeneration failure. Wildfire can temporarily create favourable conditions for regeneration, including reduced competition and improved seedbeds, but these benefits are short-lived and strongly dependent on burn severity and site conditions (Lebel Desrosiers et al. 2025). As time since fire increases, competitive vegetation typically intensifies and soil constraints may increase, raising the cost and complexity of successful reforestation (Thiffault et al. 2025). Overall, science supports a time-sensitive, site-specific decision-window approach, where early assessment and timely intervention are critical to effective post-fire restoration.

Tree Planting Stocking Standards

In most jurisdictions across Canada, stocking standards are a mandated component of sustainable forest management of public lands at the provincial and territorial level, typically updated on an as-needed basis. Some provincial and territorial governments are investing in updating their stocking standards to reflect the urgency of post-wildfire recovery efforts. For example, the province of British Columbia (BC) has released “fire management stocking standards” that were designed to reduce fire behaviour by reducing likelihood of crown fire and/or fast-moving high intensity ground fire (BC Ministry of Forests, 2016). Also in BC, recently proposed “enhanced stocking standards” allow for some flexibility in species selection and stocking rates, recently highlighted in the work led by Secwépemc communities on their traditional lands following the Elephant Hill wildfire (Dickson-Hoyle and John 2021).

Modified versions of traditional stocking standards (provincially variable tree species selection and sourcing, spacing, stocking levels, and free-to-grow criteria) would allow for improved adaptation to a changing climate under the growing threat of future wildfires and other climate change impacts in Canadian forests. The Society for Ecosystem Restoration in Northern BC (SERNbc) is also working on Ecosystem Restoration Plan (ERP) stocking standards to guide reforestation activities following major wildfires, using the Shovel Lake Wildfire as a model for future planning strategies for forest recovery after wildfire in BC (Daust and Karen Price Consulting, 2019).

Species Selection

Site conditions after the recent wildfires in Canada range from favourable for natural regeneration after low severity burns, to near-primary succession conditions under high-severity fire, requiring creative solutions for forest recovery. In low-severity events, organic layers often remain partially intact, seed sources survive, and soil structure is largely preserved, allowing natural regeneration to proceed (Certini 2005; Johnstone et al. 2016). In contrast, high-severity fires can substantially reduce organic layer depth and alter soil physical, chemical, and biological properties, creating post-fire environments that differ greatly from pre-disturbance conditions (Certini 2005; Whitman et al. 2019). Such changes have been linked to reduced conifer recruitment and shifts in species composition, particularly where residual seed sources and remaining soil conditions are limited (Johnstone and Chapin 2006; Whitman et al. 2019).

Under these altered conditions, post-fire species selection and planting prescriptions warrant reconsideration. Increasingly, practitioners are adapting reforestation strategies to account for burn severity, soil changes, and projected climate conditions when selecting species and seed sources for high-severity sites. Some survey responses from forest managers are congruent with this shift, with about four out of ten respondents in the survey indicating that the tree species being planted post-fire are different from the species composition prior to the fire (Figure 6). Generally, the survey respondents report a wide variety of changes in species shifts, namely using more *Populus tremuloides* (aspen) and other broadleaf species, but also shifting to more *Larix laricina* (tamarack), *Pseudotsuga menziesii* (Douglas fir), *Pinus* (pine) spp. under different recovery strategies (Figure 7). Jeni Christie with Zanzibar Holdings Ltd. explains (personal communication, July 11, 2025), that on xeric sites, reforestation crews are increasingly having to prioritize *Pinus ponderosa* (yellow/ponderosa pine) in areas that were previously dominated by Douglas fir, indicating a species conversion toward a Ponderosa pine-leading stand on severely burned, hot, and dry sites. These planting prescriptions are based on detailed post-wildfire site plans. However, the implementation of these site-specific stocking standards often requires an amendment from the local district in order to deviate from regional stocking standards. These stocking standards derive from a climax stand and, despite having integrated some species and climate-adapted aspects, they are not always suitable for the new conditions created by severe wildfires.

Are the tree species being planted different from the species that were present in the forest before the wildfire?

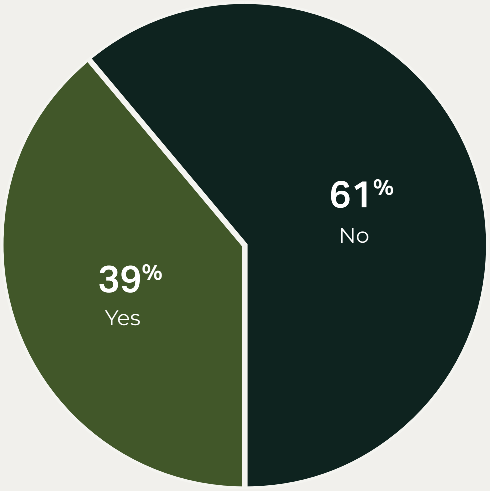

Figure 6: Proportion of forest manager survey respondents planting tree species different from those found pre-fire (n=23).

Trends in changes in tree species composition from pre-fire to post-fire restoration

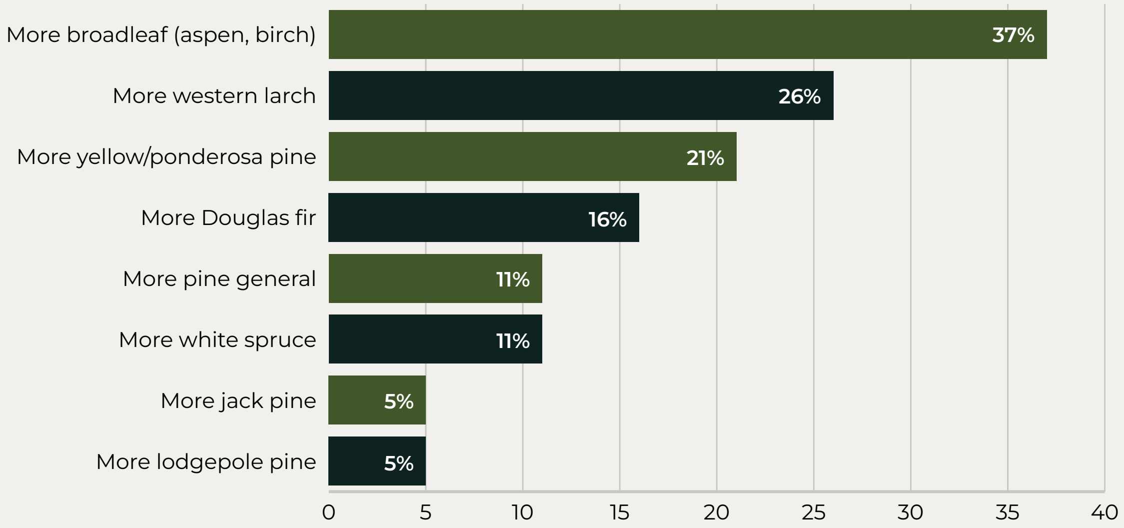

Figure 7: Frequency of species mentioned in comments of tree planting survey respondents excluding forest manager tree planting respondents who are not shifting species pre- to post-fire (n=19).

What the Science Tells Us

Species Selection

Scientific evidence supports that species choice following wildfire should be driven by future climate suitability and ecosystem resilience, rather than solely by historical composition. Climate change is expected to increase drought stress, fire frequency, and disturbance severity, reducing the likelihood that some locally dominant species will remain viable over a full rotation (D'Amato et al. 2023), from the perspective of a commercial forest management context. Post-fire restoration therefore represents a strategic opportunity to re-align species composition with projected climate and disturbance regimes (Lebel Desrosiers et al. 2025).

Adaptive silviculture frameworks emphasize that resilience is enhanced by promoting species and genotypes with diverse functional traits, including drought tolerance, varied regeneration strategies, and differential sensitivity to pests and fire (Blondeel et al. 2024; Nagel et al. 2025). Where vulnerability assessments indicate declining habitat suitability, forest-assisted migration, particularly assisted population or range expansion, can reduce long-term risk, when implemented cautiously and within an explicit adaptation strategy (Palik et al. 2022). Overall, science supports diversifying species choices and explicitly accounting for future conditions as central pillars of post-wildfire forest restoration.

Spacing

Tree planting prescriptions that follow conventional stocking standards are typically geared towards achieving a tree planting density that maximizes merchantable volume of wood (Davis et al. 2001), balancing other co-benefits such as maintaining biodiversity, and buffering against pests and disease. In post-wildfire forest restoration, spacing can vary widely. Three quarters of tree planting survey respondents have modified their spacing in post-wildfire recovery sites, as compared to conventional spacing (Figure 8). By modifying the spacing in these landscapes, successful forest establishment can be guided by allowing for natural regeneration of broadleaf species through the lowering of typical spacing of planted conifers. Maximizing the establishment success by increasing the density to overcome competition from surrounding vegetation, is another strategy used. This tends to be a balanced approach and needs to be done to a level that also avoids overstocking, which can result in higher levels of intraspecific competition. Spacing is also affected when modifying microsite selection criteria, avoiding dead standing debris or seeking out obstacles (Figure 9).

Is your spacing different for post-wildfire sites compared to traditional sites?

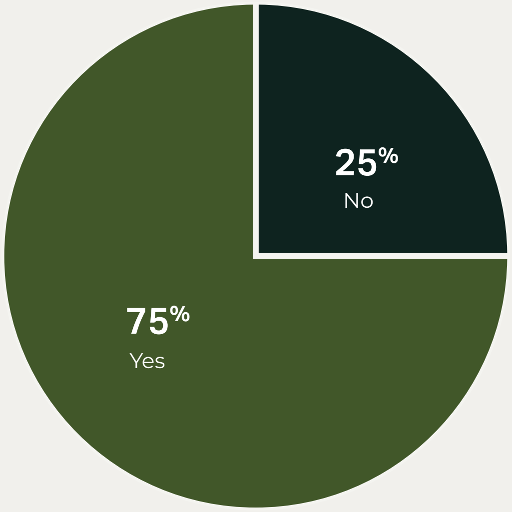

Figure 8: Difference in spacing after wildfire as reported by tree planting survey respondents (n=24).

Reasons selected for modifying the spacing post-wildfire compared to traditional operations

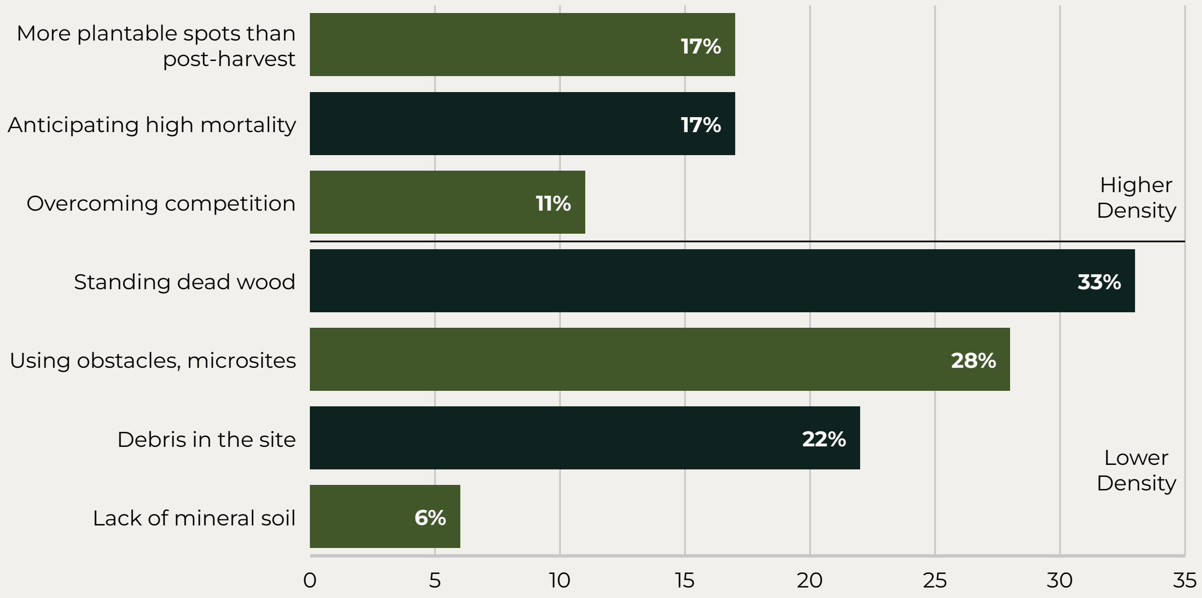

Figure 9: Reasons for modifying tree spacing after wildfire, as reported by tree planting survey respondents (n=18) excluding those who reported that they do not modify spacing for post-fire" after "respondents.

What the Science Tells Us

Tree Spacing

Research supports that planting density is primarily a tool for managing establishment risk and site constraints, rather than a direct guarantee of higher growth at the stand level (Thiffault et al. 2021). Higher planting densities can help buffer anticipated early mortality, improve the likelihood of occupying limited plantable microsites, and accelerate canopy closure where competition pressure is high, which aligns with common operational motivations for increasing density after wildfire. However, research also shows that planting density alone does not consistently affect growth or survival. Density effects are strongly mediated by site conditions and site preparation. For example, in boreal *Picea mariana* (black spruce) plantations, higher density only enhanced growth when combined with intensive site preparation; without it, density has little effect on height or diameter during the first decade (Fetouab et al. 2024).

Structural constraints such as standing wood, debris, and heterogeneous microsites can further limit the capacity to reach target spacing. Overall, science supports adaptive spacing strategies, where planting density is adjusted to microsite availability, expected mortality, and competition intensity, rather than uniform prescriptions applied across post-fire landscapes.

Microsite Selection

In the survey, ninety-two per cent of tree planting respondents reported providing instructions to their planters to seek out specific microsites for planting, with obstacle planting being the most common directive (Figure 10). The overall objective of post-wildfire microsite selection is to target areas that will have the highest access to water, shade and lowest threat from non-target vegetative competition, factors known to influence early seedling survival and growth (Steinbrunner et al. 2025; Swanson et al. 2023). Obstacle planting, the practice of placing seedlings adjacent to stumps, logs, or residual debris, often on the shaded northeast or north-facing side, is not a new concept in tree planting and has been shown to be effective in post-wildfire forest recovery (Marshall et al. 2023). In BC (mostly in the regions south of Prince George), this approach has been applied for species such as Douglas fir in burn sites where exposed mineral soil and intense solar radiation can limit establishment.

Jeni Christie of Zanzibar Holdings Ltd. corroborates this trend (personal communication, July 11, 2025), stating that Douglas fir has only been planted in areas with adequate shade but notes that although shade is important, recent post-wildfire reforestation assessments suggest that moisture availability and related site factors may be stronger determinants of successful tree establishment. The majority of healthy planted Douglas fir seedlings were observed in microsites that offered enhanced access to soil moisture over just shade alone. While survival is greater for Douglas fir planted adjacent to snags and logs compared to those planted in the open, many of these trees still exhibited signs of significant moisture stress. Furthermore, planting near structural debris has been noted as a deterrent to wildlife browse by ungulates.

What specific instructions about microsites did you train your planters to target in post-wildfire operations?

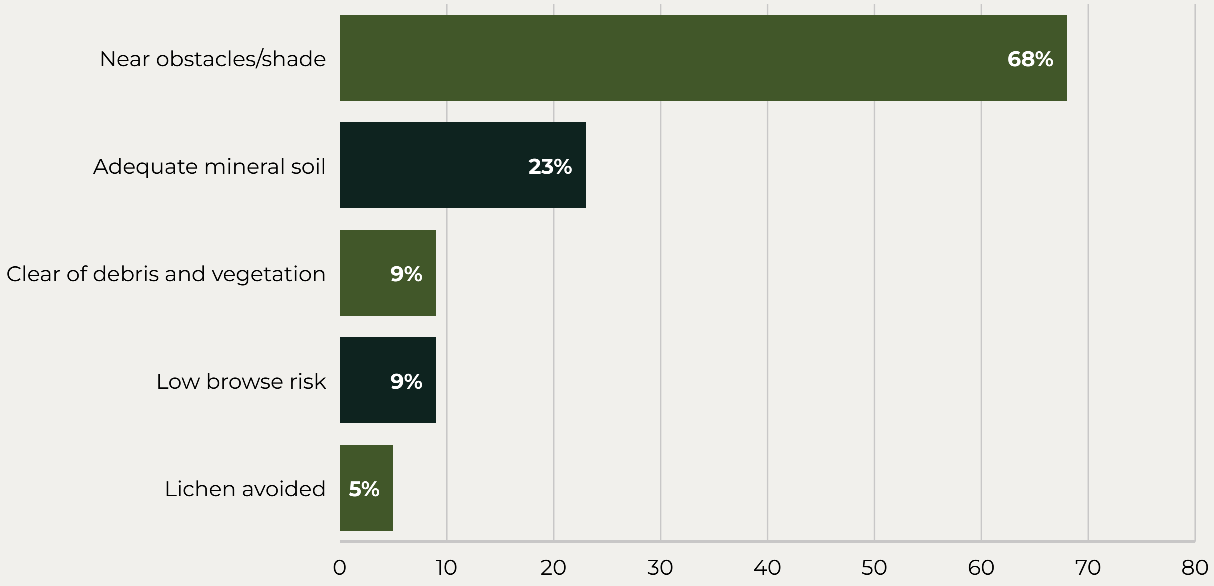

Figure 10: Reasons for selecting tree planting microsites following wildfire, as reported by tree planting survey respondents excluding those who reported that they do not provide specific instructions to planters for post-wildfire operations (n=22).

What the Science Tells Us

Microsite Selection

Science shows that microsite selection is a major driver of seedling survival and early establishment, particularly in post-disturbance environments characterized by exposure, moisture limitation, and heterogeneous substrates (Henneb et al. 2020). Planting seedlings adjacent to obstacles such as stumps, coarse woody debris, rocks, or microtopographic features can moderate microclimate, reducing solar radiation, wind exposure, and soil temperature extremes while improving soil moisture availability (Gray and Spies 1997). Obstacle-associated microsites can also increase planting success by improving moisture access, reducing competing vegetation, and limiting exposure, particularly under dry or exposed conditions (Spittlehouse and Stathers 1990). These effects can also be most pronounced in recently burned landscapes, where dead wood, ash, and uneven organic-layer consumption create strong spatial contrasts in growing conditions (Lebel Desrosiers et al. 2025). In some contexts, microsite selection may also reduce browse pressure by limiting visibility or access for ungulates (Côté et al. 2004).

Clustering is also being applied in post-wildfire tree planting projects, the objective being to achieve the target density at the block level by clustering similar or companion species together close to an obstacle or other type of microsite that should enhance survival. Others in the survey note using the trenches created by machines during the site preparation activities to enhance water availability for newly planted seedlings, targeting the sides of the trenches that will get pools of water following rainfall.

Site Preparation and Salvage Logging

Site clearing is a popular practice in tree planting operations regardless of the disturbance type. Following harvest, debris is cleared from the site in many instances and "prepped" prior to planters coming in to start their work. In the case of post-wildfire disturbance, there is often both standing and downed woody debris following the fire, making planting conditions different than in post-harvest operations. Many forest managers have started practicing salvage logging operations after wildfire, regardless of whether the site will be replanted. Salvage logging is carried out for a few reasons: to harvest any commercial value from the surviving wood timber found on site after the fire, to mitigate future fire risk by reducing fuel loading on the site, and to prepare land for tree planting (Barrette et al. 2013). Usually, it's done only when it makes economic sense for the forest management company or when recommended through provincial programs and incentives to mitigate future fuel loads, but it does improve site conditions for planting operations that follow. Tree planting respondents reported that salvage logging operations had occurred on under fifteen per cent (on average) of the burned sites that they had tree planting projects on (Figure 11).

Example of seedling planted into microsite in North Shuswap, BC after 2023 Bush Creek East wildfire, 2025.

For post-wildfire sites in your jurisdiction, approximately what percentage are being salvage logged?

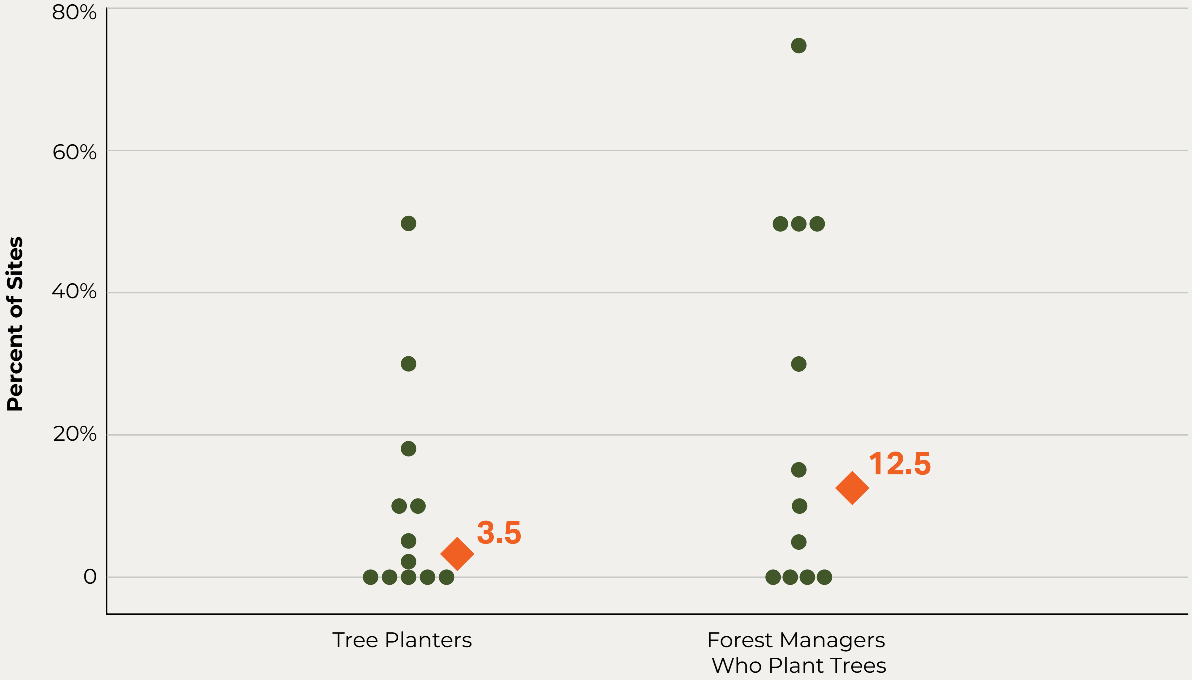

Figure 11: Percentage of sites salvaged logged before planting operations commenced after wildfire, as reported by survey respondents who only plant trees (n=12) and forest managers who plant trees (n=12). Dots represent individual respondents; orange diamonds represent the median value.

What the Science Tells Us

Salvage Logging After Wildfire

Research shows that salvage logging has mixed and context-dependent effects on post-fire regeneration and restoration outcomes. Salvage logging can improve accessibility and planting efficiency, reduce physical obstacles for planters, and in some cases facilitate site preparation for reforestation, particularly where high volumes of downed wood limit plantable microsites. These operational benefits help explain why salvage logging is often used to support planting activities. However, a growing body of research highlights that retaining some burned wood on site can benefit forest recovery. Coarse woody debris contributes to microsite heterogeneity, moderates microclimate, reduces competing vegetation, and can improve seedling survival, especially under dry or exposed conditions (Steinebrunner et al. 2025). Deadwood can also provide partial protection from ungulate browsing and support broader ecosystem functions (de Chantal and Granström 2007). Science thus overall suggests that salvage logging is neither inherently beneficial nor detrimental for regeneration. The most effective post-fire strategies tend to balance targeted material removal to enable planting with strategic retention of deadwood to support microsite quality, resilience, and long-term ecosystem recovery (Trottier-Picard et al. 2014).

Stock Type Selection

One of the most influential consequences of increasing fire severity in recent years on forest recovery is observed through impacts to the soil (Lv et al. 2025). The physical and chemical features of soil have been demonstrated to influence tree seedling success after artificial regeneration (Munson and Timmer 1995).

To combat harsh conditions in the soil profile after wildfire, some forest managers and tree planting companies are experimenting with different types of tree seedling stock to give the newly planted trees the best odds of success in establishment. Based on the survey results, almost a third of tree planting respondents are trying out larger stock to achieve better results after planting (Figure 12), with a few noting that plugs with longer root systems may show positive outcomes. The BC Timber Sales - Seedling Services group administered by the BC Ministry of Forests is trialing PSB 420 plugs in various sites across the province to see what success this experimental root system may have in the conditions after wildfires with a high severity. According to Dr. Jodi Axelson, Research Leader, Silviculture with the BC Ministry of Forests (personal communication, July 4, 2025), the trials are based on research (Grossnickle and MacDonald, 2026) suggesting that deeper rooted plugs may improve drought resilience by accessing subsurface moisture during the critical establishment period.

PSB 420 is being trialed for its longer rooting depth. Photo: Caitlin Harrison, Ministry of BC.

Caitlin Harrison, Silviculture Resiliency Forester with the BC Ministry of Forests, also notes (personal communication, August 5, 2025) that while larger stock types require additional nursery production effort and slower planting rates in the field, the upfront investment may be justified if improved survival reduces the need for repeated replanting, especially on difficult sites. Results from these trials should become available over the coming years and may help inform future seedling stock type experimentation and planting operations across Canada.

Alternatively, smaller plugs can work for rocky sites or areas that may have limited mineral soil after severe wildfires or areas with shallow soil affected by wildfire according to Sylvain Montpellier, PRT Growing Services Ltd. (personal communication, August 6, 2025). More field trials are needed for testing various seedling stock types for planting trees after wildfire.

What differences in stock types are you using for post-wildfire sites?

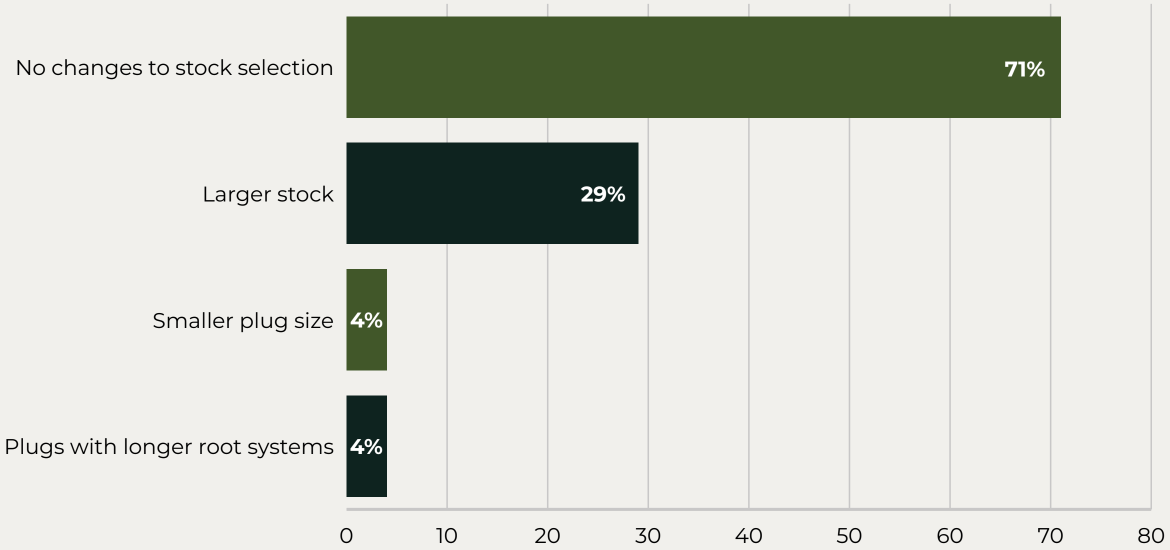

Figure 12: Changes to tree seedling stock type, as reported by tree planting survey respondents (n=24).

What the Science Tells Us

Stock Type Selection

Science shows that seedling stock type strongly influences early survival and stress tolerance, particularly under dry, exposed, or resource-limited conditions. Larger planting stock and seedlings with greater root system development generally exhibit higher drought resistance, improved water uptake capacity, and greater physiological capacity during establishment, largely due to increased root volume and carbohydrate reserves (Grossnickle and El-Kassaby 2016; Pinto et al. 2012). However, stock size alone does not guarantee success. Research consistently shows that stock-type performance is highly site dependent, and that physiological quality, root–soil contact, and planting conditions often outweigh size effects (Thiffault et al. 2003; Wightman et al. 2019). Overall, science supports a site-matching approach to stock selection, where root system architecture, moisture availability, and planting constraints guide stock-type choice rather than a uniform preference for larger seedlings (Davis and Pinto 2021).

Operational Costs and Occupational Health & Safety

One of the largest barriers for the operationalization of scientifically supported best practices for post-wildfire reforestation is the financial practicality of implementation on the ground. Although adaptive silviculture and climate-informed planting strategies are increasingly recommended in literature and guidance documents, their uptake is often constrained by cost, labour availability, and logistical complexity (North et al. 2019; D'Amato et al. 2023; Jull et al. 2025). Research on extreme wildfire events in western Canada found that total costs, including indirect losses to communities, infrastructure, and the forest sector, ranged from one and a half to nearly twenty times the direct fire protection costs (Subedi et al. 2025), therefore investment in proactive silvicultural activities including strategic reforestation is needed.

Financial support for reforestation activities after wildfire are limited in Canada. Post-harvest forest renewal was first supported in Canada when legislated silvicultural obligations were put in place through amendments to BC's Forest Act in 1987, with the rest of Canada following suit in the years following. This legislation ensures that forests are renewed after harvest, but wildfires can affect plans for forest renewal. The modern-day Forest and Range Practices Act (FRPA) in BC, for example, allows licensees to either continue with existing plans if fire damage is minimal, adapt silviculture strategies, or become relieved from silvicultural obligations moving forward (BC Forest Practices Board, 2025a). The Forestry Futures Trust of Ontario—carried forward as part of the Crown Forest Sustainability Act of 1994—finances silvicultural expenses in Ontario's public forests where forest resources have been killed or damaged by fire or other natural causes. In Alberta, the Wildfire Reclamation Program (WRP) administered by the Forest Resource Improvement Association of Alberta (FRIAA) allows licensees to re-establish forest cover damaged and destroyed by wildfire.

Lands without legal silvicultural obligations seem to have more flexibility for post-wildfire forest recovery, but the vast number of hectares burned still limits reforestation potential and highlights the need for prioritization. In BC, post-wildfire reforestation activities on public lands without silvicultural obligation have been supported through the Forest Investment Program (FIP) administered under the leadership of BC's chief forester. Other funding mechanisms across Canada include Natural Resources Canada's 2 Billion Trees program which provided tree planting funding nation-wide for lands without legal silvicultural obligations, no longer signing new agreements as of November 2025.

Despite having some funding mechanisms in place, consistent financial support for post-wildfire forest recovery remains largely limited throughout the rest of Canada, with reforestation projects often dependent on discretionary or program-based funds rather than stable, legislated support, and the potential for carbon credit generation is limited depending on the level of site preparation involved (Clason et al. 2022). Survey results reflect these on-the-ground challenges, with just over half of tree planting respondents reporting higher operational costs for post-wildfire planting compared to traditional operations (Figure 13), with increased tree planter compensation and access limitations cited as the primary reasons behind the higher costs (Figure 14).

Beyond financial and logistical constraints, occupational health and safety is also a focus in post-wildfire tree planting, and these requirements can influence overall costs. Smoke inhalation from nearby active fires, ash and dust inhalation, danger trees, debris in the site and isolation are just some hazards that tree planters have faced over the past decade in these types of tree planting projects. The most significant shift in safety standards relates to additional training, identified by over eighty per cent of tree planting respondents (Figure 15), followed by the need for additional personal protective equipment (PPE), cited by over half of respondents.

How have your operational costs changed for post-wildfire restoration compared to traditional tree planting?

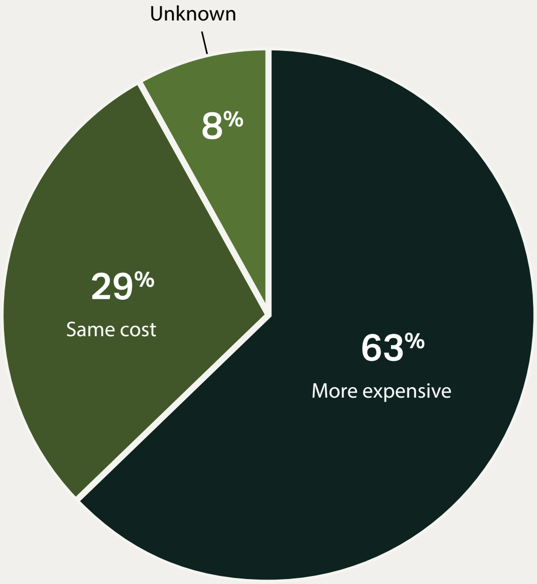

Figure 13: Differences in operational costs for post-wildfire operations compared with traditional operations, as reported by tree planting survey respondents (n=24).

Main drivers for increase in operational costs post-wildfire

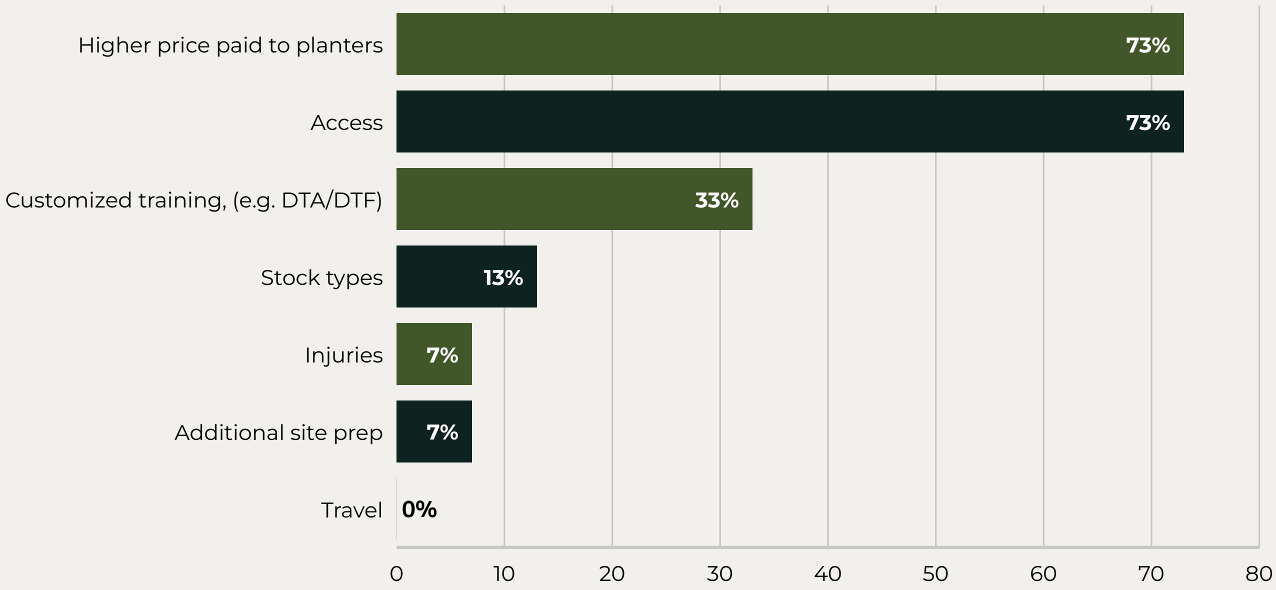

Figure 14: Reasons for higher operational costs as reported by tree planting respondents who reported higher costs in the survey (n=15).

Modifications or adjustments to workplace safety standards

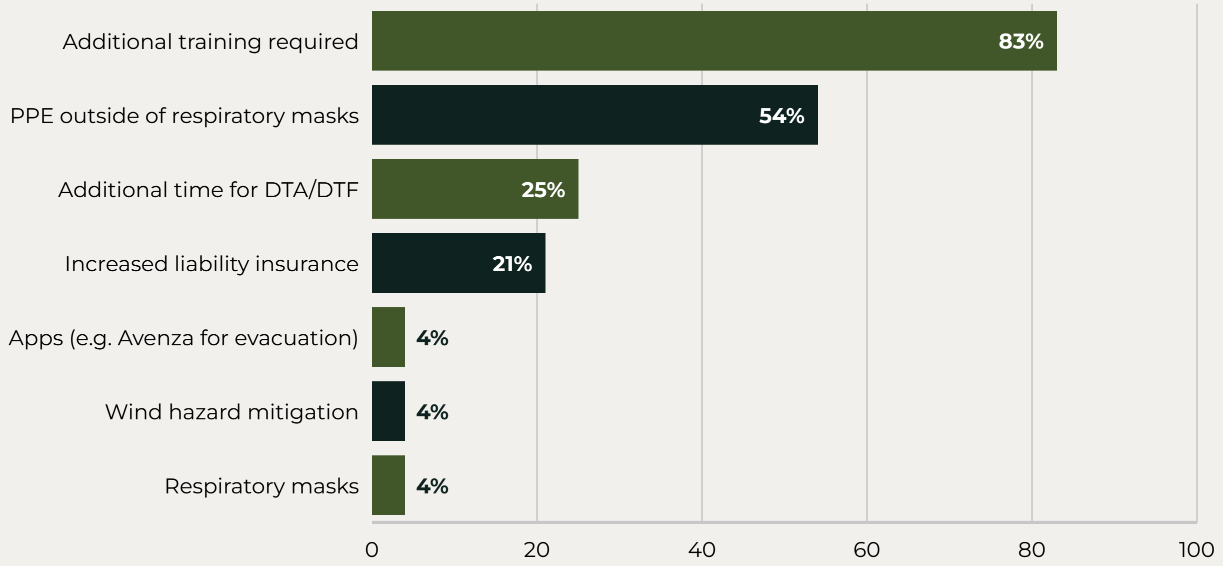

Figure 15: Workplace occupational health and safety differences between post-wildfire and traditional operations, as reported by tree planting respondents in the survey (n=24).

Future Fire Risk

Prescriptions for tree planting and associated silvicultural activities are the building blocks for the future forest, wherein the species, density, timing and methods for tree planting are setting up the future trajectory of the forest that becomes established. Early treatments can set the stage for a resilient forest or create more fuel for the fire in the decades to come. In this section, we summarize the results from the survey from both target groups across Canada, bringing together perspectives on future wildfire risk when planning for forest recovery after wildfire.

In the survey, just over half of forest manager respondents reported that future fire risk is a consideration when planning for tree planting operations (Figure 16). This result is higher comparatively than the figure provided by the BC Forest Practices Board in their “Help or Hinder? Aligning Forestry Practices with Wildfire Risk Reduction” report where only seventeen per cent of licensees sampled (n=18) in BC have adopted fire management stocking standards when regenerating stands (BC Forest Practices Board, 2025b). The BC Forest Practices Board lists four main activities that can lessen wildfire risk in regenerating stands: i) Planting deciduous trees; ii) Using cultural or prescribed burning; iii) Managing understory vegetation to reduce flammable growth and promote fire-resistant shrubs or herbaceous cover; and iv) Prescribing alternative planting densities and spacing. While these recommendations and practices are being communicated largely for western Canada, they may be transferrable to elsewhere. Adjusting planting density and enhancing biodiversity were two common open-ended responses for ways in which future fire risk can be incorporated into planning for tree planting operations after wildfire, as reported by tree planting respondents (Figure 17). There doesn’t seem to be a significant influence of tree planting design on future fire intensity (Jenkins et al. 2019). While planting density may influence future fire risk through its effects on fuel structure and canopy continuity, this relationship remains poorly resolved in boreal ecosystems. Current evidence is indirect and context-dependent, and there is no clear operational guidance linking post-fire stocking levels to fire hazard.

Did your forest recovery strategy consider future fire risk?

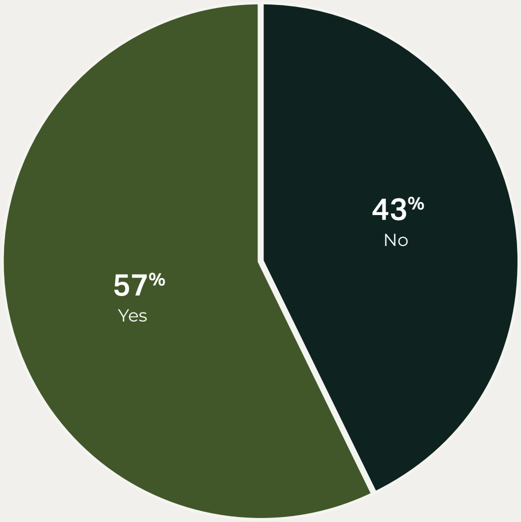

Figure 16: Future fire risk considerations when planning for forest recovery strategy as reported by forest manager survey respondents (n=23).

How was future fire risk incorporated into your operation?

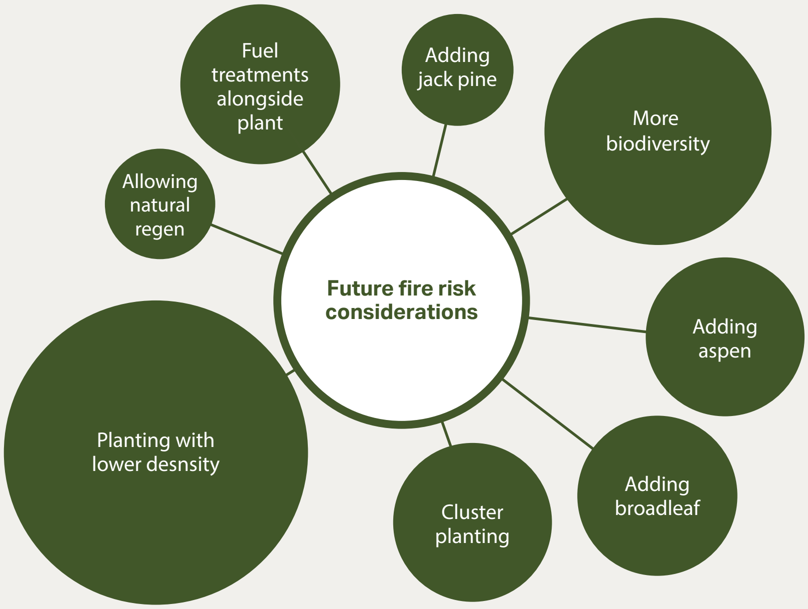

Figure 17: Open-ended responses for pathways for considering future fire risk when planning for tree planting after wildfire, as reported by tree planting respondents who reported that they consider future fire risk in their forest recovery strategy (n=13).

Perspectives

Over the last few decades, we have seen a shift towards adaptive forest management with the goal of increasing resilience of regenerating forests to future disturbances on a larger scale (Achim et al. 2022). For example, in recent years, forest managers in BC are transitioning from a traditional block-by-block forest stewardship planning (FSP) approach to a more integrated forest landscape planning (FLP) strategy. Community forests in BC are among the first to develop these FLPs and we are seeing many recent efforts made on the landscape level that used to be implemented on an individual forest stand basis. This shift will no doubt significantly improve province-wide wildfire risk reduction (WRR) measures as adaptive strategies are taking focus over traditional approaches to wildfire management.

Similarly, in Ontario, wildfire management is enabled through forest management planning using a landscape approach and through wildfire management policy in parks and protected areas. These and other landscape-level changes in planning and governance provide an important backdrop for interpreting the adaptive practices reported by survey respondents during our study.

Reforestation in a Changing Climate: Resist, Adapt, or Direct Change?

Forests across North America are facing unprecedented pressures from climate-driven increases in wildfire size, severity, and frequency. Where fire has historically been a catalyst for renewal, changing conditions are increasingly disrupting the post-fire regeneration processes that forests depend on. Over the years, post-fire regeneration failure has become a prevalent observation in boreal, montane, and mixed temperate forest ecosystems (Stevens-Rumann and Morgan 2019; Kiel et al. 2025; Fortin et al. 2026). Understanding and responding to this challenge is central to maintaining the long-term resilience of forested landscapes and their ecological, cultural, and economic values.

Two interacting factors that contribute to regeneration failure across forest types are temperature and soil moisture levels in the post-fire environment that reduce seedling survival (Boucher et al. 2020). At low elevation and moisture-limited sites, in particular, annual climate conditions have begun crossing thresholds beyond which conifer regeneration becomes unlikely, increasing the chance of transition to deciduous-dominated or non-forested states (Davis et al. 2019). Increased fire severity can eliminate seed banks and biological legacies that conifers depend on for natural regeneration. In other areas, fire return intervals have shortened and re-burns are occurring. In these forests, there is insufficient time to recover between disturbances, and on some sites, natural recovery is unlikely (Walker et al. 2025). In boreal Alaska, approximately sixty-five per cent of sites that burned at short intervals experienced regeneration failure, with many transitioning toward deciduous-dominated or open, non-forested states (Walker et al. 2025), and similar trends for large-scale conifer loss on the landscape is being observed elsewhere in the United States (Bhoot et al. 2026). While Canada's eastern boreal forests have historically been more resilient due to longer fire return intervals and wetter conditions, one-third of mature black spruce plots showed low regeneration rates following recent fires, with some expected to transition into open woodlands persisting for centuries (Fortin et al. 2026). In mixed temperate forests, shifts towards persistent shrubby and herbaceous vegetation following fire are similarly documented under warming and drying climates (Coop 2023). A systematic review of recovery pathways found that state change, where forest transitions to a different land cover type entirely, was the second most common post-fire outcome after self-replacement (Smith-Tripp et al. 2026).

These findings highlight a fundamental challenge for forest managers: under accelerating global change, resilience is increasingly difficult to define and even more difficult to act on through planning and policy. The RAD framework—Resist, Accept, Direct change, first outlined by Schuurman et al. (2022)—provides a practical structure for thinking through management responses to this challenge. Resistance strategies aim to maintain or restore historical forest composition, for example,

Waterton Lakes National Park, 2024, following the 1998 wildfire reflects the lack of forest recovery in some ecosystems.
Photo: Dr. Ellen Whitman, Natural Resources Canada.

through active planting of tree species such as Douglas fir and spruce that may struggle to regenerate naturally under the new conditions. Adaptative silvicultural strategies accept that site conditions have shifted and seek to match species to those new conditions, as reflected in the natural transition from Douglas fir to pine dominance at many western sites. Directing change goes further, actively guiding ecosystems toward new states that are ecologically better suited to the changing climate (Millar et al. 2007; Nagel et al. 2025). The planting trials and monitoring work described by forestry practitioners in this report are generating the “place-based” evidence needed to evaluate which strategies are most likely to succeed under current and projected climate conditions across the country.

Prioritization of Reforestation Efforts: A North American Reflection

Translating the RAD framework into work on the ground begins with knowing where to focus efforts. A significant emerging challenge in this field is prioritization mapping, which involves identifying where natural recovery is most likely to fail, and where active planting will deliver the greatest ecological and economic outcomes.

In the United States, significant effort has been made to improve fire severity mapping. Fire severity was first described by the US National Wildfire Coordinating Group as the “degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time” (NWCG 2005). Since then, near real-time (NRT) measurements have been advanced in recent years (Orland et al. 2025). For Canada, the interactive map found within the Canadian Wildland Fire Information System (Natural Resources Canada 2025a) is one useful tool for referencing basic fire history in a given area but has its limitations in both detail and scale. The differenced Normalized Burn Ratio (dNBR) is a radiometric value still commonly used to express changes observed pre- and post-fire on the ground using satellite imagery (Key and Benson 2006). Remote sensing advancements have since combined traditional vegetation indices like the Normalized Difference Vegetation Index (NDVI), used to map level of canopy greenness, with the dNBR values to assist in accurately mapping reforestation potential (Anees et al. 2025). Other advancements include machine learning tools combined with Sentinel-2 imagery, which provide the highest quality predictors of post-fire forest regeneration failure at finer spatial scales (Wong et al. 2025), lending a higher degree of accuracy in evaluating reforestation opportunities.

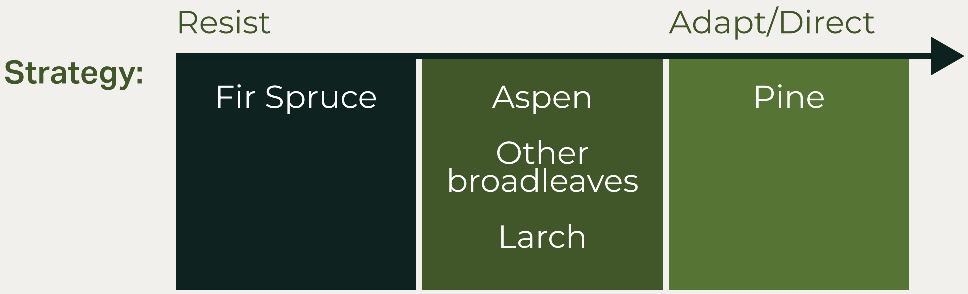

Figure 18: Examples of alternative strategies in post-wildfire tree species shifts after wildfire in western Canada.

American Forests, through partnership with the US Forest Service and others, has led the way for forest recovery in south central Oregon following severe wildfires from 2018-2022. Their approach uses maps to determine distance to nearest seed source and prioritization areas, while also working to minimize the risk of future reburns in these areas. High fire severity was defined as areas with greater than seventy five per cent basal area tree mortality, and depending on the mortality in a given area, four general approaches were applied: 1) Tree planting with fuel reduction; 2) Natural regeneration with fuel reduction; 3) Fuel reduction only; and 4) Maintenance treatments with prescribed fire within 10 years (American Forests 2023). This framework is well supported by a growing body of research which can significantly improve the accuracy of identifying where active planting will be most effective.

In BC, the Ministry of Forests has recently published a guideline on post-wildfire reforestation eligibility assessment that follows a similar pathway: beginning with fire intensity, factoring in land ownership/ management jurisdiction, and prioritizing reforestation efforts based on natural regeneration surveys, biogeoclimatic (BEC) zone classification, physical features such as topography, pre-fire species composition, and logistical considerations such as access (BC Ministry of Forests, 2026). Large-scale reviews of stand-replacing wildfires in western North America found that forest recovery was more strongly shaped by elevation, slope, aspect, seed-source proximity, and post-fire climate conditions than by burn severity alone (Stevens-Rumann and Morgan 2019; Sorenson et al. 2025). While severity mapping tells us where fire was most destructive, the climatic and topographic conditions that trees face in the years after fire ultimately determines whether forests can re-establish. The most consistent finding in recent research is that low-elevation, warm, and moisture-limited sites are where natural conifer regeneration most frequently fails (Stevens-Rumann and Morgan 2019; Coop 2023; Sorenson et al. 2025). Tree recruitment is limited and grasses or shrubs often fill the post-fire space, tipping a site away from forest classification for decades or sometimes entirely (Smith-Tripp et al. 2026; Sorenson et al. 2025). Observations of non-native plant establishment after wildfire increased with decreasing elevation, regardless of fire severity in a recent study in BC (Oeggerli et al. 2026). Topography reinforces this pattern, with native plant cover and conifer regeneration both increasing with elevation and declining on warm, south- and southwest-facing slopes (Oeggerli et al. 2026; Holden et al. 2025). Looking ahead, projected climate warming will push suitable regeneration progressively upslope, meaning that sites that are marginal today may be entirely unsuitable for forest recovery in the future.

Where Planting Investment Goes the Furthest

Analysis of tree planting outcomes across nearly three hundred fire events in the US Interior West confirms that well-targeted planting can improve post-fire forest recovery (Rodman et al. 2024). Research comparing planted and unplanted areas within the same fires found that active tree planting provides its greatest benefit precisely at these hot, dry, low-elevation sites where passive regeneration is most likely to fail, and can boost forest recovery by up to two hundred per cent (Sorenson et al. 2025). The planted areas gained forest cover approximately twenty-six per cent more rapidly than comparable unplanted sites, though outcomes varied considerably with climate, site conditions, and planting timing (Rodman et al. 2024). Cold, wet sites consistently showed the highest seedling survival and fastest forest cover recovery, while warm, dry sites lagged significantly.

Timing is also critical. Spring planting tends to perform best on cooler, wetter sites, where soil remains moist and temperatures are moderate through the growing season. In warmer, drier regions, however, late summer or fall planting can improve outcomes because milder winter conditions allow for root growth prior to the onset of summer heat, where the observed Climatic Water Deficit (CWD) is a primary cause of seedling mortality (Rodman et al. 2024).

Where shrub competition is high, planting within the first year after fire significantly improves tree seedling survival. Low-elevation, high-severity areas carry the greatest risk of invasive plant colonization in the years following fire, meaning that invasive species monitoring and early management should be treated as an integral part of the planting plan in these zones, not a secondary concern (Oeggerli et al. 2026). High-elevation, climatically suitable sites near surviving mature forest, by contrast, can often be monitored for natural regeneration before planting trees, allowing limited resources to be used where they are needed most.

Operationalizing at Scale: Collaboration Across Jurisdictions

Singular federal strategies are not likely to work effectively at the local scale, and efforts have been made to foster communication for best practices at the national scale with the intention of being implemented regionally. For example, with tree planting after forest harvest on the decline in BC, many forest professionals and tree nurseries are now wondering if some of these resources can be re-allocated towards mitigation and post-wildfire tree planting (Labbé 2025).

The financial case for scaling up reforestation as part of wildfire recovery is compelling. Canada historically averages approximately two to two and a half million hectares burned annually (Natural Resources Canada, 2025b) with associated suppression expenditures exceeding one billion dollars in severe seasons (Natural Resources Canada 2025c). Both are projected to rise under climate change, suggesting that mitigation investments to date have been insufficient to meaningfully reduce overall fire impacts. As Gray et al. (2025) argues, many jurisdictions across western North America now face a critical crossroads between continuing reactive spending on suppression and recovery at escalating cost, or shift toward proactive, landscape-scale mitigation and reforestation.

Yet even where science can identify where planting is needed most, seed supply, nursery capacity, labour, and logistics remain key constraints in delivering seedlings across large, burned landscapes (Wotherspoon et al. 2025). In the western United States, post-fire planting capacity fell short of reforestation needs by approximately one and a half million hectares between 1984 and 2021, a gap projected to more than double by mid-century if current trends continue (Dobrowski et al. 2024). The challenge, therefore, is not just knowing where to plant, but having the capacity across the full forest recovery system to do it.

Nursery capacity is a significant constraint. In the United States, only thirty-two per cent of nurseries operate at full capacity, and even full utilization would meet just twenty-five per cent of projected seedling demand without substantial infrastructure investment (Fargione et al. 2021). In Canada, nurseries collectively produce about six hundred million seedlings annually, but recent industry estimates suggest billions of additional seedlings would be required to address post-fire restoration needs, indicating a similar gap in supply and demand (Canadian Tree Nursery Association 2026). Compounding this, seedlings take one to three years to produce, so nursery production decisions must be made well in advance of planting need, creating significant planning and financial risk when demand is uncertain or highly variable between fire seasons.

Labour and logistics present further challenges. Planting windows are short and dependent upon the availability of a trained workforce. Labour shortages and rising costs limit the ability to scale following large wildfire years, while geographic distance between where seedlings are produced and where planting is needed increase transportation costs and coordination complexity (Dobrowski et al. 2024). Despite these constraints, there are reasons for optimism. Coordination mechanisms can strengthen connections between science, place-based knowledge, and regional practices, and there is growing evidence that targeted policy incentives and investments could alleviate bottlenecks in the reforestation pipeline (Fargione et al. 2021).

North Shuswap, BC after 2023 Bush Creek East wildfire, 2025. Photo: Elizabeth Jarrett.

Finally, effective reforestation depends on who is involved in the process. Indigenous communities bring long-term stewardship knowledge and cultural priorities that are essential to recovery planning, a theme explored in the section that follows. At the community scale, programs like FireSmart provide a complementary pathway, engaging landowners and residents directly in reducing wildfire risk closer to home.

Indigenous Stewardship Pathways

Global evidence confirms that Indigenous fire stewardship consistently increases biodiversity and creates more diverse habitats. The disruption of these practices through colonization has contributed to biodiversity declines and changes in fire regimes across many of these ecosystems (Hoffman et al. 2021). As climate change intensifies wildfire activity, Indigenous-led stewardship is increasingly recognized not only as culturally essential, but as an ecologically grounded approach for risk mitigation and reforestation that integrates traditional knowledge with contemporary practice (Copes-Gerbitz et al. 2024).

We expect to see more shifts in the selection of tree species that are culturally relevant as well as more resilient to future wildfires, with Indigenous communities leading the way in this effort (Copes-Gerbitz et al. 2024). For example, centered on the interconnection between the land and community well-being, the Secwepemcúl’ecw Restoration and Stewardship Society (SRSS) has made significant progress on the recovery of their traditional lands following the Elephant Hill wildfire in 2017 (Dickson-Hoyle and John 2021). Following the fire, leadership in the Secwépemc communities worked collaboratively with the BC Ministry of Forests through the Joint Technical Committee (JTC), resulting in a new model for First Nations-led wildfire recovery throughout the province. Trees were planted within “enhanced stocking standards,” allowing greater flexibility in tree densities and species selected. Principles established by the JTC arose in part from early opposition to proposals to convert Douglas fir and spruce-dominated forests to *Pinus contorta* (lodgepole pine) dominance, as well as concerns over the loss of deciduous and culturally important species. The resulting reforestation strategy followed natural succession pathways based on the pre-wildfire composition, maintaining deciduous and culturally important species instead of a blanketed conversion to pine-dominated forest.

Tiffany Traverse, a Secwépemc land and seed steward, explains (personal communication, September 16, 2025) that the authority over what is seeded or planted, and whether the land should be returned to forest at all, should be placed back in the hands of First Nations communities. Traverse notes that effective post-wildfire forest recovery cannot be directed from the national level and will be more effective from the local scale with local and traditional knowledge.

Hayden Leo, Líl’wat First Nation community member and Forestry Technician for Líl’wat Forestry Ventures (LFV), describes the work being done after the wildfires along Boulder Creek and in the Mount Meager region in BC through a committee-led process (personal communication, July 7, 2025). The erosion resulting from multiple years of floods and landslides alongside a significant wildfire in 2013 has made forest recovery difficult in the area. Like many other communities, LFV aims to recover through tree planting following regeneration surveys, while incorporating plants, berries, deciduous species, FireSmart principles, and habitat enhancements for wildlife like blacktail deer and moose.

Despite growing recognition of the value of Indigenous-led stewardship, there are significant barriers to full community engagement. Researchers also point to the growing role of “boundary spanners,” individuals or organizations that connect Indigenous knowledge holders, scientists, and fire managers to help bridge the institutional divides and knowledge gaps that hinder collaborative approaches to cultural and prescribed fire (Hoffman et al. 2024). These bridging roles are increasingly recognized as essential, not only for Indigenous-led stewardship, but for the kind of community scale risk reduction that programs like FireSmart are designed to support.

FireSmart Principles and Community Safety Considerations

In recent decades, the Wildland Urban Interface (WUI) has increased thirty-five per cent, bringing more homes and infrastructure into landscapes where wildfire is a natural and recurring process (Guo et al. 2024). Approximately twelve per cent of the Canadian population currently live in these areas, which includes thirty-two per cent of the on-reserve First Nations population (Erni et al. 2021). As climate change intensifies forest disturbances, the vulnerability of communities exposed to these events is expected to increase

(Montpetit et al. 2025). As this interface grows, so does the need for strategies that reduce wildfire risk and improve community safety.

The FireSmart Program has emerged as the primary framework for reducing ignition risk and fuel continuity near homes and communities. The program is widely endorsed across the country as a practical approach to community-level wildfire risk reduction (Partners in Protection 2003). FireSmart organizes mitigation actions into zones extending outward from structures (Canadian Interagency Forest Fire Centre 2023). While FireSmart guidance is well established in the context of the WUI, the same principles are now being discussed more often in relation to wildfire mitigation across forest landscapes farther from populated areas (Hirsch et al. 2001; McKinney et al. 2022; Ott et al. 2023).

FireSmart is most effective when adopted at the community scale, where coordinated treatment across multiple properties reduces fire spread beyond what any single homeowner can achieve alone. Actions such as thinning vegetation, increasing spacing between trees, and thoughtful species selection are most effective when applied over larger areas rather than isolated parcels. However, the benefits only materialize after a critical threshold of treated area has been reached, meaning that governments and communities must sustain investment for years before seeing measurable returns (McKinney et al. 2022; Karimi et al. 2024). These principles also reflect the same general logic that has guided Indigenous cultural burning for generations, and the two approaches could be most powerful when pursued together, each operating at the scale where it works best (Hoffman et al. 2022; Copes-Gerbitz et al. 2024).

Species selection can influence fire behavior and extend some of these principles beyond the home ignition zone and into the surrounding landscape. Such considerations are being implemented in the field, where practitioners have reported shifts in species selection based not only on recovery strategy, but also projected climate and wildfire risk. Aspen is widely recognized for its relatively low flammability once leafed out and is often utilized in firebreaks and mixed stands to reduce potential fire spread (Pelletier et al. 2026; Parisien et al. 2023; Harris et al. 2025). Adapted to regions that experience high-severity wildfires in Canada, aspen can regenerate successfully through both suckering and seedling establishment. However, regeneration success does depend on the phenology of the aspen, specifically whether leaf-out has taken place prior to the wildfire and can affect survival and recruitment (Dawe et al. 2025). These regenerative traits help explain the continued persistence of aspen across much of the Canadian landscape, even following severe wildfire events.

Photo: Shelley Barlow, BC Ministry of Forests.

Larix (tamarack, larch) has also gained attention in recent years for its potential wildfire resilience benefits. Well-adapted to northern landscapes, this deciduous conifer exhibits lower flammability during the growing season than many evergreen species and has shown persistence following fire. Wildfire ecologist Robert Gray of R.W. Gray Consulting Ltd. (personal communication, July 24, 2025), notes that larch naturally regenerates after disturbance and can be supported through thinning and prescribed burning that reduce surface fuel accumulation. He further observed that survival improved markedly once trees exceed approximately five centimetres in diameter. Stand conversion to larch has also been explored as a strategy to reduce fuel continuity and wildfire intensity in treated areas (MacKinnon and Hvenegaard 2021). The FireSmart BC Landscaping Guide (2024) similarly identifies larch as having comparatively lower flammability due to higher foliage moisture content, making it suitable for landscaping applications as well.

Photo: Integrity Reforestation

Conclusion and Recommendations

What emerges from this report is that practices for post-wildfire forest recovery are ever-changing due to the shifting behavior, extent and local impacts of wildfires in Canada within the last decade. The insights from those in the forest restoration industry presented in this report reflect a glimpse of a changing climate in both silviculture and policy in post-wildfire forest management in Canada. As wildfires increase in severity and complexity, there is need for a continuously adaptive strategy in the path forward. This will require more observations of the patterns of post-wildfire forest recovery in a changing climate through continued scientific exploration of the impacts of wildland fire on forest succession, as well as sharper observations in the field for tree planting success through facilitated conversations among practitioners. In parallel, policy developments will need to match the growing changes in silviculture for successful forest management in the future. Enhanced investment in research, long term monitoring including control plots absent of treatments, field trials and inter-regional communication will become critical in this regard.

Although much-needed focus has been placed on mitigating the risk and intensity of wildfire through adaptive forest management activities such as salvage logging, fuel treatments and FireSmart initiatives in communities, more discussion is still needed on the post-fire tree planting component, since trees are still regularly being added to the landscape both through mandated silvicultural obligations and voluntary forest restoration efforts.

On the following page, the survey results and notes from interviews with experts enable us to identify the following emerging gaps in knowledge and suggested focus for future research efforts and facilitated conversations.

Knowledge Gaps and Suggested Future Research Areas

1. Reforestation prioritization methods and tools:

- Limited ability to consistently assess wildfire severity in Canada at national and regional scales.
- Need for region-specific, decision-ready frameworks to guide tree planting priorities and resource allocation.

2. Species selection:

- Uncertainty in balancing multiple forest management values and objectives with long-term wildfire resilience.
- Limited understanding of alternative post-fire successional pathways and consequences of intervention.
- Incomplete knowledge on species adaptability and establishment success under changing conditions.
- Underrepresentation of cultural and intrinsic species values in forest recovery decision-making.

3. Indigenous stewardship pathways:

- Lack of operational models for Indigenous-led policy, governance, and standards for forest recovery after wildfire.
- Need for sustained capacity-building and continuous learning mechanisms.

4. Planting standards (spacing and microsites):

- Limited field-based knowledge on interactions between species, stock type, microsites, and browse pressure from wildlife.
- Gaps in adaptive standards.
- Need for practitioner training opportunities based on emerging research.

5. Site preparation and salvage logging:

- Incomplete field-based knowledge on ecological outcomes of site preparation and salvage logging in conjunction with post-fire forest restoration.
- Limited understanding of forest biomass retention and its impacts on wildfire risk and seedling establishment success.

6. True cost of artificial regeneration:

- Incomplete accounting of operational, logistical, and access-related costs related to planting trees after wildfire.
- Limited assessment of investments needed to maintain a safe workplace for tree planting operations.

7. Occupational health and safety:

- Limited data on cumulative health impacts of post-wildfire hazards on tree planters.
- Need for evidence-based interventions and standardized training required to improve workplace safety for tree planters.

In conclusion, this report sheds light on the evolving questions that have arisen about forest recovery over the past decade in relation to wildfire impacts, but it also serves as a call for collaboration. Public directives, industry dialogue, and concerted efforts in scientific research are all critical in the path forward. The journey ahead involves many key players including government, industry, Indigenous leaders, academia, non-governmental organizations, and the general public. The time for informed action is now.

References

Achim, A., Guillaume Moreau, G. et al. 2022. *The changing culture of silviculture, Forestry: An International Journal of Forest Research,* 95 (2). https://doi.org/10.1093/forestry/cpab047

American Forests. 2023. *Integrated Post-Fire Resilience Strategy*. 62 pp. Available online at: https://d3f9k0n15ckvhe.cloudfront.net/wp-content/uploads/2023/07/Integrated_Post-Fire_Resilience_Strategy.pdf [Accessed 1 November 2026].

Anees, S.A., Mehmood, K., et al. 2025. *Advancing forest fire burn severity and vegetation recovery assessments using remote sensing and machine learning approaches*. Ecological Informatics, 92 (103446). https://doi.org/10.1016/j.ecoinf.2025.103446

Barrette, J., Thiffault, E., and Paré, D. 2013. *Salvage harvesting of fire-killed stands in Northern Quebec: Analysis of bioenergy and ecological potentials and constraints*. J. Sci. Technol. For. Products Processes, 3.

BC Forest Practices Board. 2025a. *Terms of reference for a special investigation: Planted, then burned: are licensees meeting reforestation obligations after wildfire?* Forest and Range Practices Board. Canada. Available online at: https://www.bcfpb.ca/wp-content/uploads/2025/06/2025-ToR-Planted-then-Burned.pdf [Access 8 April 2026].

BC Forest Practices Board. 2025b. *Special Investigation Help or Hinder? Aligning Forestry Practices with Wildfire Risk Reduction.* Available online at: https://www.bcfpb.ca/wp-content/uploads/2025/06/SIR56-Help-or-Hinder.pdf [Accessed 15 January 2026].

BC Ministry of Forests. 2016. *Fire management stocking standards guidance document*. V1 February 2016. Available online at: https://www2.gov.bc.ca/assets/gov/environment/natural-resource-stewardship/land-based-investment/forests-for-tomorrow/fire_management_stocking_standards_guidance_document_march_2016.pdf [Accessed 17 March 2026].

BC Ministry of Forests. 2026. *Forest Investment Program: Post-wildfire assessment overview guidance*. Available online at: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/stewardship/forest-investment-program/forest_investment_program_post-wildfire_assessment_overview_guidance.pdf [Accessed 23 March 2026].

Bhoot, V. N., Kim, J. E., et al. 2026. *Declines in conifer forest recovery and forest loss from four decades of wildfire in California*. Journal of Geophysical Research: Biogeosciences, 131, e2025JG009105. https://doi.org/10.1029/2025JG009105

Blondeel, H., Guillemot, J., et al. 2024. *Tree diversity reduces variability in sapling survival under drought*. Journal of Ecology. 112, pp. 1164-1180. https://doi.org/10.1111/1365-2745.14294

Boucher, D., Gauthier, S., et al. 2020. *How climate change might affect tree regeneration following fire at northern latitudes: a review*. New Forests 51: 543-571. https://doi.org/10.1007/s11056-019-09745-6

Boulanger, Y., Arseneault, D., et al. 2024. *The 2023 wildfire season in Québec: an overview of extreme conditions, impacts, lessons learned and considerations for the future*. Canadian Journal of Forest Research. 55: 1-21. https://doi.org/10.1139/cjfr-2023-0298

Briand, C.H., Schwilk, D.W., Gautlier, S., and Bergeron, Y. 2015. *Does fire regime influence life history traits of jack pine in the southern boreal forest of Québec, Canada?* Plant Ecology 216: 157–164. https://doi.org/10.1007/s11258-014-0424-x

Canadian Council of Forest Ministers. 2021. *CCFM Wildland Fire Management Working Group, Action Plan 2021-2026*. https://www.ccfm.org/ releases/wildland-fire-management-working-group-action-plan-2021-2026

Canadian Council of Forest Ministers. 2024. *Canadian wildland fire prevention and mitigation strategy*. https://www.ccfm.org/wp-content/uploads/2024/06/CWFPM-Strategy-EN-2024-06-05-FINAL-_V09.pdf [Accessed 15 January 2026].

Canadian Interagency Forest Fire Centre. 2023. *FireSmart begins at home guide*. FireSmart Canada. Available at: https://firesmartcanada.ca/resources

Canadian Tree Nursery Association. 2026. *Annual seedling production and restoration need estimates*. Available at: https://igrownews.com/canadian-tree-nursery-association-latest-news [Accessed February 24, 2026].

Certini, G. 2005. *Effects of fire on properties of forest soils: a review*. Oecologia 143: 1–10.

Christianson, A.C., Sutherland, C.R., et al. 2022. *Centering Indigenous voices: The role of fire in the boreal forest of North America*. Current Forestry Reports 8(3): 257-276. https://doi.org/10.1007/s40725-022-00168-9

Clason A.J., Farnell I. and Lilles E.B. 2022. *Carbon 5–60 years after fire: planting trees does not compensate for losses in dead wood stores*. Front. For. Glob. Change 5:868024. doi: 10.3389/ffgc.2022.868024

Copes-Gerbitz, K., Pascal, D., et al. 2024. *Cooperative community wildfire response: Pathways to First Nations' leadership and partnership in British Columbia, Canada*. International Journal of Disaster Risk Reduction 114: 104933. https://doi.org/10.1016/j.ijdrr.2024.104933

Coté, S.D., Rooney, T. P., et al. 2004. *Ecological impacts of deer overabundance.* Annu. Rev. Ecol. Evol. Syst. 35.1 (2004): 113-147.

Coop, J.D. 2023. *Postfire futures in southwestern forests: Climate and landscape influences on trajectories of recovery and conversion*. Ecological Applications 33(1). https://pmc.ncbi.nlm.nih.gov/articles/PMC10078526

Danneyrolles, V., Chavardès, R.D., et al. 2025. *Contextualizing recent increases in Canadian boreal wildfire activity: decadal burn rates still within historical variability of the two past centuries*. Canadian Journal of Forest Research. 55: 1-12.

D'Amato, A.W., Palik, B.J., et al. 2023. *Building a Framework for Adaptive Silviculture Under Global Change. In Boreal Forests in the Face of Climate Change. Sustainable Management*. Advances in Global Change Research 74. Edited by M.M. Girona, H. Morin, S. Gauthier, and Y. Bergeron. Springer Cham. pp. 359-381. https://doi.org/10.1007/978-3-031-15988-6_13

Daust, D., and Karen Price Consulting. 2019. *Shovel Lake Wildfire Ecosystem Restoration Plan*. Available online at: https://sernbc.ca/uploads/library/additional_related/wildfire_recovery/Shovel_Lake_Wildfire_Ecosystem_Restoration_Plan_September_11_2019.pdf [Accessed January 18 2026].

Davis, A.S., and Pinto, J.R. 2021. *The Scientific basis of the Target Plant Concept: An overview*. Forests 12(9). https://doi.org/10.3390/f12091293

Davis, K.T., Dobrowski, S.Z., et al. 2019. *Wildfires and climate change push low-elevation forests across a critical climate threshold for tree regeneration*. Proceedings of the National Academy of Sciences 116(13): 6193–6198. https://doi.org/10.1073/pnas.1815107116

Davis, L.S., Johnson, K.N., and Bettinger, P. 2001. *Forest Management to Sustain Ecological, Economic, and Social Values*. Fourth Edition. Waveland Press, Inc., Long Grove, IL, USA.

Dawe, D., Whitman, E., et al. 2025. *Sexual and vegetative recruitment of trembling aspen following a high-severity boreal wildfire*. Fire Ecology 21: 32. https://doi.org/10.1186/s42408-025-00359-2

de Chantal, M., and Granström, A. 2007. *Aggregations of dead wood after wildfire act as browsing refugia for seedlings of Populus tremula and Salix caprea*. Forest Ecology and Management 250(1-2): 3-8. https://doi.org/10.1016/j.foreco.2007.03.035

Dickson-Hoyle, S., and John, C. 2021. *Elephant Hill: Secwépemc leadership and lessons learned from the collective story of wildfire recovery*. Available online at: https://open.library.ubc.ca/media/stream/pdf/24/1.0422761/3 [Accessed 15 January 2026].

Dobrowski, S.Z., Aghai, M.M., et al. 2024. *Mind the gap — reforestation needs vs. reforestation capacity in the western United States*. Frontiers in Forests and Global Change 7: 1402124. https://doi.org/10.3389/ffgc.2024.1402124

Erni, S., Johnston, L., et al. 2021. *Exposure of the Canadian wildland–human interface and population to wildland fire, under current and future climate conditions*. Environmental Research Letters, 12(6). http://dx.doi.org/10.1139/cjfr-2020-0422

Fargione, J., Haase, D.L., et al. 2021. *Challenges to the reforestation pipeline in the United States*. Frontiers in Forests and Global Change 4: 629198. https://doi.org/10.3389/ffgc.2021.629198

Fetouab, A., Fenton, N.J., et al. 2024. *Planting density and mechanical site preparation effects on understory composition, functional diversity and planted black spruce growth in boreal forests*. Silva Fennica 58(2): 23029. https://doi.org/10.14214/sf.23029

FireSmart BC. 2024. *FireSmart BC landscaping guide*. Victoria (BC): BC Wildfire Service. Available at: https://firesmartbc.ca/resource/landscaping-guide/ [Accessed 1 March 2026].

Forests Canada. 2025. *Reforest Canada Collective webinar series: After the smoke clears: forest recovery strategies after wildfire in Canada*. Available online at: https://www.youtube.com/playlist?list=PLaMqVqVc4pINJlJ4SEeRmbzT3Dgh-zF51

Fortin, S., Boucher, Y., et al. 2026. *Ecological factors shaping post-fire resilience in mature black spruce forests of eastern North America*. Journal of Ecology. https://doi.org/10.1111/1365-2745.70260

Gray, A.N., and Spies, T.A. 1997. *Microsite controls on tree seedling establishment in conifer forest canopy gaps*. Ecology 78(8): 2458-2473. https://doi.org/10.1890/0012-9658(1997)078[2458:MCOTSE]2.0.CO;2

Gray, R., Gregory, R., and Sandborn, C. 2025. *Wildfire management at a crossroads: Mitigation and prevention or response and recovery?* Science 390(6675): 30–33. https://doi.org/10.1126/science.adx1230

Grossnickle, S.C. and MacDonald, J.E. 2026. *Seedling field performance on hot, dry forest restoration sites: influence of plant attributes*. New Forests 57, 16 https://doi.org/10.1007/s11056-025-10140-7

Grossnickle, S.C., and El-Kassaby, Y.A. 2016. *Bareroot versus container stocktypes: a performance comparison*. New Forests 47(1): 1-51. https://doi.org/10.1007/s11056-015-9476-6

Guo, Y.X., Wang, J.H., et al. 2024. *Global expansion of wildland-urban interface intensifies human exposure to wildfire risk in the 21st century*. Science Advances 10(45). http://doi.org/10.1126/sciadv.ado9587

Harris, M.P., Coop, J.D., et al. 2025. *Aspen impedes wildfire spread in southwestern United States landscapes*. Ecological Applications. https://doi.org/10.1002/eap.70061

Henneb, M., Thiffault, N., and Valeria, O. 2020. *Regional climate, edaphic conditions and establishment substrates interact to influence initial growth of black spruce and jack pine planted in the boreal forest*. Forests 11(2): 139. https://doi.org/10.3390/f11020139

Hirsch, K.G., Kafka, V., et al. 2001. *Fire-smart forest management: A pragmatic approach to sustainable forest management in fire-dominated ecosystems*. The Forestry Chronicle, 77(2): 357–363. https://doi.org/10.5558/tfc77357-2

Hoffman, K.M., Davis, E.L., et al. 2021. *Conservation of Earth's biodiversity is embedded in Indigenous fire stewardship*. Proceedings of the National Academy of Sciences 118(32): e2105558118. https://doi.org/10.1073/pnas.2105073118

Hoffman, K.M., Cardinal Christianson, A., et al. 2022. *The right to burn: barriers and opportunities for Indigenous-led fire stewardship in Canada*. FACETS 7: 464–481. https://doi.org/10.1139/facets-2021-0062

Hoffman, K.M., Copes-Gerbitz, K., et al. 2024. *Boundary spanners catalyze cultural and prescribed fire in western Canada*. FACETS 9: 1–11. https://doi.org/10.1139/facets-2023-0109

Holden, Z.A., Jungck, E., et al. 2025. *A post-fire reforestation assessment and prioritization tool for the Western United States*. Fire Ecology 21: 83. https://doi.org/10.1186/s42408-025-00405-z

Jain, P., Barber, Q.E., et al. 2024. *Drivers and impacts of the record-breaking 2023 wildfire season in Canada*. Nature Communications 15(1): 6764. https://doi.org/10.1038/s41467-024-51154-7

Jenkins, M., Price, O., et al. 2019. *The influence of planting size and configuration on landscape fire risk*. J Environ Manage 248: 109338. https://doi.org/10.1016/j.jenvman.2019.109338

Johnstone, J.F., Allen, C.D., et al. 2016. *Changing disturbance regimes, ecological memory, and forest resilience*. Frontiers in Ecology and the Environment 14(7): 369–378. https://doi.org/10.1002/fee.1311

Johnstone, J.F., and Chapin, F.S. 2006. *Effects of soil burn severity on post-fire tree recruitment in boreal forest*. Ecosystems 9: 14–31. https://doi.org/10.1007/s10021-004-0042-x

Jull, M.J., Zielke, K., et al. 2025. *Silvicultural Systems Handbook for British Columbia: Developing Silvicultural Pathways for Diverse Forest Stand and Landscape Goals*. B.C. Min. For., Victoria, B.C. Land Management Handbook 79. Second edition.

Karimi, N., Mahler, P., and Beverly, J.L. 2024. *Optimizing fuel treatments for community wildfire mitigation planning*. Journal of Environmental Management, 370, 122325. https://doi.org/10.1016/j.jenvman.2024.122325

Keenleyside, K., Dudley, N., et al. 2012. *Ecological restoration for protected areas: principles, guidelines and best practices* (Vol. 18). IUCN. Available online at: https://portals.iucn.org/library/sites/library/files/documents/PAG-018.pdf [Accessed 7 April 2026].

Key, C.H., and Benson, N.C. 2006. *Landscape Assessment (LA) sampling and analysis methods*. USDA Forest Service - General Technical Report RMRS-GTR. Available online at: https://www.fs.usda.gov/rm/pubs_series/rmrs/gtr/rmrs_gtr164/rmrs_gtr164_13_land_assess.pdf [Accessed 15 January 2026].

Kiel, N.G., Mavencamp, E.F., and Turner, M.G. 2025. *Sparse subalpine forest recovery pathways, plant communities, and carbon stocks 34 years after stand-replacing fire*. Ecological Monographs 95: e1644. https://doi.org/10.1002/ecm.1644

Kirchmeier-Young, M.C., Malinina, E., et al. 2024. *Human driven climate change increased the likelihood of the 2023 record area burned in Canada*. Climate and Atmospheric Science 7: 316. https://doi.org/10.1038/s41612-024-00841-9

Labbé, S. 2025. *Amid wildfires, B.C. tree planting to plummet for third year*. BIV. Business Intelligence for BC. https://www.biv.com/news/resources-agriculture/amid-wildfires-bc-tree-planting-to-plummet-for-third-year-11067891 [Accessed 14 November, 2025].

Lebel Desrosiers, S., Bélanger, N., et al. 2025. *Climate change and transformation in forest fire regimes: an opportunity for the implementation of assisted migration of tree species in the Canadian boreal forest?* Silva Fennica 59(2). https://doi.org/10.14214/sf.25031

Lv, Q., Chen, Z., et al. 2025. *Increasing severity of large-scale fires prolongs recovery time of forests globally since 2001*. Nature Ecology and Evolution 9(6): 980–992. https://doi.org/10.1038/s41559-025-02683-x

MacKinnon, B., and Hvenegaard, S. 2021. *Determining suitable FireSmart treatment areas for tamarack (Larix laricina) species stand conversion: an investigation at Pelican Mountain Research Site*. FPInnovations Technical Report TR2021N15. Edmonton (AB): FPInnovations.

Marshall, L.A.E., Fornwalt, P.J., et al. 2023. *North-facing aspects, shade objects, and microtopographic depressions promote the survival and growth of tree seedlings planted after wildfire*. Fire Ecology 19(1): 26. https://doi.org/10.1186/s42408-023-00181-8

McKinney, S.T., Abrahamson, I., et al. 2022. *A systematic review of empirical evidence for landscape-level fuel treatment effectiveness*. Fire Ecology 18, 21. https://doi.org/10.1186/s42408-022-00146-3

Millar, C.I., Stephenson, N.L., and Stephens, S.L. 2007. *Change and forests of the future: Managing in the face of uncertainty*. Ecological Applications 17(8): 2145–2151. https://doi.org/10.1890/06-1715.1

Montpetit, A., Doyon, F., and Chiasson, G. 2025. *The vulnerability of Canadian forest-dependent communities to climate change: an indicator-based approach*. Canadian Journal of Forest Research 55: 1–15. https://doi.org/10.1139/cjfr-2024-0138

Munson, A.D., and Timmer, V.R. 1995. *Soil nitrogen dynamics and nutrition of pine following silvicultural treatments in boreal and Great Lakes-St. Lawrence plantations*. Forest Ecology and Management 76(1-3): 169-179. https://doi.org/10.1016/0378-1127(95)03547-N

Nagel, L.M., Janowiak, M.K., et al. 2025. *Ten years of Adaptive Silviculture for Climate Change: An applied, coproduced experimental framework*. BioScience: biaf170. https://doi.org/10.1093/biosci/biaf170

Natural Resources Canada. 2024. *The State of Canada's Forests: Annual Report 2024*. Canadian Forest Service, Ottawa, ON. 154 pages.

Natural Resources Canada. 2025a. *Interactive map - Canadian Wildland Fire Information System*. https://cwfis.cfs.nrcan.gc.ca/interactive-map [Accessed 25 February, 2026].

Natural Resources Canada. 2025b. *Interactive map – Canadian National Fire Database*. https://cwfis.cfs.nrcan.gc.ca/ha/nfdb?type=poly&year=9999 [Accessed 25 February, 2026].

Natural Resources Canada. 2025c. *Fighting and managing wildfires in a changing climate program*. Government of Canada. https://natural-resources.canada.ca/forest-forestry/wildland-fires/fighting-managing-wildfires-changing-climate-program [Accessed 1 March 2026].

North, M.P., Stevens, J.T., et al. 2019. *Tamm Review: Reforestation for resilience in frequent-fire forests*. Forest Ecology and Management 432: 209–224. https://doi.org/10.1016/j.foreco.2018.09.007

NWCG [National Wildfire Coordinating Group]. 2005. *Glossary of wildland fire terminology*. National Interagency Fire Center. Boise, Idaho. Available online at: https://archive.org/stream/glossary-of-wildland-fire-terminology/Glossary%20of%20Wildland%20Fire%20Terminology_djvu.txt [Accessed 15 January 2026].

Oeggerli, V.V., Martin, T.G., Simard, S.W. et al. 2026. *Factors influencing early post-wildfire vegetation and implications for invasive plant management in the interior of British Columbia, Canada*. fire ecol. https://doi.org/10.1186/s42408-026-00463-x

Orland, E., McCabe, T.D., et al. 2025. *Near real-time indicators of burn severity in the western U.S. from active fire tracking*. Fire Ecology 21: 55. https://doi.org/10.1186/s42408-025-00407-x

Ott, J. E., Kilkenny, F. F., and Jain, T. B. 2023. *Fuel treatment effectiveness at the landscape scale: A systematic review of simulation studies comparing treatment scenarios in North America*. Fire Ecology, 19, Article 10. https://doi.org/10.1186/s42408-022-00163-2

Palik, B.J., Clark, P.W., et al. 2022. *Operationalizing forest-assisted migration in the context of climate change adaptation: Examples from the eastern USA*. Ecosphere 13(10): e4260. https://doi.org/10.1002/ecs2.4260

Parisien, M.-A., Barber, Q.E., et al. 2020. *Fire deficit increases wildfire risk for many communities in the Canadian boreal forest*. Nature Communications 11: 2121. https://doi.org/10.1038/s41467-020-15961-y

Parisien, M.-A., Barber, Q.E., et al. 2023. *Broadleaf tree phenology and springtime wildfire occurrence in boreal Canada*. Global Change Biology 29: 6106–6119. https://doi.org/10.1111/gcb.16820

Parks Canada Agency. 2018. *A natural priority – A report on Parks Canada's Conservation and Restoration Program*. Parks Canada Agency, Ottawa. 47 pp. Available online at: https://publications.gc.ca/collections/collection_2018/pc/R62-551-2018-eng.pdf [Accessed 7 April 2026].

Partners in Protection. 2003. *FireSmart: Protecting Your Community from Wildfire*. 2nd ed. Edmonton, Alberta: Partners in Protection. https://firesmartcanada.ca/resources/ [Accessed 1 March 2026].

Pelletier, F., Cardille, J. A., & White, J. C. 2026. *Populus tremuloides as a natural fire barrier in Canada's boreal forest under a changing climate*. Forest Ecology and Management, 610, 123671. https://doi.org/10.1016/j.foreco.2026.123671

Pinto, J.R., Marshall, J.D., et al. 2012. *Photosynthetic response, carbon isotopic composition, survival, and growth of three stock types under water stress enhanced by vegetative competition*. Canadian Journal of Forest Research 42(2): 333-344. https://doi.org/10.1139/X11-189

Rodman, K.C., Fornwalt, P.J., et al. 2024. *Green is the new black: Outcomes of post-fire tree planting across the US Interior West*. Forest Ecology and Management 574: 122358. https://doi.org/10.1016/j.foreco.2024.122358

Sánchez-Guisández, M., Cui, W., and Martell, D.L. 2002. *FireSmart strategies for wildland urban interface landscapes*. Proceedings, IV International Conference on Forest Fire Research, Luso, Coimbra, Portugal, pp. 121-130. Millpress Rotterdam.

Schuurman, G.W., Cole, D.N., et al. 2022. *Navigating ecological transformation*: Resist–Accept–Direct as a path to a new resource management paradigm. BioScience 72(1). https://doi.org/10.1093/biosci/biab067

Smith-Tripp, S.M., Coops, N.C., et al. 2026. *Synthesizing spectral and field observations of post-fire conifer recovery in dry conifer forests*. Remote Sensing of Environment 307: 113–310. https://doi.org/10.1007/s10021-025-01029-9

Sorenson, Q.M., Young, D.J.N., and Latimer, A.M. 2025. *Tree planting outcomes after severe wildfire depend on climate, competition, and priority*. Forest Ecology and Management 575: 122346. https://doi.org/10.1016/j.foreco.2024.122346

Spittlehouse, D.L., and Stathers, R.J. 1990. *Seedling Microclimate*. BC Ministry of Forests. Land Management Report 65. 28 p.

Steinebrunner, F., Tischer, A., et al. 2025. *The effects of deadwood on tree regeneration and microsites: A systematic review*. Forest Ecology and Management 596. https://doi.org/10.1016/j.foreco.2025.123096

Stevens-Rumann, C.S., and Morgan, P. 2019. *Tree regeneration following wildfires in the western US: a review*. Fire Ecology 15: 15. https://doi.org/10.1186/s42408-019-0032-1

Subedi, N., Bogdanski, B., and Stennes, B. 2025. *Estimated direct and indirect costs of recent extreme wildfires in western Canada*. Information Report BC-X-463. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre. Available online at: https://ostrnrcan-dostrncan.canada.ca/handle/1845/317460 [Accessed 1 March 2026].

Swanson, M.E., Magee, M.I., et al. 2023. *Experimental downed woody debris–created microsites increase seedling survival and growth*. Frontiers in Forests and Global Change 6. https://doi.org/10.3389/ffgc.2023.1224624

Thiffault, N., Jobidon, R., and Munson, A.D. 2003. *Performance and physiology of large containerized and bare-root spruce seedlings in relation to scarification and competition in Québec (Canada)*. Annals of Forest Science 60(7): 645-655.

Thiffault, N., Grondin, P., et al. 2015. *Ecological gradients driving the distribution of four Ericaceae in boreal Quebec, Canada*. Ecology and Evolution 5(9): 1837-1853. https://doi.org/10.1002/ece3.1476

Thiffault, N., Hoepting, M.K., et al. 2021. *Managing plantation density through initial spacing and commercial thinning: Yield results from a 60-year-old red pine spacing trial experiment*. Canadian Journal of Forest Research 51(2): 181-189. https://doi.org/10.1139/cjfr-2020-0246

Thiffault, N., Nordin, P., et al. 2025. *A trans-Atlantic perspective on successful plantation establishment in boreal ecosystems: lessons learned and research opportunities*. New Forests 56: 16. https://doi.org/10.1007/s11056-024-10086-2

Trottier-Picard, A., Thiffault, E., et al. 2014. *Amounts of logging residues affect planting microsites: A manipulative study across northern forest ecosystems*. Forest Ecology and Management 312: 203-215. https://doi.org/10.1016/j.foreco.2013.10.004

Waldron, K., Thiffault, N., et al. 2023. *A pan-Canadian assessment of empirical research on post-disturbance recovery in the Canadian Forest Service*. Canadian Journal of Forest Research 53(11): 823-838. https://doi.org/10.1139/cjfr-2022-0300

Walker, X.J., Mack, M.C., et al. 2025. *Increasing wildfire frequency decreases carbon storage and leads to regeneration failure in Alaskan boreal forests*. Fire Ecology. https://doi.org/10.1186/s42408-025-00390-3

Wang, W., Wang, X., et al. 2025. *Canadian forests are more conducive to high-severity fires in recent decades*. Science 387(6729): 91–97. http://doi.org/10.1126/science.ado1006

White, J.C., Hermosilla, T., and Wulder, M.A. 2023. *Pre-fire measures of boreal forest structure and composition inform interpretation of post-fire spectral recovery rates*. Forest Ecology and Management 537. https://doi.org/10.1016/j.foreco.2023.120948

Whitman, E., Parisien, M.A., et al. 2019. *Short-interval wildfire and drought overwhelm boreal forest resilience*. Scientific Reports 9: 18796. https://doi.org/10.1038/s41598-019-55036-7

Wightman, M.G., Gonzalez, B., and Dinger, E. 2019. *Interactive effects of stock type and forest vegetation management treatments on Douglas-fir seedling growth and survival — ten-year results*. Forests 10(11). https://doi.org/10.3390/f10111002

Wong, C.Y.S., Wright, M.C., et al. 2025. *Sentinel imagery detects the presence of live trees following large wildfires in California*. Research in Ecology 4: 025006. https://doi.org/10.1088/2752-664X/add5fd

Wotherspoon, A., D'Orangeville, L., et al. 2025. *Challenges and opportunities for the operationalization of forest-assisted migration in Canada*. Canadian Journal of Forest Research 55: 1–14. https://doi.org/10.1139/cjfr-2024-0325

Appendix 1: Methodology

This study arose following a three-part webinar series "Forest Recovery Strategies After Wildfire in Canada", hosted in January of 2025 by the Reforest Canada Collective, a division of Forests Canada. Through the webinar series, nine invited speakers shared either their applied research on forest recovery after wildfire or their learned experience with tree planting after wildfire. In the weeks that followed the webinar series, conversations took place that identified a lack of a unified best management practice for post-wildfire tree planting across Canada. Through this need, this study was developed to bring in more voices from learned experience in the topic. The results of this study emerged from the online survey developed and marketed by Forests Canada as well as interviews conducted by Forests Canada staff.

The survey was designed using the Jotform survey platform and was made available in both English and French with two target audiences in mind: forestry professionals who manage forest lands in Canada and individuals who practice tree planting in Canada. The survey was also open for anyone outside of these target audiences to respond to a subset of questions to gain insights into desired topics for future knowledge mobilization and training opportunities. For the survey, 49 questions were developed, separated into four sections: 1) Background Information (completed by everyone), 2) Land Management (completed only by forest managers), 3) Tree Planting Operations Post-wildfire (completed only by tree planting practitioners), and 4) Future Efforts (completed by everyone). Question types included a combination of "yes/no", "select all that apply", "multiple choice", "rank" or open-ended questions, depending on the topic. If a topic's main themes were already well established in the conversation (ie. prioritization categories for planting after wildfire), ranking was used instead of "select all that apply" with the aim to evaluate the strength of a particular priority to the respondent. "Select all that apply" and "multiple choice" questions were employed for questions where the aim was to gain the most popular practices for a given topic across the whole respondent pool. Open-ended questions were employed where foundational knowledge is needed from the response pool, or if elaboration was needed based on the previous question.

Outreach for the survey was completed from May 26 to October 31, 2025, using social media platforms Facebook, Instagram, X and LinkedIn using both sponsored ads and conventional social media posts. Organizations and individuals active in forest management across Canada (provincial and territorial departments, tree planting companies, silviculturalists, etc.) were also directly contacted and invited to contribute to the survey.

Data were compiled and cleaned, removing duplicates and arriving at a final response number of 80 individuals. The data were aggregated into seven respondent groups: forest managers who have experienced wildfire, and those who haven't; tree planting individuals who have planted after wildfire, and those who haven't; forest managers who also plant trees on their lands and have experienced wildfire, and those that haven't; then the respondents outside of the two main target groups (neither managing forest land nor tree planting and also those located outside of Canada). A weighted scoring system was employed for the ranked questions, for example awarding six points for a first-place response and one point for a sixth-place response in a six-category ranking question. Only select responses were highlighted in the report to support the concepts being presented in the paper. The full set of responses is available upon request.

Individuals from organizations active in forest management across Canada (provincial and territorial departments, tree planting companies, silviculturalists, etc.) were contacted for an interview either from responding to the survey, or through conversations held. Photos were received from key individuals both from the survey and from personal communication. Key themes arising from the interviews were integrated into the paper to support the concepts being presented, and/or the results from the survey.

Appendix 2: Survey Questions

SECTION I: BACKGROUND INFORMATION

1. **Name:**
2. **Organization name:**
3. **Title/role at organization:**
4. **Do you make the management decisions for the lands in your jurisdiction? (Y/N)**
   Please note that if you select yes, you will complete questions in Section II: Land Management
   a. If no, will skip section II
5. **Do you lead tree planting crews in Canada? (Y/N)**
   Please note that if you select yes, it is assumed that you supervise crews on the ground, and you will complete questions in Section III: Tree Planting Operations Post-Wild ire.
   a. If no, will skip section III
6. **Provinces and territories where you currently operate in (select all that apply):**
   a. AB
   b. BC
   c. MB
   d. NB
   e. NS
   f. NL
   g. NWT
   h. ON
   i. PEI
   j. QC
   k. SK
   l. YT
   m. USA
   n. Outside of North America

SECTION II: LAND MANAGEMENT

7. **Have any of the forested areas that you have jurisdiction over (lands that you manage) experienced wildfire over the past 10 years? (Y/N)**
   a. If no: continue onto next question only then move onto section IV
8. **(If no to #7 only): Have you developed any plans or strategies for forest restoration in preparation for potential future wildfires? If so, please describe them here: ________________**
9. **How have the wildfires in your jurisdiction changed in terms of severity and frequency? Select all that apply:**
   a. Higher severity
   b. Higher frequency
   c. Lower severity
   d. Lower frequency
   e. No change in wildfire patterns compared to before the last decade
10. **What percentage of the forested areas in your jurisdiction affected by wildfire have also been affected by pests and disease? (Range 0-100%)**
11. **How would you categorize the land ownership types where the wildfires took place within the last 10 years? Select all that apply:**
   a. Public/crown land
   b. Indigenous lands
   c. Private land
   d. Protected lands (environmental and wildlife reserves, conservation areas)
   e. Municipal land
12. **(If they chose crown) For wildfires taking place on crown land, what percentage took place where there is a silvicultural obligation in place? (Range 0-100%)**
13. **In the forested areas affected by wildfire in your jurisdiction, approximately what percentage of the land has been and/or will be artificially regenerated with trees? (Range 0-100%)**
14. **For the areas where you are not artificially regenerating with trees, what are the main reasons? Select all that apply:**
   a. The forest is regenerating on its own
   b. Risk of future fire impacts to community
   c. Not a priority for restoration at this time
   d. Budget and resource constraints
   e. Other (describe): ________________
15. **How long after the fire are you waiting, on average, to plant trees?**
   a. 6 months - 1 year
   b. 1 - 2 years
   c. 2 - 3 years
   d. 3+ years
16. **What variables determine how long you wait after the wildfire to plant trees? Select all that apply:**
   a. Time to evaluate natural regeneration
   b. Competing vegetation
   c. Finding contractors/resourcing
   d. Other (please list): ________________
17. **How do you prioritize choosing regions to plant trees after wildfire? Please drag the boxes to rank from highest to lowest:**
   a. Intensity of wildfire
   b. Wildlife habitat
   c. Environmental benefits
   d. Economic investment
   e. Ease of access
18. **Are there any other variables used in your prioritization system when choosing areas to reforest after wildfire? Please list: ________________**
19. **Did you carry out regeneration assessments as part of your plans? (Y/N)**
20. **(If yes): What were the regeneration assessment activities that you carried out/are planning to carry out? Select all that apply:**
   a. Aerial surveys
   b. Ground surveys
   c. GIS mapping and modelling
   d. Others (please describe): ________________
21. **Is wildfire risk mitigation part of your forest management plan? (Y/N)**
22. **If you have made modifications to your forest management planning for post-wildfire scenarios, where did you learn about any new techniques/practice? Please list them here: ________________**
23. **For post-wildfire sites in your jurisdiction, approximately what percentage are being salvage logged? (Range 0-100%)**
24. **For the areas where you salvage logged, how many months on average after the fire did you begin the salvage logging operation?**
   a. 0-6 months
   b. 6-12 months
   c. 1-2 years
   d. 2+ years
25. **For the areas where you salvage logged, what were your motivation(s) to salvage log? ________________**
26. **Where did you source funding for your post-wildfire tree planting efforts? Select all that apply:**
   a. 2 Billion Trees program
   b. Other government funding
   c. Private fundraising
   d. NGO funding partner
   e. Other (please list): ________________
   f. No external funding
27. **(If selected b, Other government funding): Which government funding source (not including 2 Billion trees) are you using to fund your reforestation after wildfire efforts? (optional) ________________**
28. **Are the tree species being planted different from the species that were present in the forest before the wildfire? (Y/N)**

29. (If yes to previous): Please list the changes in tree species composition from pre- to post-fire restoration (e.g. spruce-dominant transitioning to pine): _________________

30. Did your forest recovery strategy consider future fire risk (e.g. using FireSmart principles or others)? (Y/N)

31. (If yes to previous): How was future fire risk incorporated into your operation? _________________

SECTION III: TREE PLANTING OPERATIONS POST-WILDFIRE

Please provide details on how each of the following aspects of tree planting has been different for post-wildfire sites as compared to more traditional operations (e.g. post-harvest renewals, environmental restoration, afforestation, reclamation):

32. What percentage of trees that were planted through your operations in the 2024 season took place on post-wildfire sites? (Range 0-100%)

33. What differences in stock types are you using for post-wildfire sites vs. other traditional operations? Select all that apply:

a. Plugs with longer root systems
b. Larger stock in general
c. No changes to stock selection compared to other traditional operations
d. Other (please describe): _________________

34. On average, what percentage of your operational sites were salvage logged before you began tree planting? (Range 0-100%)

35. Other than salvage logging, on average, what percentage of your operations involve removing woody materials from the site prior to tree planting as part of your site preparation operations for post-wildfire? (Range 0-100%)

36. Are there any general trends in species selection differences for your post-wildfire sites vs. traditional planting operations? Please describe all of the changes that you have incorporated in recent years (e.g. transitioning away from one species to favour another): _________________

37. Is your spacing different for post-wildfire sites compared to traditional sites? (Y/N)

38. (If yes to previous): What is the biggest reason for modifying the spacing post-wildfire compared to traditional operations? Select all that apply:

a. Standing dead wood, not salvage logged
b. Debris in the site
c. Lack of mineral soil
d. To reduce future fire risk
e. Spacing has not been modified in my post-wildfire operations comparted to traditional operations
f. Other (please describe): _________________

39. Did you train your planters to seek out specific microsites on post-wildfire sites? (Y/N)

40. (If yes to previous): What specific instructions about microsites did you train your planters to target post-wildfire, that would be different than in traditional operations? _________________

41. How have your operational costs on the whole changed for post-wildfire restoration compared to traditional tree planting?

a. More expensive
b. Same cost
c. Less expensive

42. (If answered "more expensive"): What have been the main drivers for your increase in operational costs post-wildfire? Select all that apply:

a. Customized training
b. Access
c. Travel
d. Stock types
e. Higher price paid to planters
f. Others (please list): _________________

43. How has access to planting sites changed for post-wildfire sites vs. traditional tree planting operations?

a. More difficult
b. No change in difficulty
c. Less difficult

44. How has operating a camp been different for post-wildfire sites? _________________

45. Have there been modifications or adjustments to workplace safety standards changes? Select all that apply:

a. Additional training required such as hazards and risks
b. Respiratory masks
c. PPE outside of respiratory masks
d. Increased liability insurance (workers compensation or equivalent)
e. Others (please list): _________________

46. If you have made modifications to your operations for post-wildfire scenarios, where did you learn about the new techniques/practice? Please list them here: _________________

SECTION IV: FUTURE EFFORTS

47. 47. Is there anything else you'd like to share with us about your post-wildfire forest restoration practices? _________________

48. Are there any key questions you have regarding post-fire forest restoration? _________________

49. Are there any post-wildfire forest restoration topics that you may be interested in for either virtual or in-person workshops? _________________

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