Nova Scotia Silvicultural Guide for the Ecological Matrix

July 2021

NOVA SCOTIA

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Department of Lands and Forestry
July 2021

ISBN: 978-1-77448-215-5

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Acknowledgements

This document would not have been possible without the knowledge and contributions of stakeholders from across the department, external experts and the broader public. The project team thank targeted stakeholder organizations for their comments and efforts through two rounds of focused review, Dr. Laura Kenefic for two rounds of detailed expert review, and the Nova Scotian public and their representative organizations for their feedback through a round of public consultation.

The Natural Disturbance Regimes project team (Peter Bush, Bruce Stewart, Peter Neily, James Steenberg, Eugene Quigley, Sean Basquill, Anthony Taylor, Dave MacLean and Celia Boone) and the members of the department's Renewable Resources Division (Scott Maston, Jamie Ring, Kevin Keys, Morgan Rice, Brad Butt, Donna Hurburt, Jane Kent, John Brazner and Mark McGarrigle) were key subject contributors. Key contributions were made by project team leads Mark Pulsifer, Matt Retallack and Tara Crewe. The project team also thank staff from across the department who contributed their knowledge and expertise. Special thanks to Peter Neily for his expertise in interpreting the FEC guide for use in SGEM. Reg Delorey provided valuable advice establishing trials early in the process.

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Citation

McGrath, T., Pulsifer, M., Seymour, R., Doucette, L., Forbes, G., McIntyre, R., Milton, R., Cogan, L., Retallack, M., and Crewe, T. 2021. *Nova Scotia Silvicultural Guide for the Ecological Matrix*, Nova Scotia Department of Lands and Forestry.

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Introduction

A key recommendation of *An Independent Review of Forest Practices in Nova Scotia* (Lahey, 2018) was to revise *Nova Scotia's Forest Management Guide* (McGrath, 2018). This was committed to in the government's response (L&F, 2018), and the *Nova Scotia Silvicultural Guide for the Ecological Matrix* is the result.

Publications from both within and outside Nova Scotia were referenced in developing this silvicultural guide, in response to feedback and recommendations from *An Independent Review of Forest Practices in Nova Scotia* (Lahey, 2018).

Guides were reviewed from Ontario (Anderson and Rice, 1993; OMNR, 1998, 2000, 2004, and 2015), Quebec (Ministère des Resources Naturelles, 2013a and 2013b), and the Northeastern United States (Leak et. al., 2014; Lamson and Leak, 2000; Leak et al., 1987; Boyce and Carpenter, 1968). Literature concerning Ecological Forestry, the Triad Approach, Retention Forestry, and Irregular Shelterwoods were reviewed and considered for application in this guide (Palik et al., 2021, Ashton and Kelty, 2018; Federowitz et al., 2014; Lussier and Meek, 2014, Messier et al., 2009; Nyland, 2016; Ohara, 2014; Raymond et al., 2009; Seymour and Hunter, 1992 & 1999; and Smith 1962). Several concepts were adopted, including Acceptable Growing Stock, as important factors in prescribing appropriate forest silvicultural treatments.

The *Nova Scotia Silvicultural Guide for the Ecological Matrix* (SGEM) replaces the previously published *Nova Scotia Forest Management Guide* (McGrath, 2018). SGEM provides guidance for each of the 14 forest groups found in the *Nova Scotia Forest Ecosystems Classification* (FEC) (Neily et al., 2013). Edatopic grids and the succession tables used in this guide are from Neily et al. (2013). The foundation for SGEM comes from Nova Scotia-based research undertaken by the province starting in the late 1960s (see Nova Scotia Forest Research Reports https://novascotia.ca/natr/library/publications/forestry-research.asp#research)

The SGEM is considered adaptive in nature and will be revised as new information is gathered and analyzed. As with the previous guide (FMG, McGrath, 2018), it will be adapted based on feedback from practitioners resulting from implementation experience. Formal auditing of results and appropriateness of treatments will be carried out to use in the adaption of the SGEM. It will also be adapted based on related Nova Scotia-based research results on a regular basis.

Context of this Guide within Sustainable Forest Management in Nova Scotia

Ecological forestry calls for an **Ecosystem-Based Management (EBM)** approach, using techniques that create stand structures and compositions similar to those resulting from natural disturbances and providing for appropriate recovery periods and intermediate treatments (Franklin et al., 2007).

"**Sustainable Forest Management (SFM)** maintains and enhances the long-term health of forest ecosystems for the benefit of all living things while providing environmental, economic, social, and cultural opportunities for present and future generations" (Natural Resources Canada, 2008).

The difficulty in applying SFM, particularly on public land (i.e. Crown land in Nova Scotia), is in satisfying the diverse, sometimes conflicting, expectations that society has for what is a finite amount of forested land. Society values economic development, but also natural intact landscapes, old-growth forests, biodiversity, and species-at-risk, as well as opportunities for hunting (Davis et al., 2001). To satisfy these demands, managers can divide the land into zones with varying ecological, social and economic goals.

The triad concept (Seymour and Hunter, 1992; Lahey, 2018) divides the forest into three zones:

1) protected land (for biodiversity);
2) high production land (for timber resources); and,
3) land that forms an ecological matrix (majority of the land), calling for a mix of protection and resource production.

The Government of Nova Scotia has committed to implementing a triad system on public land that will "protect and enhance ecosystems and biodiversity as the overarching policy priority, as they are the foundation for other values" (NSDLF, 2018).

In the context of sustainable forest management and ecological forestry, the SGEM describes appropriate silvicultural methods **for the ecological matrix within the triad**, where "conservation and production objectives are both applicable and combined" (Lahey, 2018).

The management of the ecological matrix is based on an ecosystem approach wherein the values derived from the forest reflect a multi-scale and interconnected system (D'Eon et al., 2000). Ecosystem-Based Management differs from past management that generally emphasized timber products, often at the expense of other values and with less consideration of natural limits on production. However, the concept is not particularly new, and Nova Scotia started its own process years ago with the stated intent to "fully implement an ecosystem approach to forest management" in *The Path We Share – A Natural Resources Strategy for Nova Scotia 2011–2020*. In *An Independent Review of Forest Practices in Nova Scotia* (Lahey, 2018), recommendations have reemphasized this process.

One means of achieving Ecosystem-Based Management is to apply ecological forestry practices. The term "**ecological forestry**" is described at length by Lahey (2018), but fundamentally it means that management of the forests is based on maintaining, enhancing or restoring the ecological functions in an ecosystem in which biodiversity is one of the most important considerations (Hunter and Schmiegelow, 2011).

Biodiversity is described as "..the variety and interconnectedness of all life, including all plants, animals, and other organisms, the genes they contain, and the systems and processes that link them" (*The Path We Share*, NSDNR, 2011). Forest management influences biodiversity at all levels. In turn, a biodiverse forest will support cultural values and societal demands for wildlife, for timber and non-timber products, for recreation, and for ecological services such as clean air and water (Kimmins, 1997; D'Eon et al., 2001; Villard and Jonsson, 2009; Hunter and Schmiegelow, 2011).

Forest ecosystem structures and functions occur over time and space on macro and micro scales. Because biodiversity occurs in so many different forms, both big and small, mobile or stationary, our approach to biodiversity conservation must address its needs at several ecological scales—from the landscape to the site.

In this province we use a combination of coarse-, fine-, and meso-filter approaches (Hunter and Schmiegelow, 2011) to conserve biodiversity. The coarse-filter approach secures the wide array of habitats required by most species—it provides for natural spatial variation and for inherent variation in forest types, ages, and arrangements across a broader landscape. The fine-filter approach works to identify often site-specific habitat management actions critical for the conservation of species listed at-risk under provincial or federal legislation. The meso-filter approach works at the stand level. It complements the coarse-filter approach, applying a finer scale that identifies stand-level ecosystem elements important to the conservation of biodiversity.

The SGEM presents one aspect of Sustainable Forest Management and Ecological Forestry in Nova Scotia. It applies to forest attributes at the stand-level scale within the ecological matrix zone of the triad system.

Objectives of this Guide

The *Nova Scotia Silvicultural Guide for the Ecological Matrix* (SGEM) recommends appropriate silviculture methods intended for use in the ecological matrix zone in which biodiversity priorities and timber objectives are both applicable and combined (Lahey, 2018). The guide applies to Crown land, specifically land in the ecological matrix zone of the Triad system.

The SGEM supports sustainable forest management and biodiversity conservation in Nova Scotia through prescription of silvicultural treatments that will:

- Enable a broader range of silvicultural options to protect and promote uneven-aged management, including irregular shelterwood harvesting
- Promote multi-aged and mixed-species forests
- Produce a range of forest conditions that are similar to those occurring naturally following natural disturbance
- Restore native forest structure in previously-altered stands.

The prescriptions in this guide limit the lower retention treatments to situations where:

- Vegetation types are naturally subject to frequent stand-replacing disturbance
- Areas that are part of well-considered restoration activities intended to address degraded conditions caused by human influences

The SGEM supports biodiversity by:

- Not prescribing harvesting in sensitive forest groups
- Moving away from even-aged management towards multiple-aged management with greater tree species diversity
- Introducing the retention of live permanent reserve trees in all harvests
- Restoring Acadian forests to late-successional conditions
- Promoting a diversity of stand structures, ages and compositions

Biodiversity and Forest Structure Characteristics

Trees left standing after a harvest are commonly referred to as **retention**. Retained trees can serve as focal points for restoration efforts, provide habitat for biodiversity, as well as growing stock for future harvest.

It is important to identify a special class of retention called **permanent reserve trees**. Permanent reserve trees are intended to be maintained on the landscape through future stand interventions to (i) promote and replace those individuals lost to natural mortality, (ii) ensure long-term structure, as a seed source, and (iii) provide habitat for wildlife throughout the forests under management. Permanent reserve trees include those often referred to as supercanopy trees, as well as cavity trees, mast trees, and large trees to support nests and dens (if existing) in a stand.

Descriptions and biodiversity values of wildlife trees can be found in Appendix I, with more detail provided in *A Field Guide to Forest Biodiversity Stewardship* (Neily and Parsons, 2017).

Implementing the approach laid out in the *Nova Scotia Silvicultural Guide for the Ecological Matrix* will provide horizontal and vertical structures critical for biodiversity conservation. Live structures create shade that limits excessive soil dryness and higher soil temperatures that subsequently impact soil biota, as well as provide nesting and feeding space for most forest birds and many mammal species. Dead or partially dead trees or snags create habitat for cavity-associated species, like woodpeckers, some waterfowl, furbearers and rodents (Lindenmayer and Franklin, 2002; Villard and Jonsson, 2009; Hunter and Schmiegelow, 2011; Neily and Parsons, 2017). Downed coarse woody material is important for invertebrates, amphibians, reptiles and small mammals (Gitzen et al., 2007; Pinzon et al., 2016; Joelsson et al., 2019).

Retention

Determining the number of trees to retain and how they should be distributed throughout an area in order to make biodiversity a priority is a complex issue, because no one solution is suitable for every set of circumstances.

In general, the value of retention in supporting biodiversity is widely accepted within the scientific community. Many studies have shown that different taxonomic groups (birds, mammals, spiders, etc.) require different minimum levels of retention and/or coarse woody material to maintain populations (Gitzen et al., 2007; Mori et al., 2014; Seung-Il Lee et al., 2017; Basile et al., 2019). Retention distribution is also a consideration. Some species prefer clumped or aggregated retention, while others respond more favourably to dispersed retention (Gitzen et al., 2007; Fedrowitz et al., 2014; Beese et al., 2019). The intent of the SGEM is to allow for a variety of retention levels that will provide important habitat features for most species requiring a range of conditions, from early-successional open habitats to late-successional closed canopy conditions.

Coarse Woody Material (CWM)

In addition to trees that provide resources for wildlife, coarse woody material (CWM), also known as coarse woody debris, is a critical component contributing to biodiversity and long-term ecosystem productivity. Most of our forest biodiversity is found in the soil in the form of bacteria, fungi, algae, invertebrates, and other groups. These life forms are involved in processes of organic matter decomposition, nitrification, nitrogen fixation, and nutrient and water uptake by plants. Twigs, limbs, and leaves (i.e., slash) left on the forest floor contribute to soil fertility, but only tree boles are generally considered as contributing to CWM, with large diameters being more persistent due to their slower rates of decay. CWM on the forest floor acts as a reservoir for the slow release of water and nutrients, as a substrate for seedlings, and as habitat for many species of amphibians, invertebrates, mammals and fungi (Lindenmayer and Franklin, 2002; Hunter and Schmiegelow, 2011).

Structural Diversity

Structural diversity at the stand level is achieved by deliberately retaining structures that are indicative of natural disturbance events—such as fire, insect infestation, disease or wind. Depending on their intensity, disturbance events will result in different levels of retention of living and dead trees, left standing or fallen, and these become the legacy from the previous stand and provide ecological continuity going forward.

Information on the number and percentage area of a stand, and the configuration (i.e., number, size and shape of patches) of trees remaining after a natural disturbance is sparse in Nova Scotia. But recent research on structures remaining after Hurricane Juan suggests that white pine and hardwoods are more likely to be retained than balsam fir and spruce (Taylor et al., 2019), and that wind-blown stands still contained an average of 7.8 m^2/ha of standing trees, of which 3.8 m^2/ha were alive (Taylor et al., 2017).

Snags (standing dead trees) are one component of retained structures. The number of snags in a forest is highly variable because of natural succession and the uneven impact of disturbance events. The best local information is found in Stewart et al. (2003). Two old-growth softwood (hemlock, white pine, red spruce) sites in Nova Scotia contained 47–149 stems/ha, and a volume of 40–57 m^3/ha of snags. Two old-growth hardwood (sugar maple, yellow birch, American beech) sites contained 11–100 stems/ha and a volume of 17–25 m^3/ha of snags.

The Maritime Boreal forest in Nova Scotia may reflect results from softwood forest in New Brunswick. Declining balsam fir and black spruce forests more than 50 years old in New Brunswick had snag (> 9 cm Dbh) volumes of 8–148 m^3/ha and densities of 25–1,000 snags/ha. But these forests do not closely reflect natural disturbance, because sites had previously been managed to control spruce budworm and fire (Taylor and MacLean, 2007).

Another method of determining functional levels of one type of retention is based on the minimum number of snags needed for cavity-nesting wildlife, such as woodpeckers. Research in the Fundy National Park region of New Brunswick concluded that a minimum of 16 potential nest trees/ha (> 25 cm Dbh) should be retained in harvest operations (Woodley, 2005). Taylor and MacLean (2007) estimated a 2:1 live to dead ratio for retained trees would be needed to offset breakage or blowdown rate. In Appalachian hardwood forests, Stow (2003) recommended 7.5 live cavity trees/ha as the minimum level retained. These metrics relate to retaining only large diameter structures as habitat, and thus are much lower than ratios that would represent the high number of stems, most of them very small, created by natural disturbance.

The range of average CWM in old-growth softwood and hardwood forest in Nova Scotia was 71–91 m^3/ha and 45–58 m^3/ha, respectively (Stewart et al., 2003). In comparison, Hurricane Juan created an average of 197 m^3/ha of CWM (> 2 cm diameter) in wind-blown sites (Taylor et al., 2017). In and near Fundy National Park, where the forest was not sprayed for spruce budworm and thus better reflects natural disturbance impacts, CWM volumes averaged 216 m^3/ha, 125 m^3/ha and 77 m^3/ha respectively for softwood, mixedwood and hardwood stands (including CWM with diameters ≥ 10 cm) (Frego et al., 2005). Minimum CWM (average diameter ≥ 10 cm, ≥ 2 m) levels recommended to be retained after harvest were 110 stems/ha for softwood, 40 for hardwood, and 60 for mixedwood.

Retained trees should reflect patterns created by natural disturbance, and therefore these trees should exist as clumps as well as dispersed structures. Currently, the *Wildlife Habitat and Watercourses Protection Regulations* (WH&WP) require that wildlife clumps be left to provide cover and habitat for many forms of biodiversity.

The Lahey (2018) review recommended that retention be increased beyond the levels required for legacy tree clumps in the WH&WP. The SGEM addresses this. It prescribes retention levels of 1/5 to 2/3 of the basal area. This will allow for potentially larger legacy tree clumps in addition to dispersed trees within a harvest area.

It is inevitable that some trees remaining after harvest will blow down. These trees will contribute to habitat as CWM and nutrient sustainability. Trees that remain standing also are important for biodiversity, and various practices will increase the longevity of these trees as standing structures. A proportion of retention will exist within the protection of large and medium-sized clumps and thus be less vulnerable to blowdown. Trees must also be retained in small clumps or as single trees to facilitate uneven-aged forest structure and to provide shade and seed for silvicultural purposes.

Natural Disturbance Ecology as a Foundation for Ecological Forestry

Ecological forestry based on study of natural forests is not a new idea (D'Amato et al., 2017), but society's growing mandate to conserve biodiversity has renewed research and application of using nature's template to design silvicultural systems such that "emphasis is placed on natural patterns and processes, understanding them, working in harmony with them, and maintaining their integrity" (Seymour and Hunter, 1999).

The coarse-filter theory of conservation biology states that if management provides the full range of structures and compositions that existed in unmanaged forests, then we can expect such forests to provide habitat for most species, thereby maintaining biodiversity on the managed landscape (Hunter and Schmiegelow, 2011).

Palik et al. (2021) define ecological silviculture as "an approach for managing forest ecosystems, including trees and associated organisms and ecological functions, based on natural models of development and that explicitly incorporates principles of continuity, complexity/diversity, timing, and context into prescriptions."

The science of disturbance ecology, involving reconstruction of natural disturbance regimes for forests of various kinds, provides the essential knowledge base to formulate ecologically based silvicultural systems. Key parameters of natural disturbances—return intervals, severities, and surviving legacies—translate directly into silviculture as rotations and cutting cycles, harvest removal rates, and residual structural targets (Taylor et al., 2020; Seymour and Hunter, 1999; Betts and Forbes, 2005).

Disturbance Regimes

Although every forest ecosystem has unique disturbance patterns, scientists have synthesized four archetype disturbance regimes to inform silvicultural practice (Palik et al., 2021).

Two of these are relevant to Nova Scotia:

- Forests driven by gap-scale disturbance
- Forests experiencing mixed-severity disturbances that can vary over time from light to stand-replacing

From decades of disturbance ecology research in the Acadian region, we know that forest stand structure is naturally uneven-aged; indeed, unharvested old-growth forest remnants may have 20 distinct age cohorts arising from light, partial disturbances every decade (Seymour et al., 2002, Fraver et al., 2009).

Forests of simpler composition and structure, growing on sites where climate, nutrients or water is limiting, may experience more episodic, heavier disturbances (mostly from wind or spruce budworm; Taylor et al., 2020), but even they can have a second age class. Except for stand-replacing crown fires, all-natural disturbances—even very severe ones like hurricanes—leave some vegetation in place to recolonize the disturbed site and accelerate recovery to a later successional stage.

Given that partial disturbances dominate Nova Scotia's forest landscape, it follows that silviculture should focus on uneven-aged systems, where applicable, implemented by partial harvests of varying intensity based on the intersection of stand attributes (structure, composition, management history) and enduring biophysical features of the landscape.

To this end, the decision keys in the guide provide stand-specific prescriptions for harvesting and management. On the landscape scale, Nova Scotia's *Ecological Land Classification (ELC)*, provides a province-wide forest ecosystem classification based on factors such as climate, physiography, and site conditions (Neily et al., 2017).

Experience across northeastern North America has shown that variants of the shelterwood and selection systems offer promise in addressing the multiple objectives of ecological silviculture while also maintaining economic viability of the forestry infrastructure and producing uneven-aged structures natural to many ecosites in Nova Scotia (Meeke et al., 2012). These systems promote advance regeneration of long-lived, intermediate and shade-tolerant, late-successional Acadian species, retain and promote growing stock of these species over multiple stand entries, and facilitate retention of diverse, permanent stand structures with a component of large legacy (veteran) trees that are never harvested.

For these reasons, uneven-aged systems can do two things: maintain forest communities that exhibit later-successional characteristics, and restore those that do not, due to past excessive disturbance from humans. In a similar fashion, where stand-replacing disturbances predominate due to climatic, nutrient or water limiting conditions, uneven-aged systems with less retention are appropriate.

Forest Ecosystem Classification for Nova Scotia
(Adapted from Neily et al., 2013)

Application of ecological silviculture in the *Nova Scotia Silvicultural Guide for the Ecological Matrix* (SGEM) relies on the use of the *Forest Ecosystem Classification for Nova Scotia* (FEC) (Neily et al., 2013). The structure of SGEM is organized around the 14 Forest Groups (FG) described in the FEC (you will find a set of management keys for 6 of the Forest Groups where harvesting is recommended). SGEM relies on FEC and other site and stand data to recommend appropriate ecological based treatment prescriptions.

The FEC includes (3) major elements: (i) Fourteen (14) Forest Groups (FG), (subdivided into 88 sub-categories termed Vegetation Types (VT) and their variants), (ii) nineteen (19) Soil Types (ST) along with their associated phases and (iii) seventeen (17) Ecosites (ES). Ecosites categorize sites with similar soil moisture and nutrient regimes which can be determined by identifying ST and VT combinations (pgs. 407–422 of Neily et al., 2013). The ecosites can be shown in an Edatopic grid (pg. 365, Neily et al.).

Ecosites are units that represent ecosystems that have developed under a variety of conditions and influences, but which have similar moisture and nutrient regimes. An ecosite is associated with a finite range of soil and site conditions and a finite range of VTs that grow naturally under those conditions.

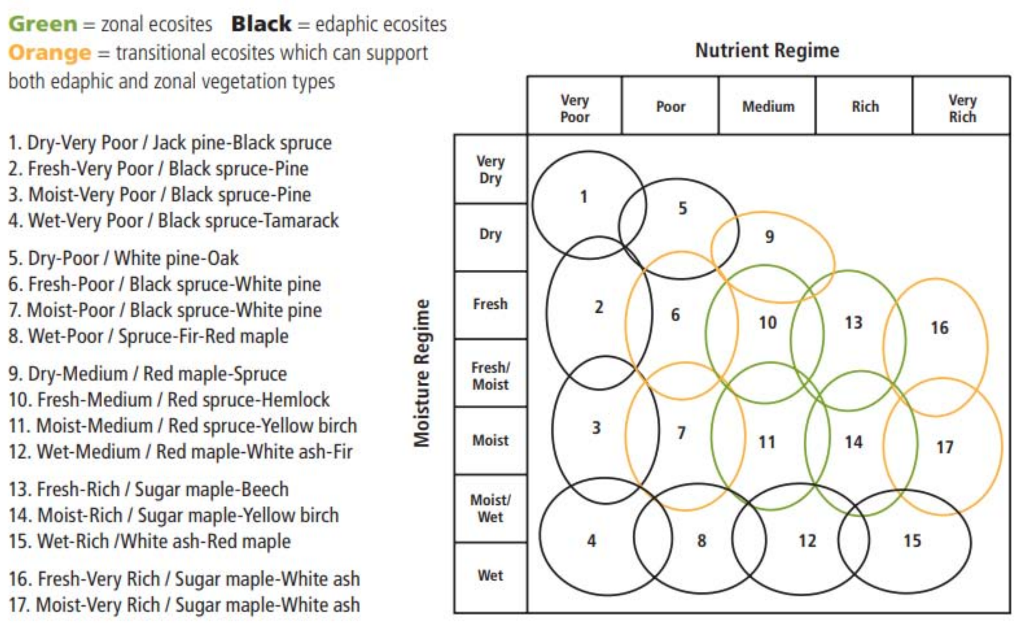


Figure 1: Edatopic Grid for Acadian Ecosites (Neily et al., 2013)

All elements of the FEC are utilized in SGEM. For example, soil type is used to estimate windthrow hazard and nutrient-sustainable harvest levels, while Ecosite is used to identify natural disturbance patterns that influence treatment prescriptions

Ecosite classifications in Nova Scotia fall into one of two climatic regions: **Acadian** and **Maritime Boreal**. These climatic regions are subdivided into zonal and edaphic (azonal) types. In general, classical assemblages of long-lived Acadian species, such as red spruce, eastern hemlock and sugar maple, are limited to zonal ecosites with at least medium soil fertility on well drained sites within the Acadian climatic region. Uneven-aged silvicultural systems such as Irregular Shelterwood and Selection variants (which maintain high levels of continuous cover and several distinct age cohorts) are feasible mainly on these ecosites.

Edaphic ecosites, on the other hand, result in climax forest conditions that reflect the dominance of site over climate. Acadian edaphic ecosites are associated with site limited climax forest mainly containing species such as black spruce, jack pine, balsam fir, red oak and red pine. Uneven-aged management is also appropriate in Edaphic Ecosites but limited to systems that produce or maintain fewer cohorts and retention through Irregular Shelterwood, Shelterwood with Reserve and Partial Overstory Removal systems.

Natural disturbance patterns also vary according to ecosite with Acadian zonal ecosites being associated with natural disturbances that generally have longer return intervals and more residual structure following disturbance than Acadian edaphic ecosites (MacLean et al., 2021).

Each VT description in the FEC includes a discussion of possible successional pathways, which are summarized in the Successional Development section for the major Acadian Forest Groups of Spruce-Hemlock, Spruce-Pine, Intolerant Hardwood, Tolerant Hardwood, and Mixedwood. Vegetation Types can have multiple succession paths depending on the Ecosite and the severity of disturbance. Therefore, ecosite is used in SGEM to modify prescriptions to align with the natural disturbance regime associated with zonal versus edaphic versions of the same VT with the same stand condition. The ES descriptions in the FEC define whether zonal or edaphic climax forests are natural in specific ecosites (pgs. 366-382, Neily et al., 2013)

Different restoration pathways in SGEM are triggered when **Long-lived Intermediate to Tolerant (LIT)** species and vertical structure are lacking relative to late-successional conditions in Acadian zonal ecosites. In Acadian edaphic ecosites these species generally do not occur naturally and restoration of LIT species is not appropriate.

Climate Change

Climate change poses a considerable threat to forest ecosystems and forest management across all ownership types in Nova Scotia. The type and severity of anticipated climatic change is highly variable across Canada's ecozones and jurisdictions. For Nova Scotia, situated in the Atlantic Maritime ecozone and Acadian Forest Region, all 21st century climate change scenarios predict increases in temperature and precipitation, although both with seasonal variability. The **Intergovernmental Panel on Climate Change's (IPCC)** scenarios—called Representative Concentration Pathways—predict mean annual temperatures increases from approximately 2 ^{o} to 6 ^{o}C and increases in mean total annual precipitation from approximately 100 to 300 mm for Nova Scotia by the year 2100 (IPCC, 2014; Bush & Lemmen, 2019).

Some research demonstrates the potential for increases in forest productivity with the rising temperatures—especially if water availability is not a limiting factor (Taylor et al., 2017; D'Orangeville et al., 2018). The Acadian Forest Region is a transitional zone between boreal forests to the north (dominated by colder-climate conifer species like balsam fir, black spruce, white birch) and the temperate deciduous forests to the south (dominated by warmer-climate broadleaved species like red maple, red oak, white pine). Some Acadian tree species are near either the southern or northern limits of their geographic ranges—meaning that the former may become climatically maladapted to future climates, while the latter may experience increases in abundance and/or productivity (Steenberg et al., 2011, Taylor et al., 2017). New successional pathways and forest communities may be possible in an altered climate.

There are still high levels of uncertainty around future warming and corresponding species- and ecosystem-level responses, so a commitment to on-going ecological and silvicultural research and monitoring is necessary to inform any future adaptation measures (e.g., assisted migration).

On-going operational adaptations in the forest sector will also be important—such as adapting for increased precipitation/flooding, and declining frozen-ground conditions in winter, both of which can increase the threat of soil damage during harvests.

One of the more immediate impacts of climate change is the alteration of **natural disturbance regimes (NDR).** Specifically, there are both observed and forecasted increases in the frequency and severity of natural disturbances, such as windstorms/hurricanes, pest outbreaks, drought and wildfire (Seidl et al., 2017). These impacts affect wood supply, but also carbon storage and a forest's capacity to act as a carbon sink.

The increase in structural complexity and species diversity in forest ecosystems that will result from implementing ecological forestry and the SGEM is an important adaptation to climate change, as it enhances resilience to natural disturbances (Messier et al., 2013).

As the SGEM is considered adaptive by nature, new measures for climate change will be incorporated as future research is completed. This would include on-going research on the role of NDR in ecological forestry in Nova Scotia and potential impacts of climate change on NDR frequency and severity.

Importantly, the implementation of the SGEM can also be a tool in the fight against climate change. Trees capture atmospheric carbon dioxide through photosynthesis as they grow, and forests—including living forest biomass and dead organic matter—store large amounts of carbon for significant periods of time. Moreover, carbon stored in forest products can often reduce overall net emissions by offsetting more emissions-intensive products. This ability for forests to act as carbon sinks helps reduce the overall concentration of carbon in the atmosphere and thereby reduce the associated impacts of climate change (Smyth et al., 2014). The silvicultural prescriptions in the SGEM will lead to higher amounts of carbon storage on the landbase and further strengthen the role of Nova Scotia's forests and forest sector in combatting climate change.

A multi-faceted and adaptive approach to climate change in forest management is critical, given the uncertain and evolving nature of climate change. For example, climate change adaptation in forest management aims to avoid adverse impacts or to exploit opportunities and might include increasing species and structural diversity or assisted migration programs. In contrast, climate change mitigation could involve management action to reduce greenhouse gas emissions or increase carbon sinks like forests (IPCC, 2014). By leveraging aspects of both mitigation and adaption, the Triad model of ecological forestry is one such multifaceted approach for managing a diverse set of forest values and trade-offs in a changing climate (Nitschke & Innes, 2008).

Soil Health

Soil health is fundamental to sustainable forest management. In general, soil health is defined as the continued capacity of a soil to sustain biological productivity, maintain environmental quality, and promote plant and animal health (Doran et al., 1996). From a management perspective, soil health involves the maintenance of nutrient cycling capacity and resilience to disturbance or stress (O'Neill et al., 2005).

For stand-level management, maintenance of soil health and related biodiversity is promoted by:

- Recognizing damage hazards associated with different soil types
- Mitigating potential soil damage through appropriate operational planning
- Integrating soil nutrient sustainability into harvest prescriptions

Soil Damage Hazards

Harvesting activities will frequently result in some form of ground disturbance. However, disturbance does not necessarily mean damage, and the potential for soil damage can be avoided or greatly reduced through proper planning. Damage hazard interpretations have been made for all FEC soil types in Nova Scotia (Neily et al., 2013). These include hazard ratings for compaction, rutting, erosion, and forest floor loss.

To ensure that harvest prescriptions minimize soil damage, measures to identify site-specific soil hazards and prevent soil damage will be incorporated in operational plans.

Nutrient Sustainability

Nutrient sustainability is fundamental to long-term site productivity. Forest harvesting can harm nutrient sustainability if biomass removal rates do not consider site-specific nutrient budgets. Over the last several years, the Nova Scotia Department of Lands and Forestry has been working to test and update a forest **nutrient budget model (NBM-NS)** that allows nutrient sustainability to be integrated into forest management planning (Keys et al., 2016). This ongoing work includes a provincial sampling program to acquire current soil and tree tissue chemistry data for model calibration. Enough progress has been made that NBM-NS can now be used to inform harvest planning by estimating **sustainable mean annual increment (SusMAI)** values for various combinations of FEC vegetation and soil types across Nova Scotia. In addition, these estimated SusMAI values consider historic and ongoing acid rain impacts on base cation nutrient (calcium, magnesium, potassium) contents. Having such detailed data enables greater attention to be given to the promotion of forest soil health.

To ensure that silvicultural prescriptions are in keeping with nutrient sustainability estimates, **harvest mean annual increment (HarMAI)** values (total merchantable harvest volume/age of harvest material) will be calculated and compared to SusMAI tables. If HarMAI is greater than SusMAI for a given **vegetation type (VT)** and **soil type (ST)** combination, the proposed prescription will be adjusted until HarMAI is less than or equal to SusMAI, in order to ensure nutrient sustainability.

Silvics of Common Nova Scotia Trees

Knowledge of the characteristics (silvics) of common native trees in Nova Scotia is critical to understanding how silvicultural activities affect regeneration, growth, and succession. The SGEM requires information on age, longevity, rooting depth, and shade tolerance of tree species to determine silvicultural systems and intervention strategies.

Regeneration treatments are optimally timed after stands reach full seed-bearing age, and at the time that the understory re-initiation phase of development occurs, especially for even-aged stands. Waiting for seed-bearing age increases opportunities for natural regeneration. Merchantable timber losses are reduced if harvesting takes place before the overstory declines, which is characterized by slow growth and increased mortality. Mature and dying trees help biodiversity by adding coarse woody material, wildlife habitat, and nutrients, among other benefits. It is recognized that retention of mature trees is required in all stands, even if it is past the understory re-initiation phase. This will result in a cohort of older trees beyond the re-initiation age, augmenting biodiversity and creating uneven-aged stands.

Table 1. Silvics of Common Nova Scotia Trees (below) summarizes silvics values used for Pre-Treatment Assessments (PTAs).

The column "Full Seed-bearing Age" lists ages occurring 10–40 years after minimum seed-bearing ages. "Shade Tolerance" defines the ability of a species to regenerate from seed in shaded conditions. Tolerant and intermediate species are successful in regenerating in partial shade produced with shelterwood and selection systems, while intolerant species are not.

Silvics can vary according to site and development stage. White spruce, for example, growing on old fields are known to have a shorter lifespan than when growing in natural forest conditions. Another example is white ash, known to be more tolerant of shade early in its life cycle but less tolerant of shade with age.

This table is based on the best localized silvic information available and relies on the Maritime-specific Harrison guide, when applicable, and on Burns and Honkala (USDA, 1990) and Farrar (1995) guides when necessary. Modifications have been made based on Nova Scotia conditions as they vary. Where possible, maximum longevity figures have been based on Nova Scotia old growth data.

It is recognized that some species are inherently more prone to windthrow because of their shallow rooting characteristics. For example, if red spruce and yellow birch are growing on the same site; the yellow birch would be more resistant to windthrow.

Various reproduction characteristics are also shown in Table 1, including typical seed dispersal distances, reproduction methods, and flowering characteristics. Some species, such as red oak, have heavy seed that will not disperse very far from parent trees unless assisted by foraging animals. The seed of other species can disperse over long distances (e.g., white pine). Some species have both male and female flowers on individual trees, while others, such as white ash, have trees that carry only female flowers or only male flowers. All species reproduce through seed, but some can also reproduce through vegetative methods, including suckering (from roots), sprouting (from stumps), and layering (from lower branches). Better stem form is usually produced from seed-source regeneration.

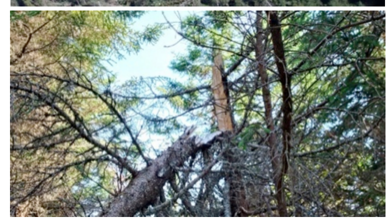
One of the key features of Table 1 is the assignment of species into categories used in the SGEM decision keys. Long-Lived Intermediate–Tolerant species (LIT) are shade intermediate-tolerant that predominate in late succession stands under light disturbances. Long-Lived Tolerant species (LT) are shade-tolerant species that regenerate readily under heavy shade. In some cases, species can be categorized differently, depending on where they are growing. For instance, white spruce growing on Old Field, Coastal, or Highland forest groups is not considered a LIT species because of its relatively short lifespan. However, when white spruce grows in other forest groups it qualifies as a LIT species. Similarly, red maple is considered LIT when growing in a Tolerant Hardwood forest group, but not when growing in other forest types.

Table 1. Silvics of Common Nova Scotia Trees

Species	Full Seed-Bearing Age (years)	Senescence/ Onset of Understory Reinitiation (years)	Maximum Longevity (years)	Wind-firmness	Shade Tolerance	Rooting Depth	Flowers	Reproduction Method	Seed Dispersal Distance (m)	LIT	LT
Softwoods											
Red Spruce	45	100	335*	M	T	Shallow	M	SE	100	Yes	Yes
Eastern Hemlock	50	100	382*	P	T	Shallow	M	SE	20	Yes	Yes
White Pine	50	100	288*	G	IM	Deep	M	SE	200	Yes	No
White Spruce (OF, CO, HL)	40	60	70	M	IM	Shallow	M	SE	12	No	No
White Spruce (Other FG)	60	80	150	M	IM	Shallow	M	SE	12	Yes	No
Black Spruce/Coastal	30	70	277/150*	P	IM-T	Shallow	M	SE, L	100	No	No
Balsam Fir	30	50	160*	P	T	Shallow	M	SE	30	No	No
Red Pine	50	70	300	M-G	I	Deep	M	SE	12	No	No
Jack Pine	40	60	200	G	I	Deep	M	SE	30	No	No
Eastern Larch	40	60	150	M	I	Shallow	M	SE, L	50	No	No
Hardwoods											
Sugar Maple	80	100	276*	G	T	Deep	Po	SE, SP	100	Yes	Yes
Yellow Birch	70	90	370*	G	IM	Deep	M	SE, SP	150	Yes	No
White Ash	50	80	250	G	IM-T	Deep	D	SE, SP	140	Yes	No
Red Oak	50	80	205*	M	IM	Deep	M	SE, SP	5*	Yes	No
Red Maple (TH)	40	80	188*	M	IM-T	Shallow	Po/D	SE, SP	100	Yes	No
Red Maple (Other FG)	40	60	100	M	IM-T	Shallow	Po/D	SE, SP	100	No	No
White Birch	50	50	120	M	I	Deep	M	SE, SP	150	No	No
Trembling Aspen	30	50	100	M	I	Shallow	D	SE, SU, SP	100	No	No
Large-tooth Aspen	30	50	100	M	I	Shallow	D	SE, SU, SP	100	No	No

Sources: Harrison, Silvics of Common Maritime Softwoods and Hardwoods. Burns and Honkala, Silvics of North America, Volume 1, Conifers, and Volume 2, Hardwoods, 1990. Farrar, Trees in Canada, 1995. Ashton and Kelty, The Practice pf Silviculture – Applied Forest Ecology, 2018 Full Seed-Bearing Age: Age when trees generally reach full seed production Senescence/Onset of Understory Re-initiation: Age when stand generally begins to regenerate as openings in canopy occur due to senescence (Ashton & Kelty, 2018). Maximum Longevity: Individual trees have the potential to live to these ages. Windfirmness: P – Poor; M – Moderate; G – Good. Shade Tolerance: I – Intolerant; IM – Intermediate; IM-T – Intermediate to Tolerant; T – Tolerant. Flowers: M – Monoecious; D – Dioicous; P – Prefect; Po – Polygamous. Reproduction Method: SE – Seed; L – Layering; SU – Suckering; SP – Sprouting. Seed Dispersal Distance (m) – Red Oak – Birds and mammals will take seeds over much longer distances. LIT: Long-Lived Intermediate–Tolerant species. LT: Long-Lived Tolerant species. White Spruce (OF, CO, HL): White Spruce of Old Field, Coastal Vegetation, and Highland forest groups. White Spruce (Other FG): White Spruce in non-Old Field, Coastal, and Highland forest groups. Red Maple (TH): Red Maple in the Tolerant Hardwood forest group. Red Maple (Other FG): Red Maple in non-Tolerant Hardwood forest groups. * - Ages modified based on Nova Scotia Department of Lands and Forestry FEC and Forest Research Plot Database (NSDLF. 2021. Draft AN old Growth Forest Policy for Nova Scotia)

Windthrow Hazard

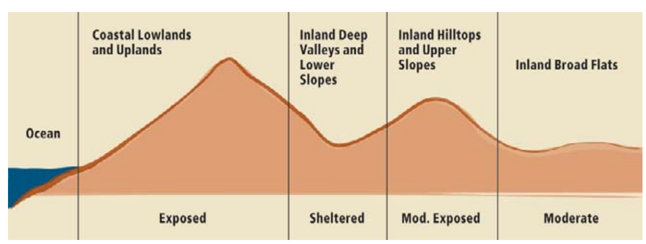


When prescribing uneven-aged silvicultural systems in Nova Scotia, the potential for windthrow and stem breakage of residual trees is a major concern. Many parts of Nova Scotia have frequent storms involving high winds, potentially damaging to standing trees. Trees are especially at risk when growing in shallow soils or exposed sites.

Retained trees are initially more susceptible to wind damage, especially for harvests that leave lower retention (McGrath and Ellingsen, 2009). In the longer term, spacing stands will augment windfirmness as root systems expand into the increased soil space. Meeting partial harvesting objectives (e.g., provide seed and shade for regeneration and vertical structure) depends on retained trees remaining standing with crowns intact.

To mitigate the risk of wind damage, this guide incorporates an assessment of windthrow hazard and wind breakage as important considerations when prescribing treatments based on data collected during the PTA. (Breakage risk is also discussed in Appendix I: Acceptable Growing Stock (AGS) and Unacceptable Growing Stock (UGS))

Fallen trees provide biodiversity values by contributing downed wood material and nutrients (See: Tree Biodiversity and Classification section of Appendix I). These biodiversity values will be tracked to ensure they are maintained and augmented. Windthrow hazard ratings do not reduce retention levels, but they are considered when deciding on the retention distribution. In higher windthrow situations, Gap Silvicultural systems are recommended over Uniform systems.



The windthrow hazard rating (low, moderate, or high) depends on site exposure and soil characteristics. The soil component of windthrow hazard is directly determined from soil type (Neily et al., 2013). The main soil factor influencing windthrow hazard is potential rooting depth, which is related to drainage, texture, stoniness, proximity of bedrock to the soil surface, and overall depth.

Windthrow hazard also depends on exposure of the stand to winds due to topography, slope position, and proximity to the coast (Stathers et al., 1994). *Forest Ecosystem Classification for Nova Scotia* (Neily et al., 2013, http://novascotia.ca/natr/forestry/veg-types/) defines the exposure classes as either exposed, moderately exposed, moderate, moderately sheltered, or sheltered . This information is provided in Figure 2 (above) and Table 2 (below)

Wind exposure has been mapped in Nova Scotia (Keys et al., 2017) to consistently assess exposure and provide a rating. These maps are to be used for PTA wind exposure ratings (See Figure 3).

Wind exposure rating, combined with the soil type, determines windthrow hazard—as shown in Table 3. Stand density, tree species rooting patterns, crown dimensions, and overall tree health are also factors.

Even if there is potential for windthrow or an absence of LIT species for a site, retention is still required to achieve biodiversity and nutrients sustainability goals. In areas such as these the distribution of retained trees should be considered to meet specific biodiversity objectives.

For the Tolerant Hardwood forest group, windthrow hazard is not considered when prescribing silvicultural treatments. These vegetation types include deep-rooted species on deep soils, therefore less prone to windthrow.

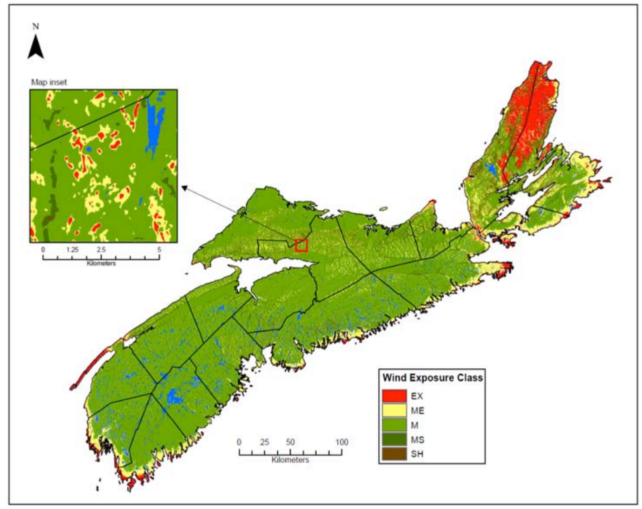


Figure 2. Provincial Wind Exposure Map (Keys et al., 2017)

Table 2. Wind Exposure Definitions Adopted from Neily *et al.,* (2013)[A]

Class	Description	Code
Sheltered	The most extreme category of protection from wind and atmospheric drought stress, best illustrated by lower slopes of deep valleys where protection is provided on all sides.	**S**
Moderately Sheltered	Intermediate, between moderate and sheltered. Includes middle slopes between high ridges and broad basins that are afforded some wind protection from one or more directions.	**MS**
Moderate	The topographically neutral category. Includes broad flats, lower and middle slopes of strong ridges (plus sheltered upper slopes), and upper slopes of gentle relief in a flat landscape.	**M**
Moderately Exposed	Intermediate, between exposed and moderate. Includes upper slopes of inland ridges or hills, except where sheltered by a larger hill.	**ME**
Exposed	Sites with extreme exposure. Includes upper slopes of moderate ridges immediately along the coastline and steep upper slopes of uplands open to winds from two or more directions.	**EX**

[A] Exposure refers to the relative openness of a site to weather conditions, particularly wind.

Table 3. Windthrow Hazard Rating Categories Based on Exposure and Soil Type[A]					
Soil Type (Keys *et al*., 2011)	Exposure Class				
	Sheltered	*Moderately Sheltered*	*Moderate*	*Moderately Exposed*	*Exposed*
1, 1-G, 2, 2-G, 2-L, 8, 8-C					
Stony phases					
3, 3-G, 3-L, 5, 9, 9-C, 11					
Stony phases					
6, 12					
Stony phases					
All wet, organic, moist shallow, and talus soil types (ST4, ST7, ST10, ST13, ST14, ST16, ST18, ST19)					
Dry shallow soil types (ST15, ST17) with 0-15 cm depth or stony (S) phase					
Dry shallow soil types (ST15, ST17) with 16-30 cm depth and non-stony phase					

Stem Breakage Hazard

Breakage hazard is considered in the evaluation of whether a tree is classed as unacceptable growing stock (UGS).

When live-crown ratio is less than 1/3 (ratio of length of live crown to total tree height) or H/D (ratio of total tree height in metres to diameter at breast height in centimeters) ratio is greater than 0.8, a tree is considered prone to stem breakage when thinned—and is thus considered UGS.

When UGS levels are too high, the stand is not considered suitable for Commercial Thinning or Selection, although retained tree cover will be left in all cases to meet biodiversity objectives. Stands with low proportions of AGS will be considered for High-Retention Irregular Shelterwood Treatments.

NOTE: For more details, see Appendix I. Acceptable Growing Stock (AGS) and Unacceptable Growing Stock (UGS).

Retention

Foresters recognize three fundamental reasons to retain a tree, or collection of trees, in a partial harvest:

- **Growing Stock** – trees that are left to grow to larger sizes and older ages to meet product specifications or biological objectives such as restoration of seed sources. Growing stock can be considered Acceptable (AGS) or Unacceptable (UGS), based on tree characteristics such as bole quality, tree vigor, crown characteristics, and evidence of pest and pathogen attack (See Appendix I).
- **Regeneration** – trees left to provide both seed and partial shade to improve the establishment and early development of tree seedlings and saplings.
- **Biological Legacies** – remnant trees and other biological structures (e.g., large snags and downed logs) inherited and retained from the previous forest that facilitate biological continuity between old and young cohorts in stands under regeneration.

Managing growing stock and regeneration has been fundamental to silviculture since its inception. The biological legacy is a much newer concept, having emerged during the last three decades, in an era where managing forests to sustain biodiversity has become an important societal goal.

Leaving trees for regeneration is best illustrated by the classical single-cohort, Uniform Shelterwood method. Here, foresters leave overwood trees—to provide seed for the new crop as well as partial shade to improve germination and establishment. Overwood trees are then partially or fully removed when the regeneration objective is met.

Any tree left after the regeneration period is completed, either in a simple, single-cohort system or in regeneration patches of more complex Irregular Shelterwood and Group Selection systems, is termed a reserve tree, or simply, a reserve.

Reserve trees can be biological legacies left permanently, hereafter called "**permanent reserves**," or they can be growing stock trees that are harvested in the future. Some of the residual overwood trees can become reserve trees once their regeneration function is served, if they are not harvested in partial overwood removal cuttings. The converse is not true, however. Overstory trees that will later be harvested are never termed "permanent reserves." Under this usage, reserves are not automatically left permanently, so if this is intended, such trees should be termed permanent reserves. Similarly, while all legacy trees should normally be treated as permanent reserves, trees need not possess characteristics of classic legacies (old, large size, etc.) to qualify for permanent retention as future legacies.

The term **residual**, long in use, applies to any tree or stand that is not removed in any silvicultural treatment, including non-commercial practices. Residual stands are most commonly associated with thinning treatments and usually have quantitative specifications of species preferences, tree density and/or spacing.

The term **retention** has come into wide use as a collective noun that describes individual trees or assemblages of trees that are retained after a partial cutting. Retention is most often applied to regeneration treatments accomplished via commercial harvests. Retention thus encompasses all three objectives listed above. The pattern of retention trees can be dispersed throughout the harvest or aggregated (clumped). "Retention" can also be used as an adjective to describe anything involving this issue, such as "retention targets", "retention policy", etc.

Because "retention" is a general, inclusive term lacking specific silvicultural intent, silvicultural prescriptions and systems should instead focus as much as possible on the targeted objectives of **growing stock, regeneration, and permanent legacy**. For example, a Gap Irregular Shelterwood prescription that simply specified "2/3 retention" is not particular helpful or descriptive. Alternately, specifying that 0.1–0.2 ha gaps cover 1/2 of the stand area, with an overwood in the gaps of 12 m^2/ha basal area, including no fewer than 10 large legacy trees/ha of gap, along with a matrix of immature AGS stocked at 20 m^2/ha, covers the important details.

Retention Objectives

Trees will be retained for all harvests recommended in the SGEM. This retention is left to meet various objectives, including the maintenance and/or enhancement of the following:

1. Biodiversity and Wildlife Habitat. — See *A Field Guide to Forest Biodiversity Stewardship* (Neily and Parsons, 2017); https://novascotia.ca/natr/library/forestry/reports/Biodiversity-Stewardship-Guide.pdf).
    - 1.1 Stand structures natural to ecosites. For example, vertical and horizontal diversity and multi-aged structure in stands where they naturally occur
    - 1.2 Persistent stand openings
    - 1.3 Tree Composition (retain Diversity trees — uncommon species such as black cherry and ironwood). Larger trees (living and snags) for providing legacies, super-canopy trees and future Coarse Woody Material
    - 1.4 Living and dead cavity trees that provide shelter, nesting, hibernacula and den sites for wildlife
    - 1.5 Mast bearing trees
    - 1.6 Large mature trees suitable for raptor nests
2. Late Succession LIT species
    - 2.1 Shade and seed source for regeneration of late successional Intermediate to Tolerant Species (LIT)[1].
    - 2.2 Increase proportion of LIT species in the overstory
3. Aesthetics

[1] LIT species = eastern hemlock, red spruce, white pine, white spruce (not on Old Field or Coastal vegetation types), red maple (on Tolerant hardwood vegetation types), red oak, sugar maple, yellow birch, white ash. See FMG and FEC, https://novascotia.ca/natr/forestry/veg-types/pdf/vegtypes.pdf).

4. Tree Health
    4.1 Increasing proportion of Acceptable Growing Stock (AGS).
    4.2 Limit machine damage
5. Soils Health
    5.1 Nutrient sustainability and site productivity.
    5.2 Structure
    5.3 Biota
6. Merchantable growing stock for future harvests
    6.1 Quality
    6.2 Pole size patches

Incorporating Retention into Silvicultural Systems

The potential to meet these objectives will vary by stand and vegetation type, but the goal is to retain 1/5–2/3 of each stand.

The retention rate varies depending on a number of different factors including forest groups, ecosites, windthrow hazard, AGS levels, species content and other stand factors. In general, lower retention is prescribed in Edaphic Acadian Ecosites and for situations with a lower LIT content before harvest. When LIT species predominate along with AGS, Selection or Commercial Thinning is prescribed with high retention rates (2/3). These silvicultural methods are recommended when high levels of LIT exist and the mature overstory is healthy (high level of AGS), enough to be maintained over a long period. An existing uneven-aged structure is an additional requirement for Selection management systems.

When the amount of AGS is lower, the Irregular Shelterwood systems are prescribed, where the mature overstory is kept for a shorter period than with Selection and Commercial Thinning methods, but long enough to create or maintain uneven-aged structure. The amount of retention in Irregular Shelterwoods varies with the amount of pre-treatment LIT species with 1/2–2/3 retention prescribed. When Edaphic Acadian ecosites are encountered, where natural disturbance regimes are characterized by more severe disturbances, prescribed retention rates are lower. In some cases, restoration efforts will require lower retention rates and enhancement planting to restore naturally occurring late succession species where inadequate seed source of LIT species occurs.

When selecting reserves, preference should be given to keeping LIT species that are healthy and windfirm[2]. to reduce risk to blowdown and stem breakage, thereby helping to meet objectives 1, 2, 3, 4 and 6.

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[2] For guidance on tree indicators for identifying risk of wind damage (p. 10, H/D ratio and LCR). Retained trees will ideally have slenderness coefficients below 0.8 and live crown ratios greater than 1/4, (with their lower live crown being less than half the height of the main canopy).

In some higher windthrow situations trees may be left in small clumps to reduce windthrow risk. Keeping LIT species with these characteristics helps to achieve objectives 1, 3, and 6 by ensuring that the trees retained are of a form and have a suitable crown structure to be long-lived.

As well as keeping overstory LIT species for biodiversity and regeneration purposes, retention should support the growing stock objective 6 by retaining pole-sized growing stock, especially of LIT species with healthy crown-structures and slenderness-coefficients,[3] where they occur. Often, patches of smaller growing stock grow in canopy openings. They should be retained and released without damaging them. As well as retaining the patches of growing stock, forest workers should take care to protect advance regeneration of LIT species. These retained trees will help achieve objectives 1, 2 and 6.

Not all retention necessarily consists of LIT species, as other retention objectives could be met by leaving non-LIT species to function as retention (e.g. cavity trees, trees containing raptor nests, saplings left for vertical diversity). However, only live trees count towards retention requirements. The total retention objective should be achieved by meeting as many retention objectives as possible.

Uncommon components of stands, especially LIT species, must be retained to enhance biodiversity (objective 1). Black ash and cedar are species-at-risk in Nova Scotia, and protected legally from harvest. Ironwood, black cherry, and disease-free beech are examples of species that should be retained when possible as diversity trees. Large, old super canopy trees are another example of an uncommon feature to retain. Keeping legacy trees, such as large diameter sugar maple, yellow birch, or white pine, over multiple rotations will support objectives 1 and 2 by reducing the amount of nutrients removed from a site and post-harvest leaching. This is important in shallow and stony-phased soils, in which nutrient stores are lower.

In all cases one of the primary objectives for leaving retention is for biodiversity and creating or maintaining structures representative of natural disturbances specific to the ecosite (OMNR, 2010).

Table 4. Minimum level of Permanent Reserve Trees per hectare by Ecosite for Live Trees.

Acadian Zonal	Acadian Edaphic
20	15
Except for diversity trees, these trees should be >= 30 cm Dbh if they occur in the stand. If not, they should consist of the largest trees possible.	

A certain portion of this retention is slated as permanent; mainly to meet biodiversity objectives such as stand structure and future Coarse Woody Material (CWM). Trees retained for these purposes are called "permanent reserves" as they are to be left until they die.

Dead permanent reserve trees need to be replaced to maintain minimum levels in subsequent harvest. Special Management Zones (SMZ) along streams are not included in this retention, while Legacy Tree Clumps left as part of the Wildlife

[3] See "Characteristics of UGS trees" section in Appendix I.

Habitat & Watercourses Protection regulations **are** included in this retention (https://novascotia.ca/natr/wildlife/habitats/protection).

Retention required for wildlife **Special Management Practices (SMPs)** will also be included as part of the prescribed retention (https://novascotia.ca/natr/wildlife/habitats/terrestrial/). For example, if trees are retained in patches to provide shelter for moose, these will be included in retention amounts.

The minimum levels of live permanent reserves to be retained are shown in Table 4.

Live permanent reserve trees must be retained as per the priority list provided in Table 5, but not all trees retained should be from one category. For example, Cavity trees are important for biodiversity, but it is not expected that all permanent reserve trees would contain cavities. All trees with large stick nests must be retained, but these are rare. Trees containing large stick nests likely to be raptor nests are protected under the *Nova Scotia Wildlife Act* (Note: a minimum buffer distance must be applied to raptor nests — See more detail in *A Field Guide to Forest Biodiversity Stewardship*; https://novascotia.ca/natr/library/forestry/reports/Biodiversity-Stewardship-Guide.pdf). One or more super canopy trees, or trees likely to become super canopy trees, should be retained per hectare. The remaining permanent reserve trees would consist of diversity trees, mast trees or large legacy trees depending on the stand structure and species present.

Table 5. Priority List for Live Permanent Reserve Trees

Category	Description
1. Cavity Trees	Live standing-trees that contain hollows or cavities in the trunk or limbs, or that show signs of decay that may become cavities.
2. Trees with large stick nests	Raptor nests—Most raptors will return to the same nest each year. It is a violation of the Nova Scotia Wildlife Act to disturb raptor nests, and a minimum buffer distance must be applied.
3. Diversity trees	Trees unusual in context, representing a small portion of the stand, or providing for diversity within the stand (e.g., an ironwood tree, an uncankered beech, or a large yellow birch in a softwood stand).
4. Super Canopy trees	Trees projecting above the canopy of dominant and codominant trees.
5. Mast Trees	Trees bearing mast (e.g. red oak, beech, beaked hazelnut, wild apple trees and large cone-bearing conifers)
6. Legacy trees	Large, mature trees with characteristics that allow them to survive a disturbance. (e.g., healthy stem, no sign of disease, >1/3 live crown)

Wherever possible, permanent reserves are to be left both in clumps and as distributed trees throughout the site, as this will increase the benefits derived from the residual trees.

Approximately 1/2 of the permanent reserve retention will be in clumps and 1/2 in distributed trees. The distributed trees should be selected to be windfirm and left in small groups to reduce the risk of windthrow. Although standing dead trees do not count towards required retention levels, all dead trees should be left where it is safe and operationally possible to do so. This applies especially to the largest diameter trees, as they contribute towards future CWM and soil nutrients.

Retention levels must be reviewed at each harvest entry to ensure that the proposed harvest is sustainable from a nutrient perspective using the Nutrient Budget Model. If they are not sustainable, harvest plans must be revised.

Summary

- Leave the prescribed retention (1/5 – 2/3)
- Ensure permanent reserves (as shown in Table 4) are left for biodiversity reasons
- Leave permanent reserves distributed, with approximately half in patches and half as distributed trees (could be small clumps)
- Permanent reserves should be the largest trees available (See Table 4)
- WH&WP legacy tree clumps and trees left for SMP reasons are included in retention levels
- The proportion of LIT species and AGS must be higher after treatment
- Biodiversity features must be maintained after treatment
- If retention levels do not support nutrient sustainability, harvest plans must be revised until it is nutrient sustainable

Restoration

One of the main objectives of this SGEM is to restore late-succession species—such as red spruce, sugar maple, eastern hemlock, yellow birch, white pine, white ash, and red oak—where they would naturally occur but are currently low in number. This SGEM prescribes retention of **Long-Lived Intermediate-Tolerant species (LIT)** (See Table 1) where they occur to in turn help increase the proportion of these late successional species through increased seeding and shade.

Where the LIT seed source trees are almost non-existent, enhancement planting will take place to restore these species.

In other situations, a few distributed mature LIT trees exist. In these cases, the LIT trees are left to provide seed and shade for help in regenerating LIT species. Non-LIT trees will also need to be retained to produce sufficient shade to favor regeneration of LIT species.

Some vegetation types dominated by intolerant or shorter-lived species[4] are early successional types but have potential to move towards their naturally occurring later successional version dominated by LIT species (See Table 1; Neily et al., 2013). This restoration process is aided by prescribing retention of LIT species in all cases where they occur. Table 6 (extracted from Neily et al., 2013) shows the possible successional links for vegetation types dominated by Short-Lived or Intolerant to Medium-Shade Tolerant species.

For example, a stand classified as IH3 (Intolerant Hardwood: Large-tooth aspen/Christmas fern–New York fern) has the potential to move towards TH3 (Tolerant Hardwood: Sugar maple–White ash/Christmas fern). The ability to move from IH3 to TH3 through partial harvesting depends on several stand characteristics, such as the presence of seed-source trees or advance regeneration of later successional species (e.g., sugar maple).

The SGEM introduces restoration recommendations where LIT species are at low levels on ecosites with the potential to grow these species. In some cases, where seed sources of LIT species are inadequate, underplanting with follow-up weeding and tending may be required to restore late successional types.

[4] rM (non-TH stands), bF, tA, ltA, eL, jP, bS, bP, rP, wS (Old Field and Coastal forest groups), wB

Table 6. Successional Links for the Vegetation Types Dominated by Short-Lived or Intolerant to Medium-Shade Tolerant Species (Neily et al., 2013)

Abbreviation	Vegetation Type	Successional Stage		
		Early	Mid	Late
IH1	Large-tooth aspen / Lambkill / Bracken	IH1,IH2	SP6	SH4,SP9
IH2	Red oak – red maple / Witch-hazel	IH1,IH2	SP4	SH4,SP9
IH3	Large-tooth aspen / Christmas fern – New York fern	IH3,IH4,IH5,IH6	IH7,MW2,MW4, SH5,SH6,SH7,SH8	MW1,MW3,SH1,SH2,SH3,TH1,TH2,TH3, TH4,TH6,TH8
IH4	Trembling aspen / Wild raisin / Bunchberry	IH4	IH7,MW2,MW4, SH5,SH6,SH7,SH8,SH9,SH10	MW1,MW3,SH1,SH2,SH3,SH4,TH6,TH8
IH5	Trembling aspen – White ash / Beaked hazelnut / Christmas fern	IH5,MW5	IH7,MW4,SH5,SH6,SH7,SH8	MW1,MW3,SH3,SH4,TH1,TH2,TH3,TH4, TH8
IH6	White birch – Red maple / Sarsaparilla - Bracken	IH6	IH7,MW2,SH5,SH6,SH7,SH8,SH9,SH10	MW1,MW3,SH1,SH2,SH3,SH4,TH1,TH2 ,TH3,TH6,TH8
IH7	Red maple / Hay-scented fern – Wood sorrel	IH3,IH4,IH5,IH6	IH7,TH7	MW1,TH1,TH2,TH3 ,TH6,TH8
MW4	Balsam fir -Red maple / Wood sorrel - Goldthread	IH4,IH5	MW2,MW4,SH5, SH6,SH7,SH10,TH7	MW1,MW3,SH1,SH2,SH3,SH4
MW5	White birch – Balsam fir / Starflower	IH5,MW5	MW2,SH5,SH6, SH8,SH10,TH7	MW1,MW3,SH1,SH2,SH3,SH4
OF1	White spruce / Aster	OF1	OF4, IH1-7	TH1,TH2
OF2	Tamarack / Speckled alder / Rough goldenrod / Shaggy moss	OF2	OF4,OF5,IH1-7, MW4	MW1
OF3	White pine – Balsam fir / Shinleaf	OF3	OF3,OF4,SH1-7	MW3
OF4	Balsam fir – White spruce / Evergreen wood fern – Wood aster	OF1,OF2,OF3,OF4	OF4	TH1,TH2,MW1,MW3
OF5	Trembling aspen – Grey birch / Rough goldenrod - Strawberry	OF5	OF4	TH1,TH2,MW1,MW3
SH8	Balsam fir / Wood fern / Schreber's moss	IH3,IH4,IH5,IH6,MW5	SH5,SH6,SH7,SH8,SH10	MW1,MW3,SH1,SH2,SH3,SH4
SH9	Balsam fir – Black spruce / Blueberry	IH4,IH6	SH9,SP4	SH4,SP5
SH10	White spruce – Balsam fir / Broom moss	IH4,IH6,MW4, MW5	SH8,SH10,TH7	MW1,MW3,TH8

MW1= Red spruce – Yellow birch / Evergreen wood fern; MW 2= Red spruce – Red maple – White birch / Goldthread;
MW3= Hemlock – Yellow birch / Evergreen wood fern;
SH1= Hemlock / Pin cushion moss / Needle carpet; SH2= Hemlock – White pine / Sarsaparilla;
SH3= Red spruce – Hemlock / Wild lily-of-the-valley; SH4= Red spruce – White pine/ Lambkill / Bracken;
SH5= Red spruce – Balsam fir / Schreiber's moss; SH6= Red spruce – Balsam fir / Stair-step-moss – Sphagnum;
SH7= White spruce – Red spruce / Blueberry; SP4= White pine / Blueberry / Bracken; SP5= Black spruce / Lambkill Bracken;
SP6= Black spruce – Red maple / Bracken; SP9= Red Oak – White pine / Teaberry;
TH1= Sugar maple / Hay-scented fern; TH2= Sugar maple / New York fern – Northern beech fern;
TH3= Sugar maple – White ash / Christmas fern; TH4= Sugar maple – White ash / Silvery spleenwort – Baneberry,
TH6= Read oak – Yellow birch / Striped maple; TH7= Yellow Birch – White birch / Evergreen wood fern;
TH8= Red maple – Yellow birch / Striped maple.

Silvicultural Systems

Silvicultural systems provide three types of functions: Regeneration, Tending, and Harvest (Nyland, 2016), and are often named after the regeneration method used—such as Clearcutting, Shelterwood, Seed Tree, and Selection.

Different silvicultural systems carry out these functions over different time frames and result in varied stand structures. For example, a **Selection** system can regenerate, tend, and harvest a stand at the same time. It can be repeated over relatively short time frames to create an uneven-aged stand structure with several age classes (cohorts). Alternatively, a **Clearcut** system could create an even-aged stand where sequential treatments are carried out at later times (e.g., clearcutting in a mature stand followed by planting and weeding).

Silvicultural systems can be categorized as either **even-aged**, or **uneven aged, with further subdivision as follows**:

Even aged	Uneven Aged		
	Multi-aged		All-aged
	Two-aged	Three-Aged	

For example, to produce or maintain two or three age classes, the multi-aged silvicultural system **Irregular Shelterwoods** is prescribed. In other cases, the goal is to create or maintain four or more age classes. In these cases, the **All-aged Selection** system is prescribed.

Lastly, two-aged systems (a subset of multi-aged systems) such as **Shelterwoods with Reserves** are required to restore late succession species natural to an ecosite or to maintain two-aged structures that are natural (e.g. Edaphic Acadian ecosites).

Several tending methods are prescribed and are applicable to all systems to enhance the growth, biodiversity and potential for stands or portions of stands. Practices such as commercial thinning, planting, and pre-commercial thinning fall into this category. The intention of this guide is to create uneven-aged, multi-species stands where ecologically appropriate to augment or maintain biodiversity and long-term timber values.

Uneven-age Silviculture Systems

Uneven-age is a general term that describes two-aged, multi-aged and all-aged stands.

Multi-aged— systems whose objective is to create or maintain two or three age classes. Irregular Shelterwood or Shelterwoods with Reserve systems achieve this objective by retaining mature trees over an extended period to create or maintain multiple age-classes.

All-aged — systems whose objective is to create or maintain at least four age classes. Selection systems achieve this by retaining the majority of the overstory at each relatively frequent time interval, creating conditions to regenerate a new cohort at each entry. In all cases, a mature overstory is continually maintained

Two-aged — systems where the overstory is partially removed to release advance regeneration or when planting or natural seeding after the release cut is performed. Reserves are left to create or maintain a two-cohort stand. This system is referred to in this guide as a Shelterwood with Reserves.

Even-aged — systems where the overstory is removed to release advance regeneration (even-aged Shelterwoods) or for natural regenerating or planting after harvesting. This creates a one-cohort stand, with trees relatively uniform in age (with the ages of the trees in the stand all within 20% of the rotation age). These treatments are not recommended in this guide.

All-Aged Silvicultural Systems

Selection

Selection management is an all-aged system in which the intention is to keep a mature overstory at all points in its life, while promoting or developing at least four age classes with a series of harvests at a relatively uniform interval. This results in a balanced age class distribution.

Different spatial arrangements of these age classes (separated by at least 1/5 of the rotation age) can be created in this system. When the age classes are spread uniformly, intermixed on the same ground, the practice employed is called Single Tree Selection. When the different age classes consist of separate small gaps of the same age, the system employed is called a Group Selection.

Care must be taken to improve the stand at every entry—avoiding degradation of the stand by removing high-quality trees while leaving low-quality trees. This practice is termed "high-grading" (or selective harvesting) and does not qualify as a selection system.

To ensure the effectiveness of Selection management, the proportion of acceptable growing stock (AGS), of Long-Lived Intermediate–Tolerant species (LIT), and of Long-Lived Tolerant species (LT) should be increased. (See Table 1. LIT & LT) These trees and species—in addition to trees functioning as biodiversity trees, such as snag trees, live cavity trees, mast trees, and super canopy trees—will help provide required retention levels after a treatment. Permanent reserve trees will be left for all treatments, including Selections.

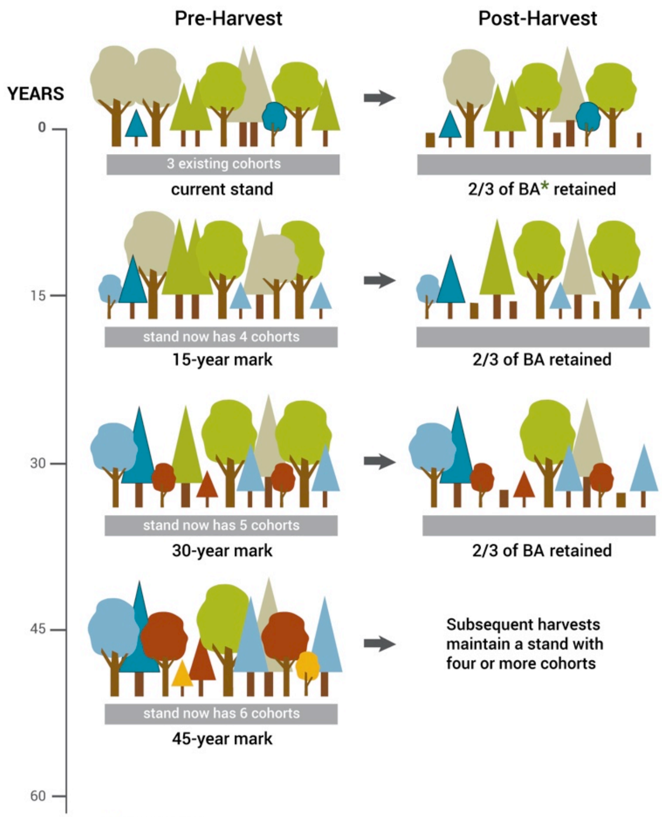
- Single Tree Selection – Different age classes are uniformly mixed spatially throughout the stand. At each entry, the intention is to create another age class in the shade of the mature overstory. This method is suited to long-lived, shade-tolerant species (LT) adapted to regenerating in shade. At the same time, senescent or low-quality stems are removed. This results in an improvement in the growth and quality of the remaining trees and subsequent value. The goal is to produce high-quality stems of high value, as well to produce a biodiverse stand. When using this system, 2/3 of the basal area is to be retained from areas not occupied by trails to encourage regeneration of shade-tolerant species such as red spruce, sugar maple, and eastern hemlock.

FIGURE 3

Single Tree Selection System

Sample of a timeline for an uneven-age stand in **Zonal Acadian ecosites**

This timeline results in **four or more** cohorts



* Basal area

Harvest Timeline

Time (years)		Cohort 1 age (yrs)	Cohort 1 BA (%)	Cohort 2 age (yrs)	Cohort 2 BA (%)	Cohort 3 age (yrs)	Cohort 3 BA (%)	Cohort 4 age (yrs)	Cohort 4 BA (%)	Cohort 5 age (yrs)	Cohort 5 BA (%)	Cohort 6 age (yrs)	Cohort 6 BA (%)	Permanent Reserves #/ha	Permanent Reserves age (yrs)
0	pre	100	20	70	50	20	30	–	–	–	–	–	–	20	100
	cut		5		5		23								
	post		15		45		7								
15	pre	115	30	85	60	35	9	15	1	–	–	–	–	20	115
	cut		5		21		7		0						
	post		25		39		2		1						
30	pre	130	30	100	45	50	10	30	10	15	5	–	–	20	130
	cut		10		15		8		0		0				
	post		20		30		2		10		5				
45	pre	145	30	115	35	65	5	45	15	30	10	15	5	20	145
	cut		5		18		5		5		0		0		
	post		25		17		0		10		10		5		
60 *	pre	160		130		80		60		45		30		20	160

* At time of this harvest, a 7th cohort is also present, age 15 years

- **Group Selection** – When a stand is relatively patchy (diverse in horizontal structure)—with trees that are not seed-bearing age (See Table 1) that have not reached their full economic potential in one area, while in other areas, patches of senescent or low-quality stems occur, Group Selection is the appropriate method.

  Small gaps are created of a size that meets silvicultural requirements for the species desired. The location of these patches must be selected (based on the conditions) and distributed throughout the stand. For example, senescent or low-quality patches could be removed to be regenerated, while younger patches of high quality will be left. Regenerating patches with an overstory could also be harvested to release established trees. Precautions to protect the young trees occurring in the area harvested must be made. Gaps of varying size will be produced, based on local conditions within a stand up to a maximum of 0.1 ha. One tenth (1/10) of the basal area will be left, dispersed within these gaps to provide additional seed and shade to encourage regeneration of Long-Lived Intermediate–Tolerant species (See Table 1. LIT).

  Creating forest gaps can not only encourage desired growth but be beneficial for biodiversity by providing a more diverse horizontal and vertical structure.

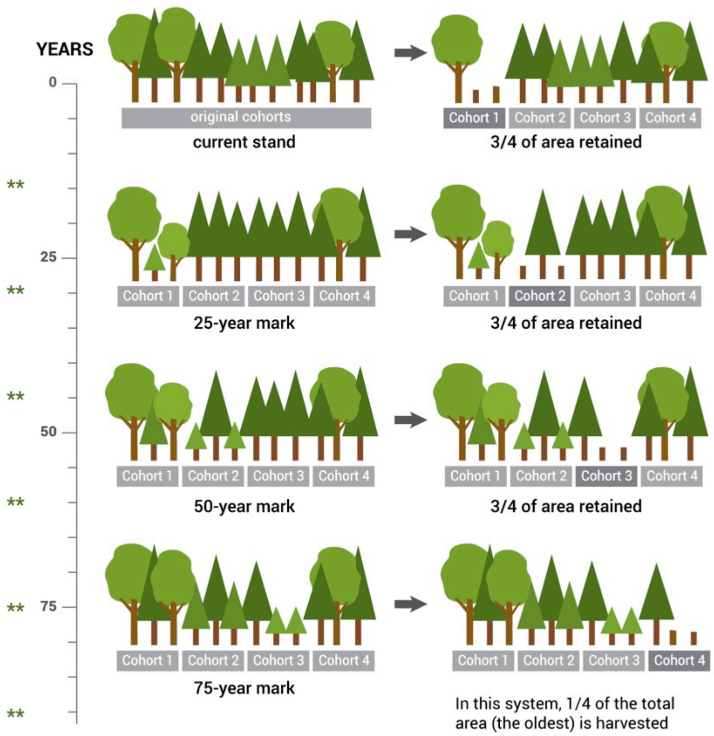
  When using the Group Selection system, the growth and quality of the trees in the residual area can be improved by using crop-tree release, pre-commercial thinning, or commercial thinning. The intention of the Group Selection treatment is to create at least four age classes—each separated by more than 1/5 of the rotation age. The remaining residual stand is to be harvested (except permanent reserve trees) when the initial harvested patches become mature.

FIGURE 4

Group Selection System

Sample of a timeline for a mature, uneven-age stand in **Zonal Acadian ecosites**

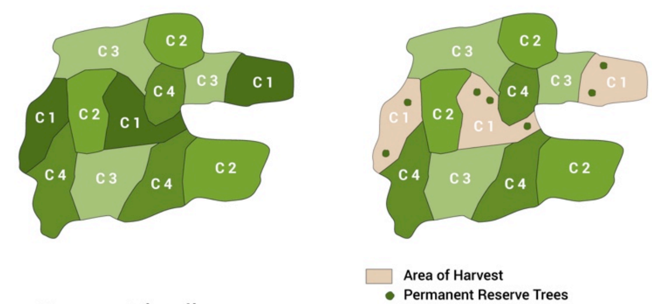
This timeline results in **four** cohorts after **four** harvests



** PCT (pre-commercial thinning) can occur between harvests – commonly at the 15-year mark

In this system, 1/4 of the total area (the oldest) is harvested every 25 years.
This timeline repeats after FOUR harvests. i.e. Next harvest would be in C1

Stand: Pre- and Post-Harvest



Harvest Timeline

The cycle could repeat after four harvests.

Time (years)		Cohort 1 area: 1/4 age (yrs)	Cohort 2 area: 1/4 age (yrs)	Cohort 3 area: 1/4 age (yrs)	Cohort 4 area: 1/4 age (yrs)	Permanent Reserves * #/ha	age (years)
0	pre	100	60	60	60	--	
**	post	0	60	60	60	7	60
25	pre	25	85	85	85	--	
**	post	25	0	85	85	14	85
50	pre	50	25	110	110	--	--
**	post	50	25	0	110	20	110
75	pre	75	50	25	135		--
**	post	75	50	25	0	20	135
100	pre	100	75	50	25	--	--
	post	0	75	50	25	20	170

* There will be 10–20% total retention in each gap: 10% for smaller gaps (0.1 ha); 20% for larger gaps (0.2 ha). As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

** PCT (pre-commercial thinning) can occur between harvests — commonly at the 15-year mark.

Multi-Aged Silvicultural Systems

Irregular Shelterwood

This silvicultural system is a hybrid between Selections and Regular Shelterwoods (Raymond et al., 2009). In both types of silvicultural systems, shade is used to naturally regenerate stands.

Irregular Shelterwood overstories are kept for a longer time than in Regular Shelterwoods. Since the overstory is kept over a longer period (in some cases over an entire rotation), more than one age class or story is produced, resulting in a multi-aged stand and canopy.

This is like Selection systems, in that mature trees are kept on site throughout the rotation, and periodic harvest occurs. In the case of Selection, at least four age classes are left throughout the stand (Seymour and Hunter, 1999, Ashton and Kelty, 2018), while in Irregular Shelterwood techniques, two or three cohorts are left. The Regular Shelterwood system is considered an even-aged regeneration method, whereas Selection and Irregular Shelterwood systems are intended to keep or create conditions to produce stands with at least two age classes. Unlike selection systems, Irregular Shelterwoods will result in age classes relatively unevenly distributed. The entry intervals are not necessarily uniform across the rotation.

Irregular Shelterwoods typically produce an irregular canopy structure with at least two canopy layers (and age classes). They are often applied in situations where multiple species occur with varied lifespans and are suited for managing at different rotation lengths (Smith, 1962).

Irregular Shelterwoods could have different spatial arrangements, including gaps, or uniform varieties—much like Regular Shelterwoods (Raymond et al., 2009). This treatment is especially effective in cases where some trees are shorter lived than the less frequently found *healthy trees of good form of long-lived species* (Smith, 1962). After treatment, the trees left are typically at least moderately shade-tolerant, of dominant or co-dominant class, and capable of further growth—as opposed to the more frequently found shorter-lived species contained in the stand that are already mature and have limited potential for growth. One example is an SH6 Red spruce/Balsam fir vegetation type, in which the shorter-lived balsam fir component grows along with longer-lived red spruce.

Permanent reserve trees are to be left for biodiversity in all Irregular Shelterwoods. Gap varieties will have distributed retention of 1/10–1/5 of the basal area left within the gaps. One-tenth (1/10) will be left in the smaller gaps (0.1-0.2 ha) and 1/5 in larger gaps (0.2-0.3 ha). Two varieties of Irregular Shelterwoods are prescribed in the SGEM:

(i) High-Retention Irregular Shelterwoods (HIR), prescribed where high basal areas of Long-Lived Intermediate–Tolerant (LIT) species occur

(ii) Medium-Retention Irregular Shelterwoods (MIR), prescribed where moderate basal areas of LIT species occur

Each of these Irregular Shelterwood varieties are subdivided into gap and continuous variants. The objective of these treatments is to provide extra growing time for these LIT trees, to provide shade and seed of these preferred species, and to remove mature, shorter-lived species such as balsam fir. Retention in all cases adds to biodiversity by keeping vertical and horizontal structure where it exists before harvest. It also creates conditions that produce another vertical layer—by opening the canopy and encouraging the growth of smaller trees and regeneration.

One variety of the Continuous Cover Irregular Shelterwood is the Extended version. Two age-classes are created after two entries with an extended period before the next harvest. Figure 7 shows an example of the Extended Continuous Cover Irregular Shelterwood (Raymond et al., 2009) It is applicable when the overstory is at risk at the time of the second entry.

The selection of Gap or Continuous Cover Irregular Shelterwoods depends on the existing horizontal structure (whether patchy or uniform) and the windthrow hazard. Where a stand is patchy or has a high windthrow hazard, Gap Irregular Shelterwoods are recommended. Where horizontal structure is uniform and windthrow hazard lower, Continuous Cover Irregular Shelterwoods are prescribed.

In all Irregular Shelterwoods, over time, gaps of young growing stock will occur in some areas while other areas within the stand will consist of mature trees. These gaps of young trees can be tended to enhance biodiversity and growth. Young trees of late succession species can be favoured to restore them while improving their health and growth rate. When tending these gaps, avoid cutting potential permanent reserve trees.

- High-Retention Irregular Shelterwood

In situations where the basal area of Long-lived Intermediate–Tolerant (LIT) trees is high, Irregular Shelterwoods with retention levels of 2/3 (basal area or stand area) is prescribed. The objective is to maintain or to move a stand towards a multi-aged, multi-species condition for ecological and silvicultural purposes. In these situations, suitable retention will be left where it exists to meet multiple objectives as listed in the "Retention" section of this guide.

The opportunity for leaving LIT trees will be more limited in some areas. This will result in a variable distribution of retention trees over the stand, with higher retention in some areas and lower in others.

- High-Retention Gap Irregular Shelterwood

This system is prescribed when the horizontal stand structure is patchy or where windthrow hazard is higher. For example, some areas may consist of advance regeneration without an overstory, while in other areas younger growing stock could occur without advance regeneration.

As with a Group Selection system, areas suited for regenerating will be selected based on their conditions and will be harvested forming small gaps. These gaps will be distributed throughout the site but not necessarily uniformly or of uniform size.

Retention will amount to 2/3 of the area. One-tenth (1/10) to 1/5 dispersed retention will be left in these harvest patches to augment biodiversity and regeneration through seeding and shading to encourage preferred species. One-tenth (1/10) of the basal area is left in the smaller openings (0.1-0.2 ha) with up to 1/5 left in larger openings (0.2-0.3 ha). A portion of these reserves are designated as permanent (See Table 4).

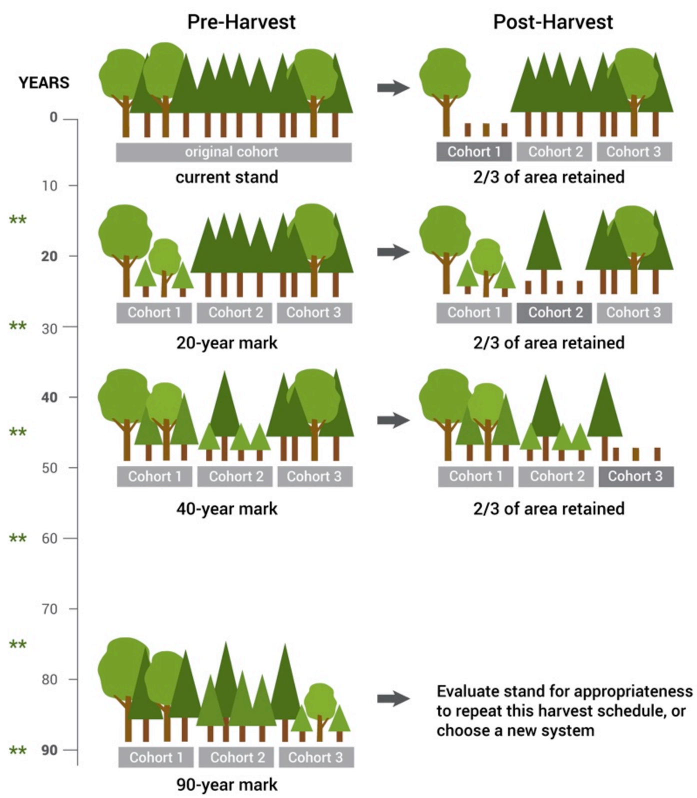
As an example, (Figure 6) a series of three harvests will be undertaken, until the initial stand is harvested except for retention. The time between entries will typically be longer than in traditional shelterwoods and will create two or three age classes. Once the initial harvested areas reach full seed-bearing age, the stand will be considered for another entry. The entry interval is not uniform.

FIGURE 5

High-Retention Gap Irregular Shelterwood System

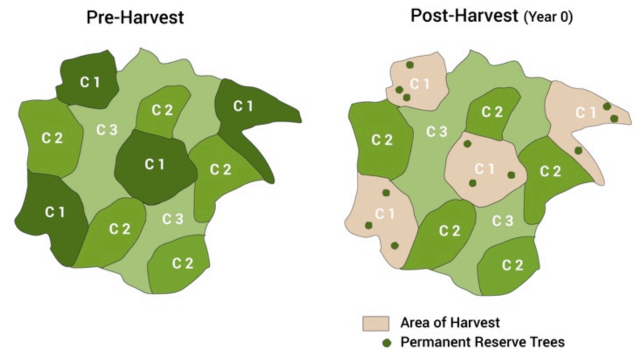
Sample of a timeline for a mature, even-age stand in **Zonal Acadian ecosites**

This timeline results in **three** cohorts after **three** harvests



** PCT (pre-commercial thinning) can occur between harvests — commonly at the 15-year mark

Stand: Pre- and Post-Harvest



Harvest Timeline

The cycle could repeat after three harvests.

Time (years)		Cohort 1 C1 area: 1/3 age (yrs)	Cohort 2 C2 area: 1/3 age (yrs)	Cohort 3 C3 area: 1/3 age (yrs)	Permanent Reserves * #/ha	Permanent Reserves * age (years)
0	pre	60	60	60		
	post	0	60	60	7	60
**						
20	pre	20	80	80		
	post	20	0	80	14	80
**						
40	pre	40	20	100		
	post	40	20	0	20	100
**						
90	pre	90	70	50		
	post	0	70	50	20	150

* There will be 10–20% total retention in each gap: 10% for smaller gaps (0.1 ha); 20% for larger gaps (0.2 ha). As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

** PCT (pre-commercial thinning) can occur between harvests — commonly at the 15-year mark.

- High-Retention Continuous-Cover Irregular Shelterwood

  This approach has similar goals to the Gap version of the Irregular Shelterwood treatment in that three cohorts are to be produced. It is applied in situations where horizontal stand structure is relatively uniform or windthrow hazard is lower.

  Two thirds (2/3) of the initial basal area will be retained to produce conditions for regenerating preferred species. The mature cover is left longer than for Regular Shelterwood treatments.

  Two partial harvests can be made to produce different age classes. Once the stand is fully regenerated and multiple age classes are produced, another entry can be considered if one of the cohorts has reached seed-bearing age. At that time, it may be appropriate to prescribe a different silvicultural system. Figure 7 shows an example of an Extended version of a Continuous-Cover Irregular Shelterwood, suited where the overstory is in decline 30 years after the initial entry (Raymond et al., 2009).

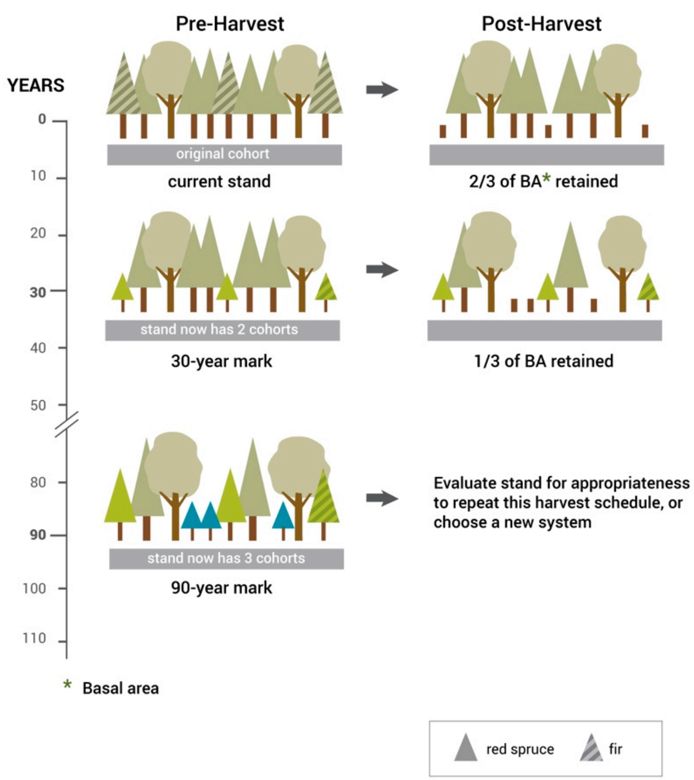
FIGURE 6

High Retention Continuous Cover Irregular Shelterwood System

Sample of a timeline for a even-age stand in Zonal Acadian ecosites

This timeline results in **three** cohorts after **two** harvests

Short-lived species (like fir) are removed to transition to longer-lived species.



Harvest Timeline

Reevaluate the stand at the 90-year mark for appropriate silviculture system.

Time (years)		Cohort 1 age (yrs)	Cohort 1 BA (%)	Cohort 2 age (yrs)	Cohort 2 BA (%)	Cohort 3 age (yrs)	Cohort 3 BA (%)	Permanent Reserves #/ha	Permanent Reserves age (yrs)
0	pre	60	100	--	--	--	--		
	post		67	--	--	--	--	20	60
30	pre	90	90	30	10	--	--		
	post		20		13	--	--	20	90
90	pre	150	10	90	30	60	60	20	150

- Medium-Retention Irregular Shelterwood

In places where the number of Long-Lived Intermediate–Tolerant (LIT) trees is moderate, Irregular Shelterwoods with retention levels of 1/2 the basal area or stand area will be prescribed. The objective is to maintain or move a stand towards a multi-aged, multi-species condition for ecological and silvicultural purposes. In these situations, suitable retention will be left to provide multiple objectives (See Retention section).

The opportunity for leaving these trees will be more limited in areas where lower levels of LIT species occur. This will result in a variable distribution of retention trees over the stand, with higher retention in some areas and lower in others.

- Medium-Retention Gap Irregular Shelterwood

This approach is prescribed when the horizontal stand structure is patchy or when windthrow hazard is relatively high.

As with a Group Selection, areas suited for regenerating will be selected based on their conditions, and openings of appropriate size harvested. Retention should amount to 1/2 of the area in small patches distributed throughout the site, but not necessarily uniformly or of uniform size. One-tenth (1/10) to1/5 dispersed retention will be left in these patches to augment biodiversity and to encourage preferred species regeneration through seeding and shading. One-tenth (1/10) of the basal area will be left in smaller openings, and up to 1/5 in larger openings. This retention will include a minimum density of permanent reserve trees (See Table 4).

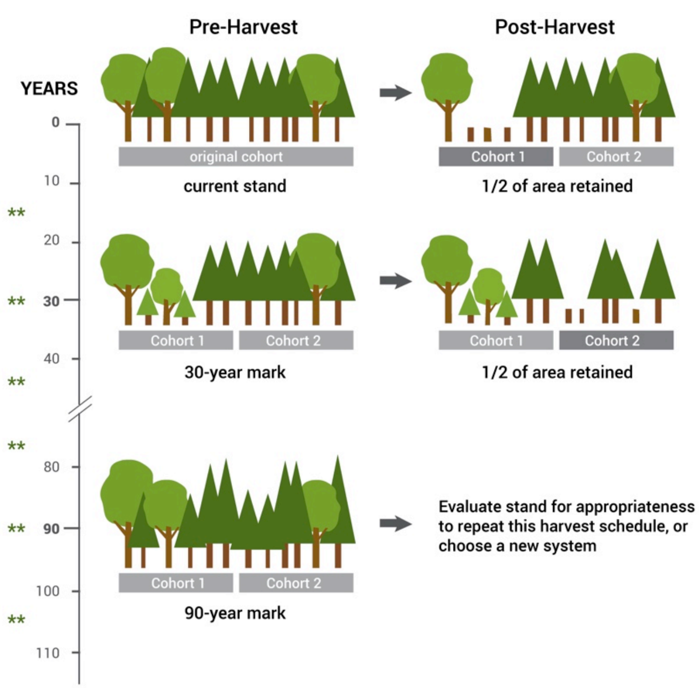
A series of two harvests will be undertaken, until the initial stand is harvested except for retention. The time between entries will be longer than in Regular Shelterwoods and will create or maintain two or three age classes. Once the initial harvested areas reach full seed-bearing age, the stand will be considered for another entry.

FIGURE 7

Medium-Retention Gap Irregular Shelterwood System

Sample of a timeline for a mature, even-age stand in **Edaphic Acadian ecosites**

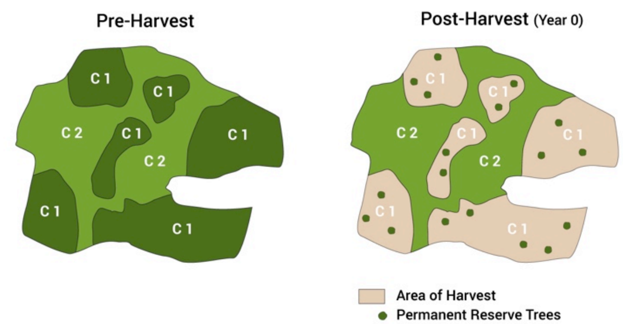
This timeline results in **two** cohorts after **two** harvests



** PCT (pre-commercial thinning) can occur between harvests — commonly at the 15-year mark

Nova Scotia Silviculture Guide for the Ecological Matrix *July 2021*

Stand: Pre- and Post-Harvest



Harvest Timeline

The cycle could repeat after two harvests.

Time (years)		Cohort 1 C1 area: 1/2 **age** (yrs)	Cohort 2 C2 area: 1/2 **age** (yrs)	Permanent Reserves * **#/ha**	Permanent Reserves * **age** (years)
0	pre	60	60		
**	post	0	60	7	60
30	pre	30	90		
**	post	30	0	15	80
90	pre	90	60		
	post	0	60	15	150

* There will be 10–20% total retention in each gap: 10% for smaller gaps (0.1 ha); 20% for larger gaps (0.2 ha). As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

** PCT (pre-commercial thinning) can occur between harvests — commonly at the 15-year mark.

Nova Scotia Silviculture Guide for the Ecological Matrix

- Medium-Retention Continuous-Cover Irregular Shelterwood

  This approach has similar goals to the Gap version of the Irregular Shelterwood treatment, in that two or three cohorts are to be produced. It is applied in situations where horizontal stand structure is relatively uniform or windthrow hazard is lower.

  Half of the initial basal area will be retained to produce conditions for regenerating preferred species. The mature cover is to be left longer than would have been the case for Regular Shelterwoods, and two cuts can be made to produce different age classes. Once the stand is fully regenerated and multiple age classes are produced, another harvest can be carried out if one of the cohorts has reached seed-bearing age. At that time, it may be appropriate to prescribe a different silvicultural system. Permanent reserve trees (as specified in Table 4) will be left.

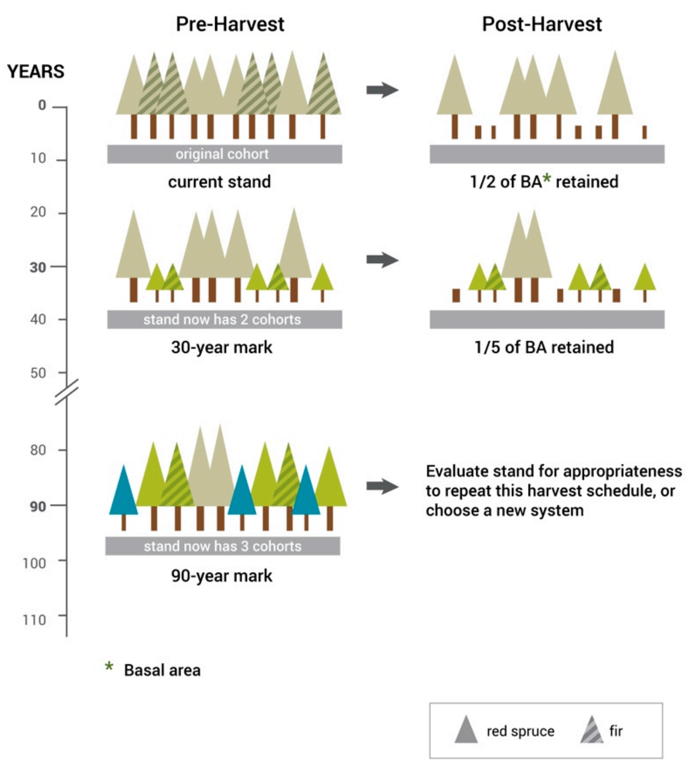
FIGURE 8

Medium Retention Continuous Cover Irregular Shelterwood System

Sample of a timeline for a mature, even-age stand in Edaphic Acadian ecosites

This timeline results in **three** cohorts after **two** harvests

Short-lived species (like fir) are removed to transition to longer-lived species.



Harvest Timeline

Reevaluate the stand at the 90-year mark for appropriate silviculture system.

Time (years)		Cohort 1 age (yrs)	Cohort 1 BA (%)	Cohort 2 age (yrs)	Cohort 2 BA (%)	Cohort 3 age (yrs)	Cohort 3 BA (%)	Permanent Reserves * #/ha	Permanent Reserves * age (yrs)
0	pre	60	100	--	--	--	--		
	post		50	--	--	--	--	15	60
30	pre	90	90	30	10	--	--		
	post		10		10	--	--	15	90
90	pre	150	5	90	30	60	65	15	150

* There will be 10–20% total retention in each gap: 10% for smaller gaps (0.1 ha); 20% for larger gaps (0.2 ha). As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

Two-Aged Silvicultural Systems

Two-aged silvicultural systems are only recommended in this guide for either (i) restoration purposes or (ii) where the ecosite is naturally stand-replacing (such as on some Edaphic Acadian ecosites).

Where restoration is required and there is very low stocking of LIT species, Shelterwoods with Reserves and partial overstory removals are prescribed for several reasons:

(i) to release late successional species that are naturally regenerating

(ii) to provide shade for regenerating LIT species when adequate LIT seed source exists, or

(iii) to allow an enhancement planting with LIT species if needed.

When two-aged systems are practiced, minimum retention levels of 1/5–1/3 will be left as reserves, with a minimum portion of this retention being permanent reserves. One-fifth (1/5) of the basal area is left on Edaphic Acadian ecosites, while 1/3 is left on Zonal Acadian ecosites.

In two-aged regeneration systems, the initial cut either provides shade and seed for regeneration or releases existing established regeneration. After the regeneration is established (5–10 years after the initial cut) or when releasing existing established regeneration, 1/5–1/3 of the basal area is retained, with permanent reserve density as prescribed in Table 4. The interval between initial cut and release is shorter than with Irregular Shelterwoods.

- Shelterwood with Reserves

  This system uses retained trees to produce shade conditions suited for regenerating desired species. It is used when no adequate established and acceptable regeneration exists, and adequate seed-source mature LIT trees are present. It is referred to as the establishment cut part of the system. Once an adequate amount of established regeneration exists, a release cut can be carried out. Reserve trees are left after the release cut.

  Shelterwood with Reserve systems may be applied uniformly over the stand or arranged in strips or gaps. Where high windthrow hazards exist, Gap or Strip Shelterwoods with Reserves are recommended over Uniform Shelterwoods with Reserves.

  At minimum, the Shelterwood with Reserves system will consist of a cut to release adequate stocking of established regeneration, with reserves of 1/5 to 1/3 of the basal area.

In some cases, adequate regeneration is not present, but adequate seed source of LIT species exists. In these cases, a two- or more cut Shelterwood with Reserves will be utilized. The first establishment cut will retain 1/2–2/3 of the overstory (keeping LIT trees to provide adequate seed and shade for seedling establishment. Once this regeneration is established (i.e., seedlings exceeding 0.3 m tall and rooted in mineral soils), 5–10 years following the establishment cut, this regeneration will be released while leaving 1/5–1/3 of the basal area for biodiversity reserves. Some of this retention will consist of permanent reserve trees according to specifications found in Table 4.

More than one establishment cut may be required to create conditions suited for establishing enough stock or to protect the quality of regeneration. For example, if regeneration of high-quality white pine is desired where white pine weevil infestations are common, shade trees will be required until regeneration reaches 10 m tall to prevent weevil damage. Scarification to help regenerate species such as yellow birch and pine may be required. In other cases, when adequate regeneration is not established after 10 years, a second establishment cut is required.

- Partial Overstory Removal and Plant

  In some cases, existing regeneration and adequate seed source of LIT seed trees is not present. In these cases, a Partial Overstory Removal and Plant is prescribed with 1/5–1/3 basal area retention, followed by enhancement planting to provide adequate stocking of LIT species natural to the ecosite. This is considered one of two restoration systems that are used along with the Shelterwood with Reserves.

- Uniform Shelterwood with Reserves

This system involves uniformly thinning the overstory to produce light conditions suited for regeneration of desired species (i.e., establishment cut). The regeneration is subsequently released when previously regenerated trees become established with sufficient stocking, while leaving reserves of 1/5—1/3 of the basal area (release cut or partial overstory with reserves), and when conversion to multi-age irregular shelterwood is not possible.

One-fifth (1/5) of the basal area is left for Edaphic Acadian ecosites, while 1/3 is left for Zonal Acadian ecosites. These reserves must consist of a minimum density of permanent reserve trees (See Table 4).

Two thirds (2/3) of the basal area is to be retained in the area between extraction trails during establishment cuts when regenerating long-lived shade-tolerant species (sugar maple, red spruce, or eastern hemlock). If regenerating long-lived intermediate shade-tolerant species, such as yellow birch, white ash, red oak, or white pine, 1/2 of the basal area should be retained from the area between extraction trails.

This treatment can be used to increase the proportion of long-lived or shade-tolerant species and move the stand towards later successional vegetation types. The stand should be assessed 10 years after the establishment cut. If enough established regeneration exists, a partial overstory removal cut with retention is carried out at 15 years. In the partial overstory removal cut, 1/5–1/3 of the basal area is to be left as reserves with a given density as permanent reserves (See Table 4). These reserve trees are mainly left for biodiversity. If adequate regeneration has not been realized after 10 years, return to keys and formulate a new prescription.

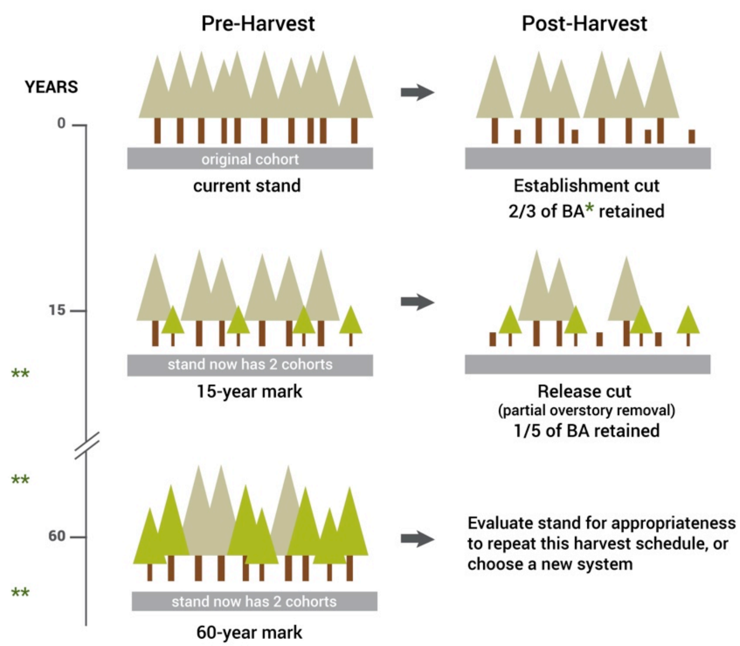
In some cases, sufficient stocking of established regeneration exists initially. In these cases, an establishment cut is not prescribed, and a release cut is made (partial overstory removal).

FIGURE 9

Uniform Shelterwood with Reserves System

Sample of a timeline for an even-age stand in **Edaphic Acadian ecosites**

This timeline results in **two** cohorts after **two** harvests



* Basal area

** PCT (pre-commercial thinning) can occur after partial overstory removal

Harvest Timeline

Reevaluate the stand at the 60-year mark for appropriate silviculture system.

Time (years)		Cohort 1 age (yrs)	Cohort 1 BA (%)	Cohort 2 age (yrs)	Cohort 2 BA (%)	Permanent Reserves * #/ha	Permanent Reserves * age (yrs)
0	pre	60	100	--	--		
	post		67	--	--	15	60
15	pre	75	99	15	1		
	post		20		1	15	75
60	pre	120	10	60	90 *	15	120
	post						

* Large increases in BA % due to rapid growth of Cohort 2

- Gap Shelterwood with Reserves

In some cases, Uniform Shelterwood techniques are not possible because of the shallow rooting nature of the species (e.g., black spruce) or because of rugged ground conditions or windthrow risk. Such cases may be more suited to regenerating stands by using small gaps to increase wind firmness or allow access.

For species such as black spruce growing on poor Edaphic sites larger openings (0.3 ha) are prescribed to create structures naturally produced. If intermediate shade-tolerant and deep-rooted species such as white pine are being regenerated, larger openings could be used (0.2–0.3 hectares).

The Gap Shelterwood with Reserves system is distinguished from a Group Selection or Gap Irregular Shelterwood system in that the gaps are uniformly distributed throughout the site, and the overstory is removed over a relatively shorter period. Typically, 15 years (or when the previous gaps are regenerated) separates each series of patches, with the overstory being removed within 20% of the rotation age, forming a two-aged stand.

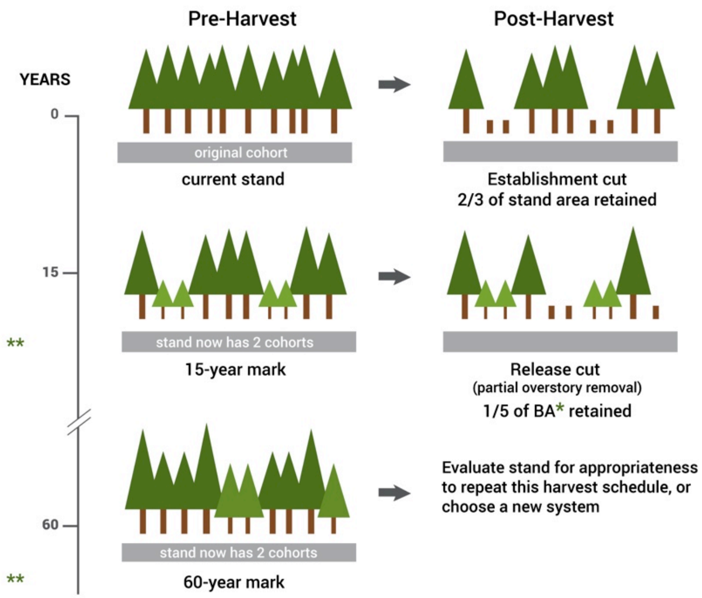
In Group Selections and Irregular Shelterwoods, the gaps are selected based on initial conditions and distributed throughout the area where possible. Re-entry times are delayed so that separate age classes are formed with ages separated by over 1/5 of the rotation age resulting in an uneven-aged stand. One-tenth (1/10) to 1/5 of the basal area is to be left as reserve trees in the harvested gaps with a given density of permanent reserves. One-tenth (1/10) of the basal area is retained for smaller openings (0.1-0.2 ha) and up 1/5 for larger openings (0.2-0.3 ha)

FIGURE 10

Gap Shelterwood with Reserves System

Sample of a timeline for a mature, even-age stand in **Edaphic Acadian ecosites**

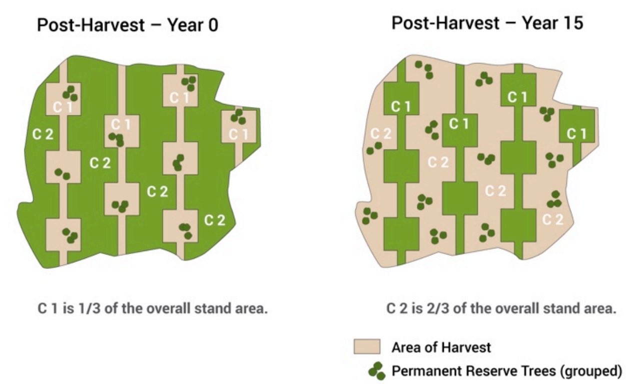
This timeline results in **two** cohorts after **two** harvests



* Basal area

** PCT (pre-commercial thinning) can occur in gaps after partial overstory removal

Stand: Post-Harvest



Harvest Timeline

The cycle could repeat after two harvests.

Time (years)		Cohort 1 C1 area: 1/3 age (yrs)	Cohort 2 C2 area: 2/3 age (yrs)	Permanent Reserves * #/ha	age (yrs)
0	pre	60	60		
	post	0	60	5	60
15	pre	15	75		
**	post	15	0	15	75
60	pre	60	45		
	post	0	45	15	120

* There will be 10–20% total retention in each gap: 10% for smaller gaps (0.1 ha); 20% for larger gaps (0.2 ha). As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

** PCT (pre-commercial thinning) can occur in gaps after partial overstory removal

- Strip Shelterwood with Reserves

  While a Gap Shelterwood system is preferred over a Strip Shelterwood system for biodiversity reasons, Strip Shelterwood systems will be considered with special permission as a user-defined prescription.

  This may be the case when Gap Shelterwood techniques are not possible because of the shallow rooting nature of the species (e.g., black spruce) or because of rugged ground conditions or windthrow hazard. Such cases may be more suited to regenerating stands by using narrow strips to increase wind firmness or allow access.

  For species such as black spruce, strips up to one tree height in width are recommended. If intermediate shade-tolerant and deep-rooted species (such as white pine) are being regenerated, strips up to two tree heights in width are recommended.

  The Strip Shelterwood with reserves system results in a two-aged stand, as the stand is harvested in a series of strips over relatively short periods of time—typically every 15 years or when the previous harvested strip is regenerated. Two to three passes are usually used in this system to harvest the mature forest. This system can be used in conjunction with a thinning on the side of the strips to ensure regeneration of the entire area, and to minimize damage to regeneration previously established.

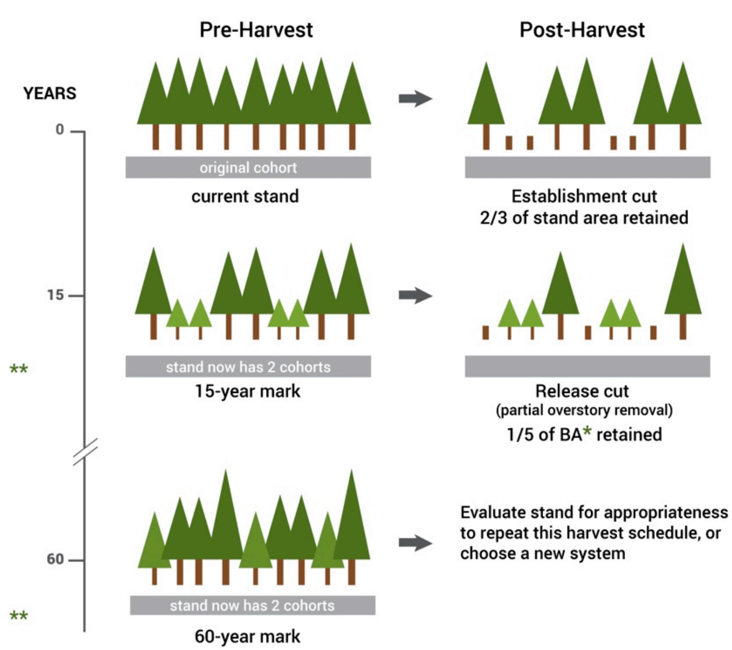
  One-tenth (1/10) of the basal area is to be left as reserve trees in the harvested strips, with a certain portion designated as permanent reserves (See Table 4). After regeneration is established, a release cut (Partial Overstory Removal) is carried out—with 1/3 left in Zonal Acadian ecosites and 1/5 left in Edaphic Acadian ecosites as reserves. Permanent reserves must make up a given density of this retention (See Table 4).

FIGURE 11

Strip Shelterwood with Reserves System

Sample of a timeline for a mature, even-age stand in **Edaphic Acadian ecosites**

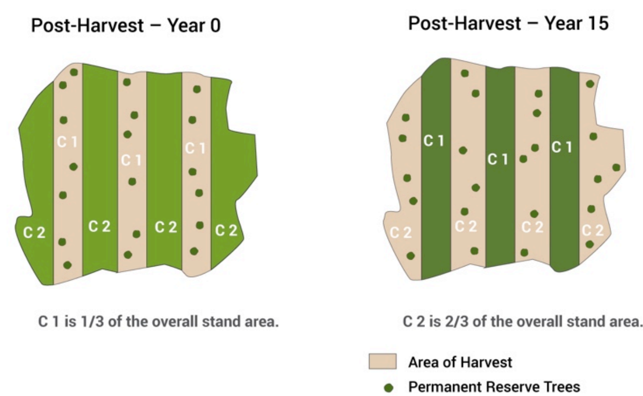
This timeline results in **two** cohorts after **two** harvests



* Basal area

** PCT (pre-commercial thinning) can occur in cut strips after partial overstory removal

Stand: Post-Harvest



Harvest Timeline

The cycle could repeat after two harvests.

Time (years)		Cohort 1 C1 area: 1/3 age (yrs)	Cohort 2 C2 area: 2/3 age (yrs)	Permanent Reserves * #/ha	Permanent Reserves * age (yrs)
0	pre	60	60		
	post	0	60	5	60
15 **	pre	15	75		
	post	15	0	15	75
60	pre	60	45		
	post	0	45	15	120

* There will be 10–20% total retention in each gap: 10% for smaller gaps (0.1 ha); 20% for larger gaps (0.2 ha). As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

** PCT (pre-commercial thinning) can occur in cut strips after partial overstory removal

- Partial Overstory Removal
  (Release cut of Shelterwood with Reserves System)

  In some limited cases, on Edaphic Acadian ecosites where adequate established LIT regeneration is present, the majority of the overstory is removed. In these cases, retention will amount to 1/5 of the basal area.

- Partial Overstory Removal and Underplant

  In some limited cases, for Zonal Acadian ecosites, where LIT seed source trees are inadequate, and established LIT regeneration is not present, the majority of the overstory is removed. In these cases. retention will amount to 1/3 of the basal area. Naturally occurring LIT species will be underplanted (See Table 7) under the reserve trees.

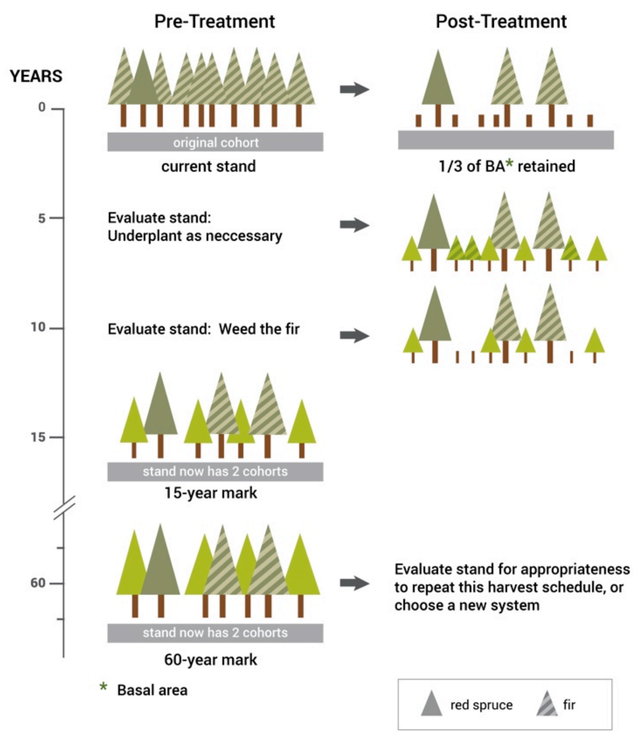
FIGURE 12

Partial Overstory Removal and Plant System

Sample of a timeline for a mature, even-age stand in **Zonal Acadian ecosites**

This timeline results in **two** cohorts

Short-lived species (like fir) are removed to transition to longer-lived species.



* Basal area

Harvest Timeline

Reevaluate the stand at the 60-year mark for appropriate silviculture system.

Time (years)		Cohort 1 age (yrs)	Cohort 1 BA (%)	Cohort 2 age (yrs)	Cohort 2 BA (%)	Permanent Reserves ** #/ha	Permanent Reserves ** age (yrs)
0	pre	60	100	--	--		
	post		33	--	--	20	60
*** 15	pre	75	33	10	1 *		
	post		33		1	20	75
60	pre	120	5	55	95	20	120

* Includes planted and natural trees

** As part of the retention, 20 of the largest trees per hectare will be permanent reserves; the remaining are available for harvest when the next cohort is harvested.

*** At age 5, underplant if necessary.
At age 10, weed planted trees if necessary.

- Salvage with Retention

  Salvaging is no longer an option within the SGEM, however it may still be necessary as a result of severe natural disturbance. IRM special approval is required on a case-by-case basis prior to initiating salvage work.

  In special cases, where a high proportion (> 50%) of the trees in a stand are clearly damaged, dead, or dying because of natural disturbances such as wind, insect infestation, disease, or fire, the stand may be considered for salvage.

  In all cases, special permission must be obtained by the forest manager (NSL&F Crown land staff) before a salvage operation is undertaken. Integrated Pest Management staff will be consulted as required. (See: https://novascotia.ca/nse/pests/ipm.asp)

  Sometimes a complete removal is required to prevent the spread of diseases or insects, but only once NSL&F Integrated Pest Management staff has been consulted. (See: novascotia.ca/natr/forestprotection/)

  Leaving live and dead retention trees will benefit the future growth and/or biodiversity of the stand. Wherever possible, windfirm LIT species and trees should be kept, helping in the regeneration of the stand, as well as protecting the advance regeneration and growing stock of saplings. In addition to leaving standing trees, especially in the case of severe wind damage, some of the larger downed trees will be left as coarse woody material to support biodiversity.

Tending

The process of restoring late succession LIT species and increasing the opportunity for moving these stands toward uneven-aged conditions can be augmented by tending treatments, such as Pre-Commercial Thinning, Commercial Thinning, Crop Tree Release, Planting and Weeding,

Some silvicultural treatments are classified as "tending," as they are intended to help younger trees increase growth and improve stand composition or tree quality and health. These treatments can be used both in even-aged and uneven-aged silvicultural systems.

Tending treatments are not meant to regenerate stands but are used in conjunction with various silvicultural systems, as appropriate. These treatments include:

(i) Commercial Thinning—a treatment that harvests merchantable timber but at the same time increases the growth and quality of the remaining trees. Although not part of the objectives for Commercial Thinning, sometimes natural regeneration is produced, especially if carried out in a stand that is past seed-bearing age. The proportion of late succession LIT species can be increased through this treatment.

(ii) Pre-Commercial Thinning—a thinning of smaller unmerchantable trees to increase growth and quality of the remaining trees and to restore late succession LIT species composition.

(iii) Crop-Tree Release—a treatment that releases a few potentially high-value trees to increase growth where relatively small numbers of these types of trees exist within a stand. This treatment can also be used to restore late-succession LIT species.

(iv) Weeding—when young, preferred long-lived trees of late successional species are overtopped, a weeding is sometimes necessary to maintain these preferred species

(v) Pruning—cutting off limbs on the lower bole of potentially high-value trees to improve the tree's value for sawlog products.

■ Crop-Tree Release

A crop-tree release is mainly a tending operation in which a few quality trees with potential for high-value are released, while the rest of the stand is left untouched. The value could be either restoring late succession species or high economic value, or both.

It is especially effective wherever a few trees of potentially high-value exist in a stand dominated by stems without high-value potential. This treatment concentrates on releasing stems that have the best potential in terms of future market value, and/or those of late succession species if there is a shortage of LIT seed-source trees.

For example, a sugar maple tree that is too small to meet minimum specifications for a high-value sawlog, but has a clear bole of sawlog length without defects and has good vigour and crown structure, will give high return by investing in its release.

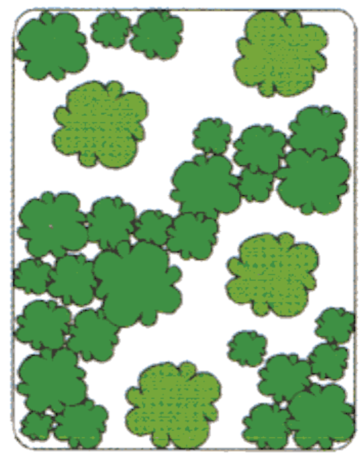


Figure 13. Crop-Tree Release (CTR) from Perkey et al. 1993.

It is important to release only the best quality trees—those that are vigorous, and of good form and potential—and to keep adequate spacing between them (minimum 10 m). Since the objective is to produce large trees of high value, they need space to grow. If too many trees are released, some will have to be cut later to release other higher value trees to make growing room, wasting the initial investment.

The crop trees should be released on at least three sides to maximize diameter growth. (To avoid exposure damage, trees on the south facing side of the crop tree can be left.) The release should cut only trees that are overtopping the crop tree or that have crowns touching the crowns of crop trees. If a tree is below the canopy or its crown does not touch the crop tree, it should be left standing.

In some cases, two high-value trees are growing next to each other. The combined crowns of these trees can be considered as one crown and released on all sides. This will result in a three-sided release.

Timing will impact the efficacy of this tending treatment. Ideally, trees in the 15–20 cm Dbh class should be released. If trees are released at an earlier stage, branch growth will be encouraged, lowering their quality and potential value. Releasing trees too late in their development results in lower response rates.

Crop trees should be self-pruned for at least the length of one sawlog, or manually pruned. Avoid pruning in the same year as the release treatment to prevent epicormic branching (shoots emerging from previously dormant buds).

Some lower-quality merchantable-sized trees of relatively low value may have to be cut to release the crop trees. These trees should only be removed if this can be done without damaging the crop trees as the main objective of this treatment is to release the trees with the highest potential. Caution should also be taken in these operations to avoid cutting trees with biodiversity value, such as trees with nests, snags, etc.

This treatment will result in areas with small holes in the canopy formed by releasing crop trees, interspersed with unthinned areas augmenting horizontal structure.

- Pre-commercial Thinning (PCT)

A pre-commercial thinning is a treatment in which healthy, vigorous trees of good form (straight boles without defect) of preferred species are spaced by cutting less desirable stems (those showing poor health or form) to accelerate diameter growth and improve stand composition. This treatment is performed when the stand is not yet of merchantable size. It can be used to restore late successional LIT species to prepare the stand for future uneven-aged regeneration systems, such as in Selection and Irregular Shelterwoods by retaining LIT species during treatment.

Cut stems are left on site to leave nutrients for the residual trees. If carried out effectively, the stands treated with PCT can reach merchantable size earlier, thereby increasing the Mean Annual Increment of merchantable volume (GNY model: http://novascotia.ca/natr/forestry/programs/timberman/growthyield.asp). Stand succession can also be influenced by favouring tolerant species and moving stands towards later successional vegetation types (Neily et al., 2013).

This treatment is prescribed where high levels of AGS (Acceptable Growing Stock) exist, uniformly distributed throughout the stand (on average at least every 3 m). Small areas within the stand can be left untreated to augment horizontal and vertical structure. The spacing of the trees left as future crop trees should be at least 1.8 m, but not more than 2.4 m. Selection of the appropriate spacing and timing of the PCT treatment depends on the species and the anticipated future management plan for the stand.

If trees in softwood stands are spaced less than 1.8 m apart, natural mortality due to crowding will occur before the stems become merchantable size. If softwoods are spaced wider than 2.4 m, excessive branching could occur, degrading wood quality. When Commercial Thinning (CT) is anticipated as a follow-up treatment, a PCT of 2.4 m spacing is recommended (refer to the *Forestry Field Handbook*, NSDNR, 1993).

In terms of PCT timing, to maximize the growth returns from softwoods, early PCTs are most effective. In general, softwood PCTs should be performed when the crop trees are between 2 and 6 m tall. If done earlier, crop tree selection is difficult, but when done too late, growth response and thinning productivity are lower.

Care must be taken to favour preferred species, even when they are shorter than less preferred, competing species. This is especially true in fir/spruce stands, as the fir is often dominant over spruce, but the spruce has better long-term growth, value and ecological potential.

Care must also be taken when releasing quality softwood from low-quality vigorous red maple sprouts. In this case, the thinning may be more effective when carried out later (at 6 m height), as the red maple clumps will re-sprout and overtake crop trees unless controlled. It is also prudent to leave a couple of weak stems in the red maple clumps to reduce re-sprouting.

Finally, care should be taken to maintain tree species diversity when carrying out this treatment. See the FEC (Neily et al., 2013) for guidance on natural species diversity. A representation of all species should be kept, especially those that are uncommon. Vertical and horizontal structural diversity can be augmented by leaving small unthinned areas within the PCT.

For hardwoods, spacing should be 2.4 m, as released trees require that space to reach an average diameter (at breast height) of 15 cm before they become overcrowded and self-thinning occurs. The 2.4 m spacing is especially important when the goal is to produce hardwood sawlogs as a future product. Wider spacing produces increased branching and more defects.

Pre-commercial thinning of hardwoods should occur later than for softwoods, as branching of hardwoods has a larger potential impact on future value. Hardwoods should be thinned when between 6 and 9 m tall (Nicholson et al., 2010).

The timing of PCT treatments in Mixedwood stands is more complex because the optimum times for PCT differ for hardwoods and softwoods. If there is potential for growing high-quality hardwoods in a mixedwood stand, the stand should not be thinned early, as branching would be encouraged and reduce the value of the hardwoods for sawlogs. Two options are available:

(i) Thin the softwood early, while leaving areas around high-quality hardwoods unthinned. The high-quality hardwood can be released later (with a Crop-Tree Release) when the trees are at least 9 m tall. This will also augment horizontal diversity.

(ii) Wait until all trees are at least 6 m tall, and thin both softwoods and hardwoods.

- Commercial Thinning (CT) –

  The goal of this treatment is to harvest commercial trees while improving the growth, quality, and species content of the residual trees. This treatment is used to increase the proportion of LIT species in a stand to restore late successional species content. This treatment will enhance the windfirmness of the stand over the long term and increase the probability of success for moving a stand towards an uneven-aged, late successional type.

  CT is recommended where high levels of uniformly distributed AGS (Acceptable Growing Stock) and adequate merchantable basal area exist.

  The objective of this treatment is to harvest lower-quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. Caution is advised to avoid harvesting trees of high biodiversity value, such as trees with nests, or large-diameter trees with cavities.

  The objective of this treatment is **not** to regenerate the stand but to improve the growth and species mix of residual trees. It can result in higher yields and higher value of quality products, with an increased piece size and harvesting efficiency. It also can be used as a tool to influence stand succession to favour high-quality, later successional species and later successional vegetation types.

  The residual trees should be left until the stand grows back the volume that was removed and becomes fully stocked. On average softwood sites, this will take on average 15–20 years when retaining 60–70% of the basal area from the area between extraction trails (NSDNR, 1993).

  Care should be taken to release trees throughout the stand. Limited release is achieved from extraction trails. Most trees in the area between extraction trails should be released to maximize the benefit of the treatment. Some limited areas should be left untreated purposely to augment vertical and horizontal structure.

  Care must be taken to limit stem, root, and crown damage when harvesting and extracting trees. It is also important to minimize trail width and maximize leave-strip width, within the limits of the harvesting and extraction equipment used. Root and soil damage can be minimized by using brush mats on extraction trails. At least 30% of the basal area must be taken from the area between extraction trails to achieve enough release of future crop trees. Although not the main objective of Commercial Thinning, sometime natural regeneration is produced especially, when carried out in older stands.

The best opportunities for CT occur on more productive ecosites with average to high Land Capabilities (LC 4+ softwoods, LC 2+ hardwoods; NSDNR, 1993). Response times will be quicker and the time for volume replacement through growth reduced. Stand age also affects commercial thinning response, especially in shorter-lived species. For example, it is not recommended to commercially thin balsam fir when it is over 40 years old.

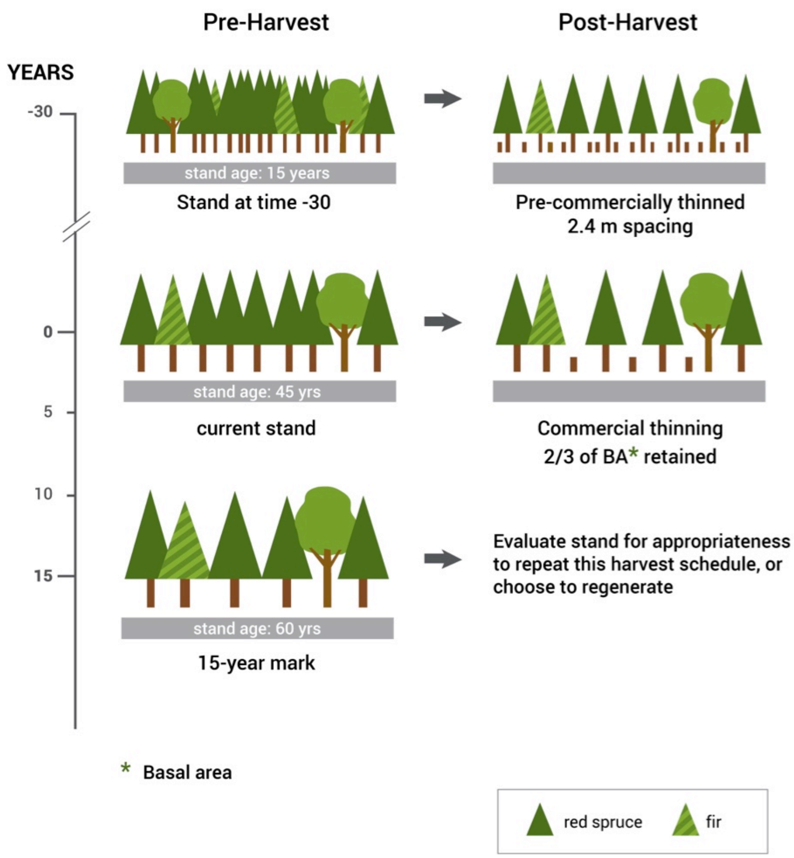
When performing CT in stands that were previously Pre-Commercially Thinned or Planted, special care is required in timing. CT performed too early will result in increased costs, higher amounts of low-value products, and lower volumes. A late CT will result in slow growth and low live-crown ratios that will negatively impact the response of a stand. To obtain estimates of optimum timing for CTs and predicted response times and growth results, refer to the *Forestry Field Handbook* (NSDNR, 1993; https://novascotia.ca/natr/forestry/handbook/).

FIGURE 14

Commercial Thinning, in a previously pre-commercially thinned stand

Sample of a timeline for an even-age stand in **Zonal Acadian ecosites**

Short-lived species (like fir) are removed to transition to longer-lived species.



Nova Scotia Silviculture Guide for the Ecological Matrix *July 2021*

- Pruning

  Pruning is best applied to those species that have a high economic return (e.g. production of knot-free lumber and veneer). The pruning of sugar maple, yellow birch, red oak, red spruce and white pine is a viable silvicultural option in areas where high-value species can be grown.

  Only healthy trees with high-value potential should be pruned— and no more than one tree every 10 m. Release of these trees should also be considered to accelerate their growth to reach merchantable sizes. Released trees should have the highest value potential and be 15 cm in Dbh or more. Note: Trees should not be pruned and released in the same year.

Restoration Planting

Natural regeneration from seed is the preferred option for regenerating forests in the ecological matrix, but in some cases inadequate seed source is present and enhancement planting is required to restore LIT species to their naturally occurring sites.

Restoration planting can be used to restore sites to late successional LIT species where evidence of natural regeneration of these species is not present or has not been successfully produced with Shelterwood or Selection systems. Restoration planting does not necessarily require planting an entire site but would take advantage of existing regeneration and involve fill-planting where required.

Planting before two growing seasons following harvest is not recommended for most sites. This two-year delay provides two benefits:

(i) allowing time for possible adequate natural regeneration;

(ii) reducing the hazard of debarking weevil (*Hylobius congener*).

When severe competition is anticipated in areas where debarking weevil damage is expected to be low and competition control with herbicides is not an option, planting in the same year as the harvest or underplanting may be the best choice.

Planting in mineral soil micro-sites can reduce debarking weevil damage, although increased risk of frost heaving occurs when planting in heavy soils (NSDNR, 1992). Site preparation to produce these micro-sites may be necessary in situations where debarking weevil damage is expected. Exposed mineral soil has been shown to reduce the movement of *Hylobius sp.* and ultimately allow for early reforestation and greater establishment success.

Competition from non-crop species is often a concern with this treatment. For example, some sites have moderate to high levels of competition due to herbs (e.g., hayscented fern) and ericaceous species (e.g., rhododendons, huckleberry and blueberries), which can impede regeneration. Site preparation can increase planting opportunity and success.

Some sites have thick forest floors that dry out after an overstory removal, causing seedling mortality if their roots don't extend into the mineral soil. Site preparation equipment can be used to reduce the thickness of the forest floor, creating plantable microsites. Prescribed burning could also be used as a site preparation tool in cases where the ecosite is naturally adapted to fire—especially where fire control has created an unnatural accumulation of ericaceous vegetation that prevents natural regeneration. (e.g. some Spruce-Pine vegetation types) (Neily et al., 2013)

It is imperative to maintain the planted trees, once established, to ensure adequate survival and growth. Note that dry sites may take extra care to establish seedlings. On some sites, weeding is required to prevent competition (such as from raspberries), or when coppice growth overtops planted seedlings. A spacing may also be required when ingrowth of early succession, short-lived species (such as balsam fir, crowd planted seedlings) limits the growth of planted trees. Care should be taken to preserve species diversity by maintaining a representation of all naturally occurring species.

In all cases, naturally occurring regeneration of LIT typical to the ecosite should be protected and maintained. In many cases, restoration planting would be fill planting to encourage the stand's species content toward its naturally occurring late-successional stage.

Some areas will be left unplanted to augment horizontal and vertical structural diversity (Franklin et al., 2007)

This guide provides a listing of naturally occurring species recommended for planting in each ecosite (See Table 7). Some species, such as white pine, red pine, eastern hemlock and hardwoods should be planted in Nova Scotia with caution. White pine is frequently infested with white pine weevil when regenerated in the open, resulting in multiple tops and crooked stems with low potential for sawlogs. Risk of weevil damage can be reduced by underplanting in shade to reduce damage due to infestations.

Sirococcus shoot blight is common in Nova Scotia and frequently kills red pine plantations. Red pine of native seed source should be planted only on sites where it naturally occurs.

Part of the maintenance for survival and growth of planted seedlings is protecting them from competition.

Special care must be taken when planting hardwoods and eastern hemlock in Nova Scotia. Browsing frequently occurs, necessitating seedling shelters or other means of protection to successfully establish plantations of these species.

No planting recommendations are made for wet ecosites as they will not be harvested under this guide.

Table 7. Species Planting Recommendations by Ecosite (Neily, et al. 2013)
Refer to Forestry Field Handbook (NSDNR, 1993) for hazard identifications and recommendations.

Ecosite	Moisture	Nutrient Regime	Climax Species*	Recommended Species*
AC1	Dry	Very Poor	bS, jP, rP, wP	bS, jP, rP, wP
AC2	Fresh	Very Poor	bS, jP, rP, wP	bS, jP, rP, wP
AC3	Moist	Very Poor	bS, jP, rP, wP	bS, jP, rP, wP
AC4	Wet	Very Poor	bS	No Harvesting in this Ecosite
AC5	Dry	Poor	bS, rO, jP, rP, wP	bS, jP, rP, wP, rO
AC6	Fresh	Poor	bS, rO, rP, wP	bS, jP , rP, wP, rO
AC7	Moist	Poor	bS, rO, rP, wP	bS, eL, jP, rP, wP, rO
AC8	Wet	Poor	bF, eH, rM, rS,	No Harvesting in this Ecosite
AC9	Dry	Medium	eH, rM, rS	eH, rS
AC10	Fresh	Medium	eH, rS, wS	eH, rS, wS
AC11	Moist	Medium	eH, rS, wS, yB	eH, rS, wS, yB
AC12	Wet	Medium	eH, rM, rS, wA	No Harvesting in this Ecosite
AC13	Fresh	Rich	aB, sM, yB	rS, wS, sM
AC14	Moist	Rich	sM, wA, yB	rS, wS, sM
AC15	Wet	Rich	wA, rM	No Harvesting in this Ecosite
AC16	Fresh	Very Rich	sM, wA	wS, sM, wA
AC17	Moist	Very Rich	sM, wA	wS, sM, wA
MB1	Dry	Poor	bS, jP	bS, wS, jP
MB2	Fresh	Poor	bS	bS
MB3	Moist	Poor	bS	bS
MB4	Wet	Poor	bS	No harvesting in this Ecosite
MB5	Fresh	Medium	bF, wS	wS
MB6	Moist	Medium	bF, wS	wS
MB7	Wet	Medium	rM	No Harvesting in this Ecosite
MB8	Fresh	Rich	rM, wB (coastal) wB, yB, bF (highlands)	wS wS, yB
MB9	Moist	Rich	rM, wB (coastal) bF, wB, yB (highlands)	wS wS, yB
MB10	Wet	Rich	rM	No Harvesting in this Ecosite
MB11	Fresh-Moist	Very Rich	rM, wB (coastal) bF, yB (highlands)	wS wS, yB

* aB = American Beech, bF = Balsam Fir, bS = Black Spruce, eH = Eastern Hemlock, eL = Eastern Larch, jP = Jack Pine, rM = red Maple, rO = Red Oak, rP = Red Pine, rS = Red Spruce, sM = Sugar Maple, wA = White Ash, wB = White Birch, wP = White Pine, wS = White Spruce, yB = Yellow Birch

Cautions for rP, wP, eH, and Hardwood planting; White Pine is at high risk to white pine weevil infestation when planted in the open. Weevil damage can be reduced by underplanting in shade or interplanting with faster growing species. Red Pine is at risk to Sirococcus. Where Sirococcus is known to occur, do not plant red pine. Plant stock only from local seed sources. Hardwoods and Eastern Hemlock need to be protected from browsing by using tree shelters.

Dry ecosites AC1, AC5, AC9 and MB1 are dry and planting stock may have difficulty establishing.

Wet ecosites AC4, AC8, AC12, AC15, MB4, MB7 and MB10 will not be harvested.

Using the Silvicultural Guide for the Ecological Matrix (SGEM)

Planning System for Implementing SGEM

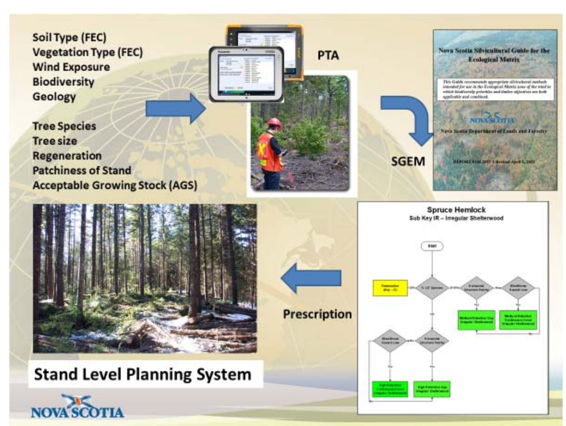
The planning system for ecological forestry at the stand level requires three basic technical tools:

- PTA system—includes data collection protocols that enable consistent collection of ecosystem, biodiversity, site, and stand-level information (required to prescribe treatments using the SGEM); and a computer program to collect, edit and compile field data to produce standard reports and harvest-plan summaries. Details of the information collected in the PTA system is detailed in Appendix I.
- SGEM—prescribes appropriate ecosystems-based silvicultural methods based on the data collected in the PTA system.
- Nova Scotia's *Forest Ecosystem Classification* (FEC) manual—defines standard vegetation types, soils, ecosites and successional links that form the framework for Nova Scotia's ecosystem-based management (EBM)

The application of these tools to inform stand-level operations under an EBM framework is illustrated in **Figure 1**. PTA and SGEM tools are described in this guide; the FEC is available on-line novascotia.ca/natr/forestry/veg-types/

This planning system has the following benefits:

- Promotes consistency across the province (e.g., common ecosystem classification and silvicultural method terminology and practices)
- Bases prescriptions on best available knowledge
- Provides transparency in the treatment prescriptions and their foundation
- Ensures that ecosystem and biodiversity characteristics are prioritized and addressed in silvicultural prescriptions
- Allows mitigation of risk, such as compaction of sensitive soils
- Establishes pre-treatment stand conditions to allow effective post-implementation evaluation of the treatments
- Allows matching prescriptions to stand and ecosystem conditions



Pre-Treatment Assessment

Proper use of this silvicultural guide requires the user to collect information on each stand to determine appropriate ecosystem-based treatments. The information is then applied to a series of decision keys found in the guide.

Each of the 14 forest groups described in Nova Scotia's *Forest Ecosystem Classification* (FEC, Neily et al., 2013) has its own set of decision keys, except where harvesting is not recommended (See "Sensitive Forest Groups" section that follows). The FEC can be accessed online at: https://novascotia.ca/natr/woodlot/pdf/Ecosystem-Classification.pdf;

The information required for moving through the decision keys is collected by using a standard ground-based data collection protocol, called the Pre-Treatment Assessment (PTA). This protocol is mandated for use on Crown land by the Nova Scotia *Code of Forest Practice* (NSDNR, 2012) and encouraged for use on private land.

A software application, called the *Pre-Treatment Assessment,* was developed for compiling the required data into a standard format for use with the decision keys. Once the field data is inputted, the application moves through the logical sequence of the decision keys and provides a recommended treatment according to the SGEM.

Notes:
The current PTA application is found online at
https://novascotia.ca/natr/forestry/programs/timberman/pta.asp.

The application is in the process of being updated to work with the keys in this revised guide and being updated to a spatial application as part of its revision.

Requirements for SGEM

The PTA requires the user to collect data concerning several key attributes about each forest stand at a series of distributed sample points. This data is used to determine an appropriate prescription in the SGEM by guiding the user through SGEM decision keys.

The process of collecting data in the field also provides an opportunity for gathering information on sensitive features for example in soil mitigation plans and identification of special features such as raptor nests outside the sample points (Neily and Parsons, 2017).

The following attributes need to be collected at a series of points distributed throughout the stand:

1. Tree characteristics, including those concerning biodiversity and mensuration values
2. Stand structure (vertical and horizontal)
3. Soil type
(See FEC, https://novascotia.ca/natr/forestry/veg-types/; OR, Forest Soil Types of Nova Scotia, https://novascotia.ca/natr/forestry/reports/NS-Soils.pdf)
4. Vegetation type
(See FEC, https://novascotia.ca/natr/forestry/veg-types/pdf/vegtypes.pdf)
5. Wind exposure (See Figure 1)
6. Regeneration stocking
7. Extent of damaging agents (e.g., blowdown, disease, insects, fire)
8. Previous treatments and what type
(e.g., PCT, CT, Planted, CTR, Shelterwood, Irregular Shelterwood, Selection etc.)
9. Cohort Ages
10. Age structure (even-aged or uneven-aged)

Other biodiversity features need to be identified spatially outside the sample points (see Appendix I)

Next, this data is used to calculate the following information, which is required for making treatment prescriptions.

1. Windthrow hazard (See Table 3)
2. Ecosite (See FEC, https://novascotia.ca/natr/forestry/veg-types/introduction.asp)
3. Average conditions across the stand (i.e., height, growing stock, regeneration stocking, soil type, vegetation type, age class)

4. The percent of the stand by species and species group. For example, the percent of the stand made up of Long-Lived Intermediate–Tolerant species (See Table 1).
5. Harvest Mean Annual Increment (HarMAI) of harvest to compare against the sustainable mean annual increment (SusMAI; See Soils section)
6. Old growth triggers that identify areas needing a full old-growth assessment.

For a detailed description of the Soil, Vegetation, and Ecosite information, refer to the FEC manual (Neily et al., 2013). Information on the other attributes are found in Appendix I.

PTA Data

A PTA software program makes application of the SGEM more efficient. This program stores collected PTA field data in a standard format and database, then compiles the data, and creates standard reports. The PTA program automates the prescription selection process based on the SGEM.

The data is stored in a database for the purpose of reviewing and identifying future improvements to treatment prescriptions, decision keys, and the PTA application itself—an example of adaptive management. The program also needs to incorporate volume cruise and compilation capabilities.

For details on the existing PTA data collection protocol see McGrath (2017).

For the current PTA application, see: http://novascotia.ca/natr/forestry/programs/timberman/pta.asp

Note:

> The PTA software is currently being revised to enable it to run on multiple computer platforms as a geo-spatial web-based application that integrates the spatial and attribute information into the same database. It is also being updated to incorporate the SGEM revisions.

Using the Keys

The SGEM provides a series of decision keys that are used to reach a recommended prescription for a given stand. A different set of recommendations applies to each forest group defined in the FEC.

Initially, the FEC forest group that best describes the stand under consideration must be determined. Each group has a Main key to be used to start the assessment of the appropriate treatment.

The user (or PTA computer program) advances through the decision keys by answering questions (indicated by diamonds) with the information collected in the PTA. For yes/no questions, the "yes" response directs the user to proceed *down* through the sub-keys, while a "no" response directs the user to proceed *sideways* or *upwards* through the sub-keys.

Eventually a silvicultural prescription is reached (green rectangle), or the user is referred to another sub-key (yellow rectangle) for further evaluation.

If a sub-key is indicated, it is followed until arriving at a prescription or a recommendation to wait and re-evaluate later ("Let it grow," red rectangle).

This guide is formatted so that glossaries for the items in the keys are displayed on facing pages. The treatments are also explained, in brief, on these facing pages. Detailed descriptions of prescriptions are provided in the "Silvicultural Systems" section of this guide.

Sensitive Forest Groups

Harvesting is not prescribed by this guide and should not occur in six forest groups that are found in sensitive ecosystems. These are:

Cedar
Flood Plain
Karst
Open Woodlands
Wet Coniferous
Wet Deciduous

These sites are known for their high biodiversity value, presence of species-at-risk that are legally protected under the *Nova Scotia Endangered Species Act*, and/or have fragile habitats.

For example, Flood Plain, Wet Coniferous, and Wet Deciduous forest types are well known biodiversity hotspots in which many species spend the duration of their lives. These forest groups support numerous aquatic and terrestrial species of conservation significance, including rare and listed species-at-risk plants, lichens, turtles, birds, and large and small mammals.

They also provide essential ecosystem functions as they regulate water flow, provide filtration, recharge groundwater, minimize flooding, distribute organic matter and nutrients, and offer cooler habitats for wildlife to shelter during the hot summer months. Wet Deciduous and Coniferous forest types, when harvested, could transition to another forest or wetland type due to rising water tables and soil damage post-harvest (Dube and Plamondon, 1995; Roy et al., 1999; Marcotte et al., 2008).

As with the above groups, Karst sites support unique biodiversity only found at these locations, including species that depend on caves for survival, such as the three species of endangered bats that overwinter in this province. Karst topography is ecologically and structurally fragile. Harvesting has the potential to cause irreparable damage to the habitat and poses a serious safety risk to workers.

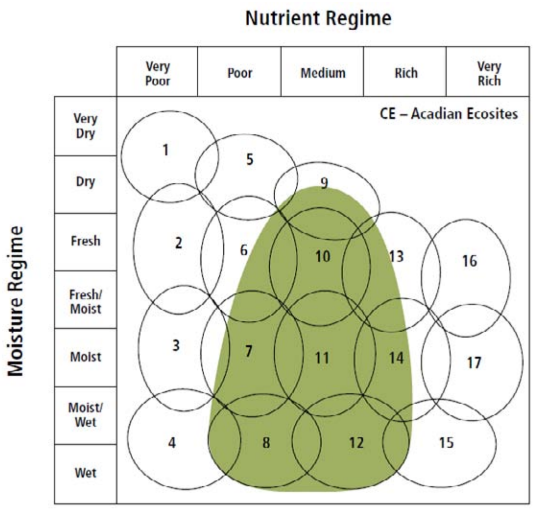
Cedar forest types should not be harvested primarily because Eastern white cedar (*T. occidentalis*) itself is listed under the *Nova Scotia Endangered Species Act due* to the limited and highly fragmented population. Any harvest of naturally occurring cedar trees increases the likelihood that the at-risk status of this species would need to be elevated to threatened or endangered.

Post-Treatment Criteria

To ensure the prescribed treatment meets objectives, quality criteria must be defined.

The current criteria are found in the *Nova Scotia Forest Operations Manual*. This manual requires updates to include criteria for SGEM prescriptions.

The system for monitoring is outlined in the *Nova Scotia Forest Operations Manual* (NSDLF, 2017) and is detailed in the Monitoring Program section of that document which requires pre- and post-treatment measurements by NSL&F staff and Licensees.



Forest Group Characteristics

The Cedar (CE) forest group includes any stand where cedar occurs (excluding ornamental escapees). These vegetation types cover a wide range of moisture regimes from dry to wet and generally are medium in fertility. The Wet Cedar type is more common than types growing in drier conditions.

Eastern white cedar (*Thuja occidentalis*) is listed as vulnerable under the *Nova Scotia Endangered Species Act.* It is estimated that approximately 12,000 mature, naturally occurring, individual cedar trees exist in Nova Scotia at 32 reported sites rarely exceeding one hectare in size (Neily et al., 2013). This fragmentation has led to genetically distinct and isolated stands, resulting in inbreeding that poses a risk to the species survival and makes every tree important (Lemieux, 2010).

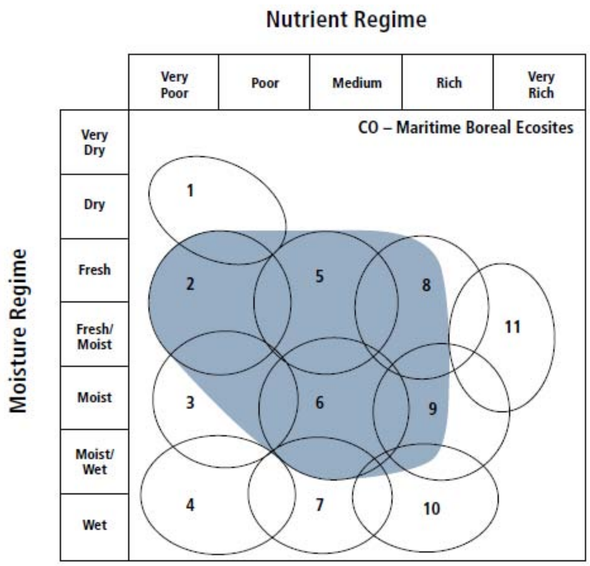
Vulnerable species are of special concern due to characteristics that make them particularly sensitive to human activities (NS GOV 1998). Ideally, by removing the key threats to these species, they should respond positively and would not need to be elevated to a legally-protected status of threatened or endangered. The most significant current threat to cedar in NS is forest harvesting (Newell, 2005).

Silvicultural Considerations

Given the status, limited population size and fragmentation of cedar stands in NS, harvesting of cedar is not prescribed by this guide and should not occur. Any harvest of cedar trees increases the likelihood that the at-risk status of this species would need elevation. Harvesting operations near stands where cedar occurs should maintain a wooded buffer to help protect the species and its habitat.

Cedar Forest Group

No Decision Key — No Prescriptions



Forest Group Characteristics

Coastal (CO) vegetation types occur on a range of sites (very poor to rich) and under various moisture regimes (fresh to moist). But all are characterized by exposure to winds from either the Atlantic or Bay of Fundy coasts (Neily et al., 2013). This forest group occurs in the Maritime Boreal ecosite group with significant coastal influences, such as high winds, cool temperatures, salt spray, and elevated humidity and fog.

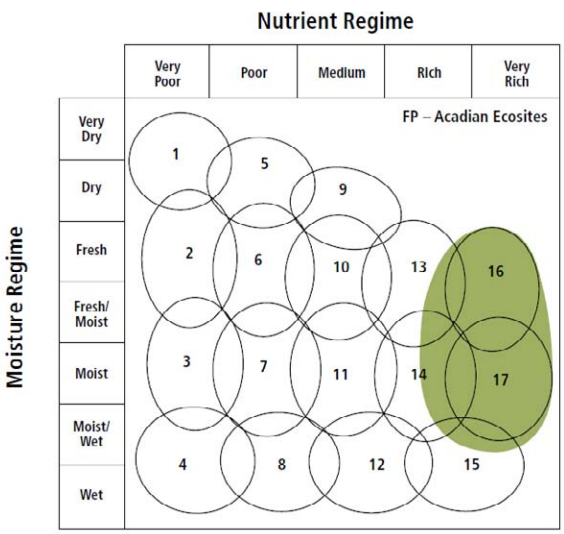
Coastal vegetation types are usually dominated by softwoods, most frequently white spruce, balsam fir, and black spruce. On more sheltered sites farther inland, white birch and red maple may occur. Coastal vegetation types are usually even-aged, and frequent windthrow or insect infestations occur. Long-lived Intermediate–Tolerant (LIT) species do not frequently occur in these vegetation types.

Silvicultural Considerations

Most Coastal vegetation types grow to limited heights owing to high winds. The coastal conditions also tend to produce even-aged stands because of the high incidence of winds and frequent storms. Hardwoods and long-lived, shade-tolerant species such as hemlock and sugar maple rarely occur, except for the Red spruce / Mountain ash / Foxberry vegetation type (CO-3) occurring on the Bay of Fundy Coast. Frequently, dense tree-regeneration of softwoods exists in mature stands. This regeneration is usually dominated by balsam fir. In the most exposed types within this group, cover is sparse or tree height severely stunted, making them unsuitable for harvesting. One of the Coastal vegetation types occurs on dunes (CO7, White spruce / Bayberry). CO7 should not be harvested due to its sensitive nature.

COASTAL DECISION KEY
(to be determined)

Flood Plain Forest Group (FP) Decision Keys



Forest Group Characteristics

Flood Plain (FP) vegetation types occur on very rich sites with fresh to moist moisture regimes. They occur along active floodplains that receive an annual or periodic enrichment from sediment. They form linear, narrow stands along rivers or streams and provide filtering benefits for these waterways.

Flood Plain forests contain the highest species diversity of any forest group in Nova Scotia (Neily and Parsons, 2017). The periodic flooding cycle promotes the growth of some of the rarest plants in NS (Neily and Parsons, 2017) and creates a rich variety of microhabitats, including active channels, oxbow ponds, and vernal pools. Vernal pools provide vital habitat for amphibians (e.g., spotted salamanders, wood frogs) to reproduce and lay eggs, as predatory fish are absent.

Protecting healthy tracts of riverine habitat is essential for the conservation of many species, including the three species of at-risk turtles in Nova Scotia (e.g., Wood Turtle; NSDLF 2020), which rely on the intact vegetation for protection from predators and as nesting habitat. Flood plain forests also provide nesting habitat for many species of rare and at-risk birds (e.g. Canada Warbler), and often supporting essential cavity trees and mast trees from small mammals. Flood plain forests provide important landscape connectivity corridors for a host of species.

Intact riparian forests provide essential ecosystem services to minimize flooding, regulate water flow, reduce erosion, distribute organic matter and nutrients, and maintain water temperatures in rivers and streams to promote healthy aquatic systems and prevent thermal stress in fish and other aquatic species. High water temperatures in the summer months have been implicated in the decline of the Atlantic salmon in Canada (Gallant et al 2017), one of the country's most important commercial and recreational fishes.

Due to their fertile soils, flood plains in Nova Scotia have been largely cleared for agriculture, resulting in few remaining large flood plain forests. Others have been frequently disturbed by human activities, including cottage and residential development, livestock grazing, and other activities including the historic practice of spring-time log drives.

Flood Plain forests are usually dominated by hardwoods, although one white spruce dominated type is included in this group. Most of the sites can form uneven-aged structures due to their ability to support long-lived and intermediate to shade-tolerant species (LIT) such as sugar maple. Flooding, channelization, and ice scouring are common in this forest group.

Harvesting in Flood Plain Forest Types is not prescribed by this guide and should not occur, for several reasons:

(i) their rarity, due to human impacts and clearing for agriculture development

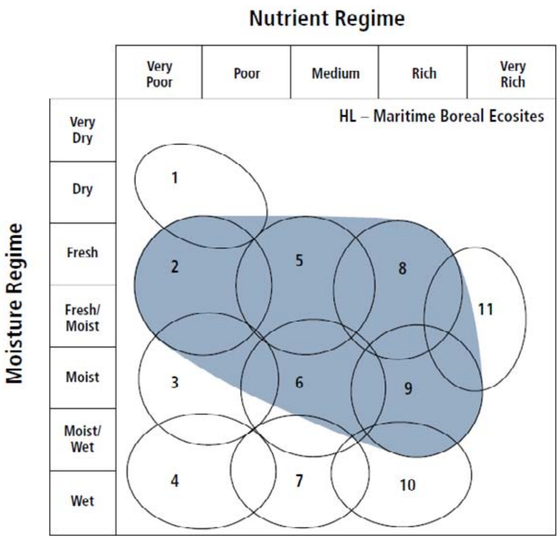
(ii) their conservation value due to the high species diversity present in this forest type, and the risk of potentially disturbing large numbers of rare and at-risk species or their habitat

(iii) their value in providing water filtering, buffering, and connectivity

(iv) their limited width adjacent to rivers or streams, which by law require a minimum 20 m Special Management Zone (SMZ) See (WH&WP, N.S. Regulations, 2002)

Flood Plain Forest Group
No Decision Key — No Prescriptions

Highland Forest Group (HL) Decision Keys



Forest Group Characteristics

Highland (HL) vegetation types occur on a range of sites, from very poor to rich and from fresh to moist. All HL types are dominated by exposure to severe winds common on the Cape Breton Taiga and in Cape Breton Highlands ecodistricts (Neily et al., 2013). This group occurs in the Maritime Boreal ecosite due to the highland influences of moist, cool climate, exposure to severe winds, and frequent freeze/thaw cycles.

Highland vegetation types are usually dominated by balsam fir, but in some of the richer sites hardwoods can co-dominate or dominate. Mixedwood or hardwood dominance is usually found on the shoulder, upper-slope transition zones between the Acadian hardwood-dominated slopes and the Maritime Boreal balsam fir-dominated Cape Breton plateau.

Silvicultural Considerations

Height is limited for these vegetation types, not usually exceeding 15 m. The balsam fir and white spruce growing on the highlands are adapted to the harsh climate, resulting in trees with more taper (higher Dbh for a given height). This also results in trees that are more resistant to blowdown.

Highland forest types are usually naturally even-aged owing to windthrow, senescence (balsam fir is short lived), or frequent severe infestations of spruce budworm. Longer-lived yellow birch can occur as an older cohort with younger balsam fir. The birch component of highland vegetation types is often damaged by ice and windstorms.

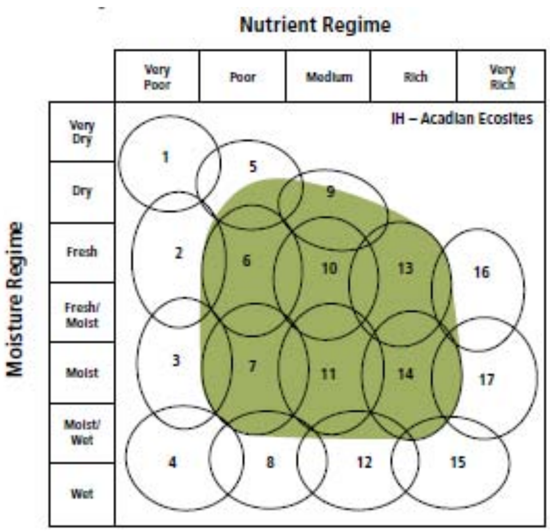
The cold winter temperatures give some protection to the balsam fir from the Balsam Woolly Adelgid (BWA), which cannot overwinter well at temperatures below -20 degrees Celsius, .It is likely that climate change will result in increased levels of BWA on the highlands.

The balsam fir-dominated plateaus of the Cape Breton highlands are strongly influenced by the spruce budworm cycle, which occurs every 30–40 years in eastern Canada (NSDNR 2005).

Thick balsam-fir regeneration is common in Highland vegetation types. On the most exposed sites, tree cover is sparse or tree height severely stunted, making the stands inoperable for harvesting.

After harvest, balsam fir is often overtopped by pin cherry and raspberry competition, reducing growth of the balsam fir. Moose browsing can impede balsam fir and hardwood regeneration.

HIGHLAND DECISION KEY
(to be determined)



Forest Group Characteristics

Intolerant Hardwood vegetation types (IH) are one of the most varied in Nova Scotia because of their occurrence on a wide variety of sites, from dry to moist and poor to rich (Neily et al., 2013).

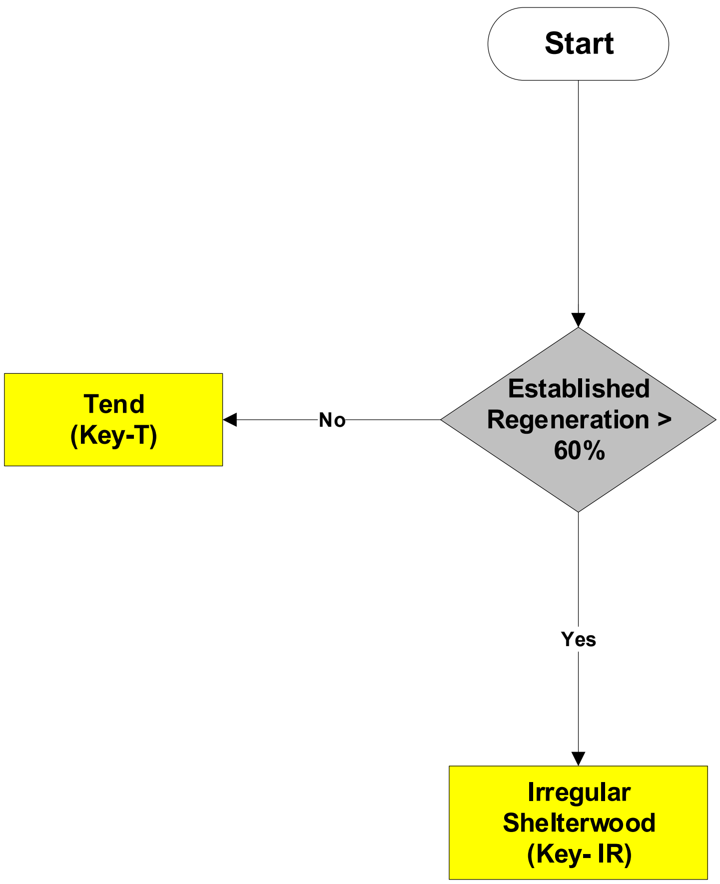
IH vegetation types are mainly dominated by shade intolerant and shorter-lived species such as red maple, white birch, grey birch, and/or aspen. The stands are mostly even-aged and naturally occur on sites that have had a stand-level disturbance. The species that dominate the IH vegetation types effectively colonize open sites through prolific and frequent seeding and/or vegetative propagation such as suckering and sprouting. Because of this, they are mainly found in early successional stands that in some cases would naturally progress towards later successional vegetation types that contain more shade-tolerant species. For example, where tolerant hardwood seed source occurs, a rich IH5 – Large-tooth Aspen–White Ash/Beaked Hazelnut/Christmas fern vegetation type could naturally succeed to tolerant hardwood stands, such as a TH3—sugar maple to white ash and Christmas fern (Table 6).

Silvicultural Considerations

Regenerating red maple or aspen-dominated IH stands in open conditions will result in the stand being dominated by these same species. Red maple stumps typically produce numerous sprouts, while aspens produce root suckers forming dense thickets. The red maple sprouts often contain rot and are of low-quality potential for timber. Red maple sprouts and aspen suckers are troublesome in open conditions when the objective is to regenerate softwood stands where they would naturally succeed from IH. They grow quickly from their existing root systems, overtopping softwood regeneration. Where herbicides are not used, these sprouts and aspen suckers are difficult to control. Manual weeding is usually not effective in controlling suckers and sprouts. In the case of red maple sprouts, if manual methods of control are utilized it is more effective to keep one or two stems to reduce the amount of re-sprouting.

Shelterwood systems variants or planting can help the natural process of moving a stand from an IH type to a later successional type, such as SH, in places where conditions are favourable. Where existing seed-source mature trees or advance regeneration of late successional species occur, a shelterwood harvest can be prescribed to provide shade to favour these shade-tolerant species. Where inadequate seed source of late successional species occur, planting may be required. When planting, effective weeding must be carried out to ensure that the later successional species become established. Regenerating these stands with clear-cuts will favour the existing shade-intolerant species.

Intolerant Hardwood
Key M - Main



KEY IH-M – Main

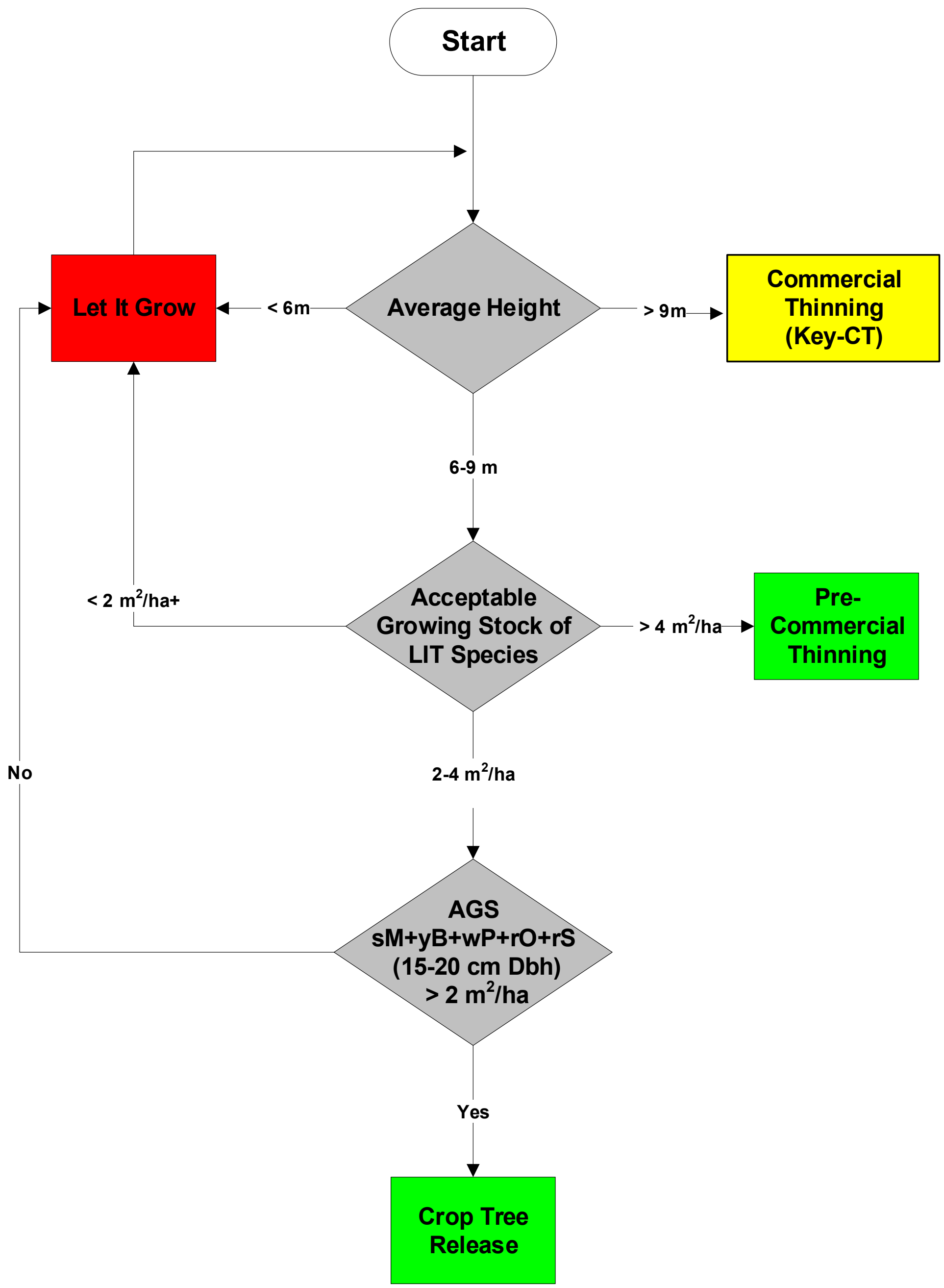
Instructions and Definitions for

Decision Diamonds

- **Established Regeneration > 60%** – Is the stocking to established regeneration[5] greater than 60% (at 2.4 m spacing)?

[5] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

Intolerant Hardwood
Sub-Key T - Tend



SUB-KEY IH-T – Tend

Instructions and Definitions for

Decision Diamonds

- **Average Height** – What is the average height of the stand in metres? Is it less than 6 m, between 6 and 9 m, or greater than 9 m?
- **Acceptable Growing Stock of LIT Species** – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[6]) of Long-Lived Intermediate–Tolerant (LIT[7]) species? Is it less than 2 m^2/ha, between 2 and 4 m^2/ha, or greater than 4 m^2/ha?
- **AGS^F sM + yB + wP + rO + rS (15–20 cm Dbh) > 2 m^2/ha** – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 2 m^2/ha?

Silvicultural Prescriptions

- **Crop-Tree Release** – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- **Pre-commercial Thinning (PCT)** – Stands that have high levels of AGS uniformly distributed (on average at least every 3 m) are appropriate for pre-commercial thinning.
- **Let it grow** – Let the stand grow and re-evaluate later.

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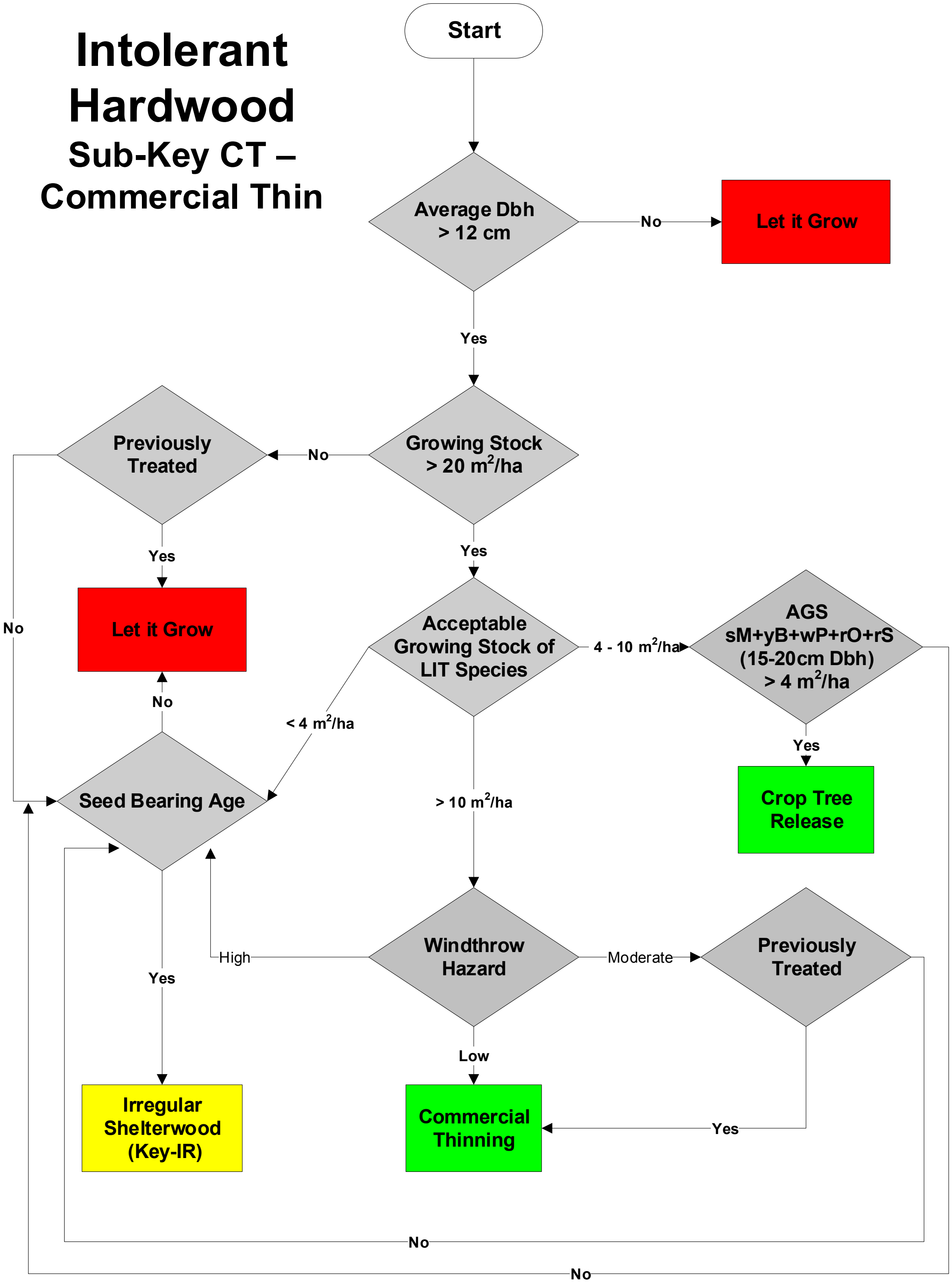
[6] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[7] **LIT** species: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

Intolerant Hardwood
Sub-Key CT – Commercial Thin



SUB-KEY IH-CT – Commercial Thinning

Instructions and Definitions for

Decision Diamonds

- Average Dbh > 12 cm – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- Growing Stock > 20 m^2/ha – Is the basal area (of trees Dbh class ≥ 10 cm) greater than 20 m^2/ha?
- Previously Treated – Has the stand been pre-commercially thinned, planted, commercially thinned, or partially harvested?
- Acceptable Growing Stock of LIT species – Is the basal area in m^2/ha of Acceptable Growing Stock (AGS[I]) of Long-Lived Intermediate–Tolerant (LIT[J]) species < 4 m^2/ha, between 4 and 10 m^2/ha, or > 10 m^2/ha?
- AGS[F] sM + yB + wP + rO + rS (15–20 cm Dbh) > 4 m^2/ha – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 4 m^2/ha?
- Windthrow Hazard – Is the windthrow hazard low, moderate, or high (refer to Table 3)?
- Seed-Bearing Age – Is the overstory dominated by trees past full seed-bearing age (Table 1)?

Silvicultural Prescriptions

- Let it grow – Let the stand grow and re-evaluate later.
- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Commercial Thinning (CT) – If high levels of AGS and adequate merchantable basal area exist, uniformly thin the stand. The objective of this treatment is to harvest lower quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. The stand should be left until it grows back the volume removed and becomes fully stocked (called “catch-up”). This will take on average 15–20 years when removing 1/3 of the basal area from the area between trails. The objective of this treatment is not to regenerate the stand although regeneration can result from this treatment, especially when carried out in older stands.

Intolerant Hardwood
Sub Key IR – Irregular Shelterwood

SUB-KEY IH-IR – Irregular Shelterwood

Instructions and definitions for

Decision Diamonds

- **Growing Stock > 20 m^2/ha** – Is the basal area (of trees Dbh class ≥ 10 cm) greater than 20 m^2/ha?
- **Previously Treated** – Has the stand been pre-commercially thinned, planted, commercially thinned, or partially harvested?
- **% LIT[8] Species** – What is the percentage of LIT species by basal area? Is it less than 20% or greater than or equal to 20%?
- **Horizontal Structure Patchy** – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.
- **Windthrow Hazard** – Is the windthrow hazard high? (refer to Table 3).

Silvicultural Prescriptions

- **Let it grow** – Let the stand grow and re-evaluate later.
- **Medium-Retention Continuous-Cover Irregular Shelterwood** – Retain 1/2 of live, standing trees by basal area, distributed throughout the site. Although retention trees will be distributed throughout the site, distribution will likely be irregular, with some areas having higher retention than others. Refer to "Irregular Shelterwood" in the section of this guide called, "Silvicultural Prescriptions" for further details. For retention objectives refer to the "Retention" section.
- **Medium-Retention Gap Irregular Shelterwood** – Leave 1/2 of the area, removing the rest of the stand in small gaps distributed throughout the site. See "Retention Objectives" in the section of this guide called "Retention"). Retain 1/10-1/5 of the basal area distributed in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this retention is designated as permanent reserves (See Table 4).

  Identify areas within the stand suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or have advance regeneration.

Maximum Gap Dimensions and Required Retention within Gap								
Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

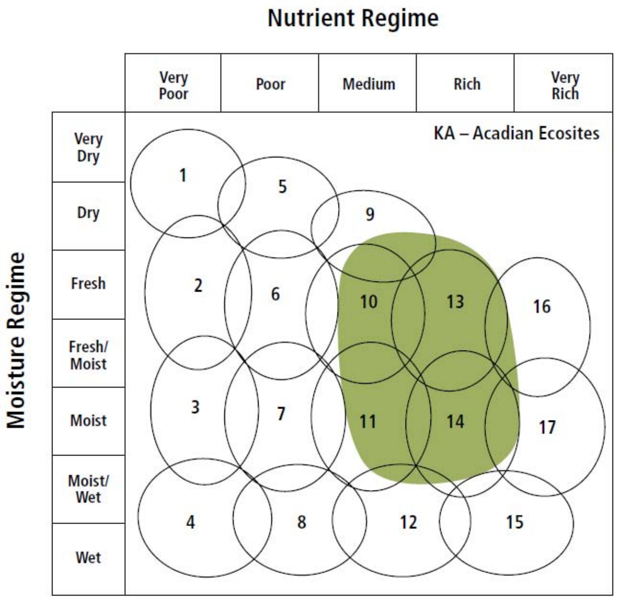
  Create gaps in these areas to create conditions for or release preferred regeneration. Leave areas of predominantly younger AGS. Harvest small gaps distributed throughout the site. The size and distribution of these gaps does not necessarily need to be uniform. Leave maximum gaps of 0.2 hectares. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this retention is left as permanent reserves (see Table 4).

- **Restoration Shelterwood** – Either Uniform Shelterwood with Reserves or Gap Shelterwood with Reserves, to be determined in consultation with IRM staff.

[8] **LIT species** – Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash

Uniform Shelterwood with Reserves – Uniformly thin overstory to produce light conditions suited for intermediate to tolerant shade-tolerant late-succession species. Two-thirds of the basal area is to be retained from between extraction trails, when regenerating shade tolerant species (sugar maple, red spruce or eastern hemlock). If intermediate shade tolerant species such as yellow birch, white ash, red oak or white pine is to be regenerated, retain ½ of the basal area from the area between extraction trails. Care must be taken to leave wind firm trees of seed-bearing age of intermediate to tolerant shade-tolerant, late-succession species as a seed source for natural regeneration. Designate permanent reserve trees according to Table 4.

Gap or Strip Shelterwood with Reserves – A gap shelterwood with reserves is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. Gap: Small groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate or release desired species. Maximum openings are to be 0.2ha and up to 1/2 of the area is to be harvested in gaps. Leave 1/10-1/5 basal area retention in gaps for reserves with a certain portion of this designated as permanent reserves (Table 4). Ten percent retention is left in smaller opening (0.1 ha) and up to 1/5 in larger openings (0.2 ha) Strip: Harvest stand in 2-stages. In the first stage, cut trees in a strip up to 1 tree height in width leaving 1/10 of the basal area distributed through the cut strip (a certain portion of these is designated as permanent reserves (Table 4). At this time, thin a strip equal in width adjacent to the cut strip, leaving 2/3 basal area retention. After regeneration has been established, cut the thinned strips (Release Cut, Partial Overstory Removal), leaving 1/5-1/3 of basal area distributed retention with some as permanent reserves (Table 4). One-fifth is to be left in Edaphic Acadian ecosites and 1/3 in Zonal Acadian ecosites.



Forest Group Characteristics

The karst forest group (KA) is identified by its occurrence on karst topography.

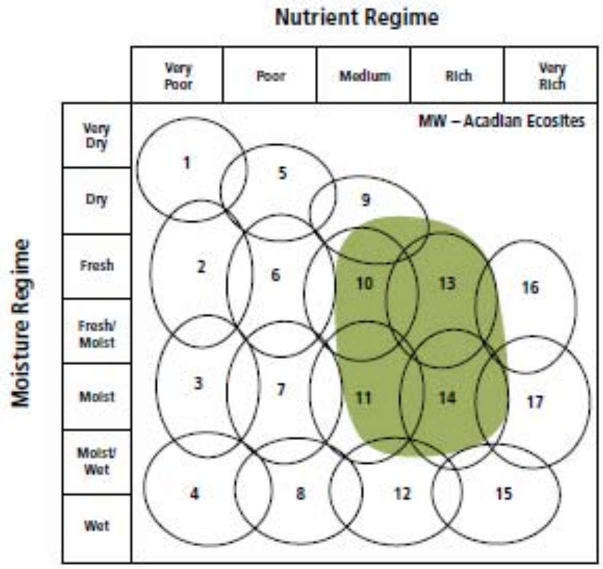
Karst topography is jagged and irregular and often includes cliffs, caves, sinkholes and underground streams created by the dissolving of soluble rock such as limestone and gypsum. KA types mainly occur on rich sites characterized by fresh to moist moisture regime (Neily et al., 2013). Late-successional tree species occurring in these types are hemlock and sugar maple.

Karst is rare in temperate Canada and the calcareous soils supports a unique biodiversity, including several species of rare plants (e.g. endangered Ram's head Lady's Slipper) and the greatest diversity of snails in the province. The presence of underground streams increases the diversity of wildlife species using this habitat and may support aquatic organisms and insect populations not found elsewhere. The caves and fissures created in karst provide shelter for mammals, overwintering sites for snakes, and are important sites for bat hibernacula (Neily and Parsons, 2017).

The three species of bats that overwinter in Nova Scotia are listed as endangered and these species and their hibernacula are legally protected under the *Nova Scotia Endangered Species Act* (1998). Overwintering bats hibernate deep in caves, often found in Karst topography, to avoid freezing temperatures and are easily disturbed by noise and vibration. Waking hibernating bats burns their fat reserves, which they need as fuel to stay in hibernation until spring and can have fatal consequences (Stawski et al 2013).

Karst topography is ecologically and structurally fragile. Harvesting in Karst sites is not prescribed by this guide and should not occur. Harvesting in these areas has the potential to cause irreparable damage to the habitat, disturb or destroy legally protected rare plants and hibernating wildlife, and lead to sedimentation in underground streams. It also poses serious safety risks to workers.

Karst Forest Group
No Decision Key — No Prescriptions



Forest Group Characteristics

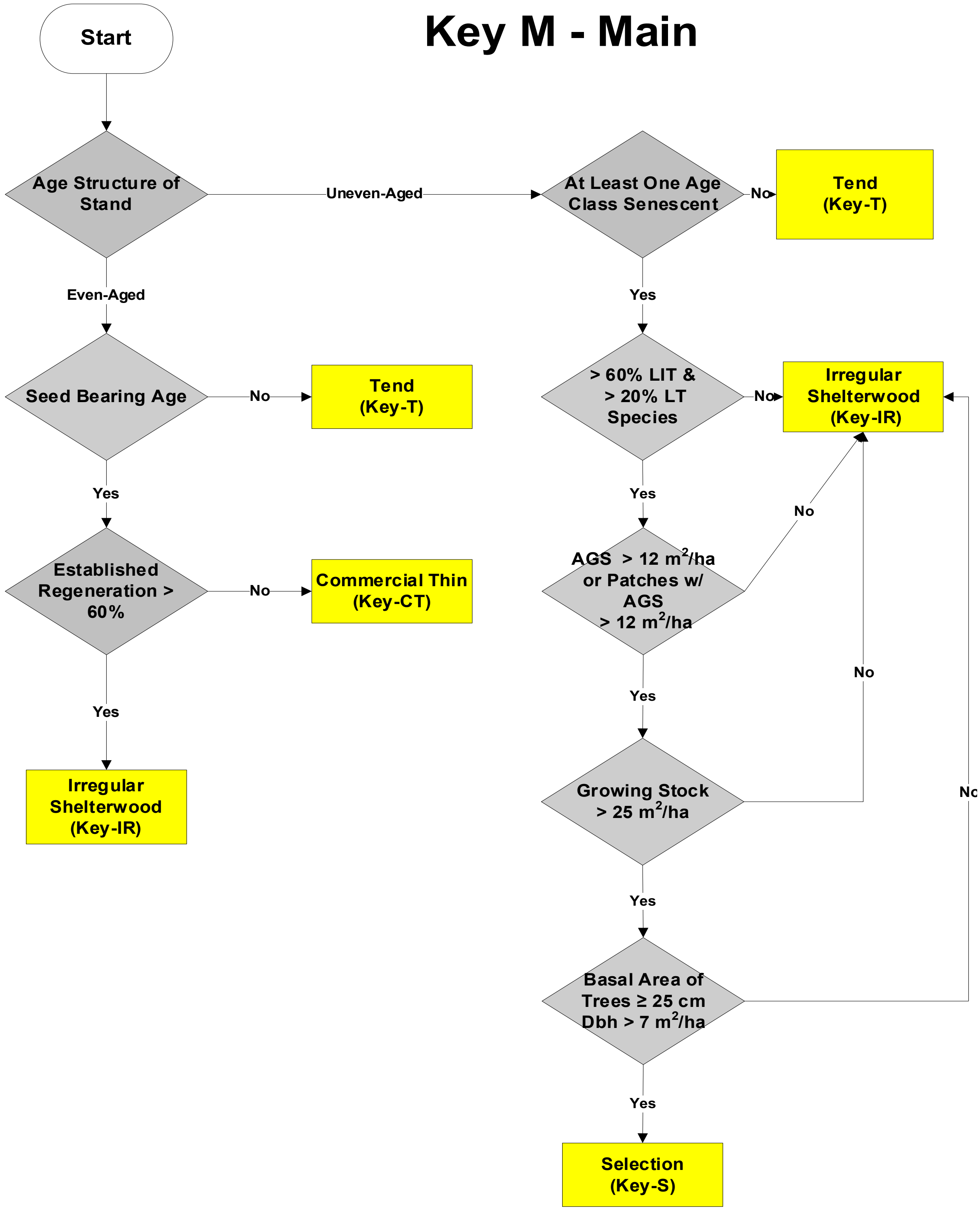
The mixedwood forest group (MW) contains some of the most diverse stands in terms of tree species. It has a wide range of successional stages, from early-late. Short-lived and/or shade-intolerant species such as red maple, balsam fir, white birch, and aspen occur in the early successional versions of mixedwood vegetation types (for example MW5, White birch – Balsam fir/Starflower). Red spruce, eastern hemlock, yellow birch, and sugar maple dominate the later successional mixedwood types (for example, MW1, Red spruce – Yellow birch / Evergreen wood fern). Another feature of mixedwood types is that the early successional version is mainly even-aged, while the later successional type can develop an uneven-aged structure. The mixedwood group occurs on productive sites ranging from a medium to rich nutrient regime and a moist to fresh moisture regime.

Silvicultural Considerations

Since mixedwood vegetation types include early to late-successional stands with shade-intolerant to tolerant species, a wide variety of treatments are recommended. Early successional mixedwoods dominated by red maple, white birch, and balsam fir can be transitioned towards later successional mixedwood versions through restoration. But a sufficient seed source for late-successional shade-tolerant species (like red spruce and sugar maple) must be present. Alternatively, early successional species can be maintained by removing most of the overstory, but in that case low-quality red maple sprouts could dominate the site, reducing the growth and survival of softwoods and later successional species. Softwood plantations of late-successional red spruce could be established by controlling these sprouts. In some cases, if a later successional mixedwood is already present and dominated by shade-tolerant and long-lived species, Uneven-aged silvicultural methods can be utilized.

Care must be taken when pre-commercial thinning (PCT) mixedwood stands with both hardwoods and softwoods of potential high value, such as with yellow birch and red spruce. If PCT is used at an early stage (typical for softwoods when 2 m tall), heavy branching will be produced in hardwoods, degrading their potential for lumber. In this situation, hardwoods should not be thinned until they are at least 6 m tall and then spaced to 2.4 m.

Mixedwood
Key M - Main



KEY MW-M – Main

Instructions and Definitions for

Decision Diamonds

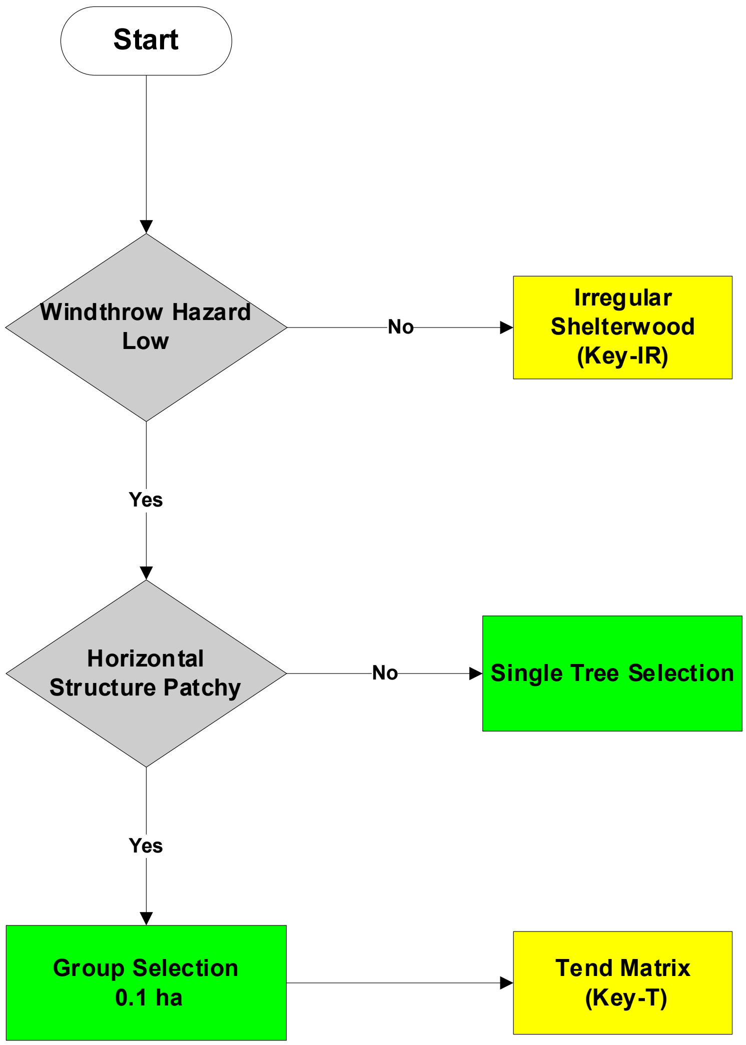
- Age Structure of Stand – Is the stand uneven-aged or even-aged. An uneven-aged stand has at least two age classes. Each age-class must be at least pole sized (> 20 years of age), with age-classes separated by at least 20 years.
- Seed-Bearing Age – Is the overstory dominated by trees that have reached full seed-bearing age (Table 1)?
- Established Regeneration > 60% – Is the stocking to established regeneration[9] greater than 60% (at 2.4 m spacing)?
- At Least One Age Class Senescent – Does this uneven-aged stand have any age-class that is past the onset of senescence (see Table 1)?
- > 60% LIT & > 20% LT Species – Is the stand made up of more than 60% Long-Lived Intermediate–Tolerant (LIT) species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash? Does it have more than 20% Long-Lived Tolerant (LT, Table 1) species, including red spruce, eastern hemlock, and sugar maple (as a percentage of stand basal area)?
- AGS > 12 m^2/ha or Patches w/ AGS > 12 m^2/ha – Is the basal area of acceptable growing stock (AGS10) greater than 12 m^2/ha, or does the stand have patches of mature trees to be harvested, intermixed with patches of smaller AGS worthy of tending? The amount of AGS in the patches must be greater than 12 m^2/ha.
- Growing Stock > 25 m^2/ha – Is the basal area (of trees Dbh class ≥ 10 cm) greater than 25 m^2/ha?
- Basal Area of Trees ≥ 25 cm Dbh > 7 m^2/ha – Is the basal area (of trees Dbh class ≥ 25 cm) greater than 7 m^2/ha of trees Dbh class ≥ 25 cm?

[9] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

[10] **AGS:** Acceptable Growing Stock trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

Mixedwood

Sub-Key S – Selection



SUB-KEY MW-S – Selection

Instructions and Definitions for

Decision Diamonds

- Windthrow Hazard Low – Is the windthrow hazard low (refer to Table 3)?
- Horizontal Structure Patchy – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.

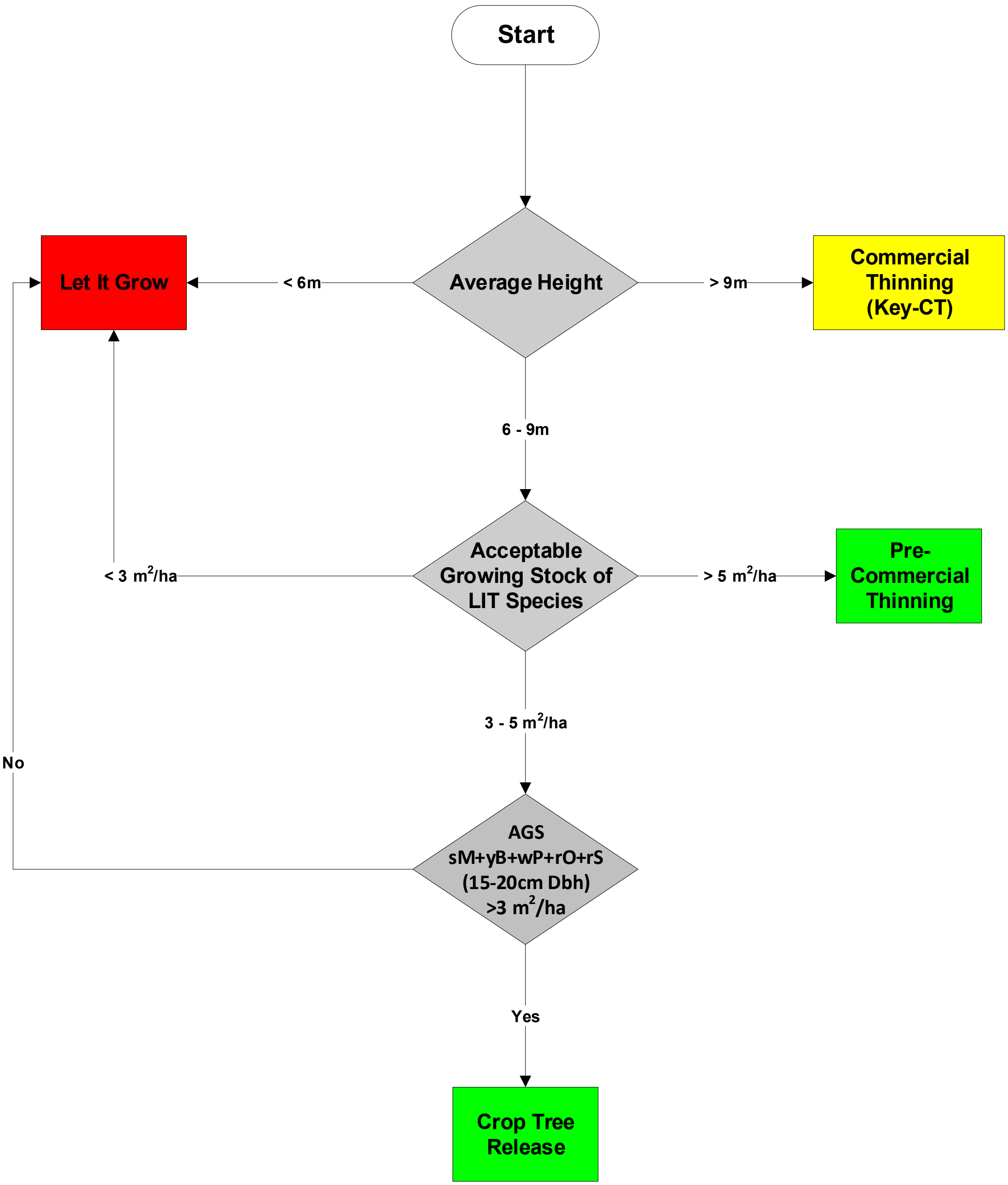
Silvicultural Prescriptions

- Single Tree Selection – This method involves a thinning across all size classes throughout the stand. This is done to create a diameter class distribution suited to sustaining a periodic harvest over relatively short harvesting cycles (10–20 years). The objective is to create conditions suitable for regeneration of preferred species at each entry, while also improving the growing stock by releasing the highest quality trees. Basal area removals of 1/3 from the area between trails are recommended, especially if the desire is to regenerate shade-tolerant species. Trail widths should be minimized and distance between trails maximized to avoid windthrow. Long-lived shade-tolerant regeneration is favoured. Permanent reserve trees must be left (see Table 4)
- Group Selection – This method involves identifying areas within the stand that are suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or have advance regeneration. Gaps are to be cut to create conditions suitable for producing seeding and/or for releasing preferred regeneration. Maximum gap dimension is 0.1 hectares. Predominantly AGS areas are to be left. They can be tended using pre-commercial thinning, commercial thinning, or crop-tree release methods. Intermediate shade-tolerant regeneration of white pine, yellow birch, and red oak is favoured. Basal area retention in the gaps will amount to 1/10 with a certain portion of this retention, designated as permanent reserve trees (Table 4).

Maximum Gap Dimensions and Required Retention within Gap								
Area		Circular Radius			Square Side Length			Retentio n
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

Mixedwood

Sub-Key T - Tend



SUB-KEY MW-T – Tend

Instructions and Definitions for

Decision Diamonds

- Average Height – What is the average height of the stand in metres? Is it less than 6 m, between 6 and 9 m, or greater than 9 m?
- Acceptable Growing Stock of LIT Species – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[11]) of Long-Lived Intermediate–Tolerant (LIT[12]) species? Is it less than 3 m^2/ha, between 3 and 5 m^2/ha, or greater than 5 m^2/ha?
- AGS[F] sM + yB + wP + rO +rS (15–20 cm Dbh) > 3 m^2/ha – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 3 m^2/ha?

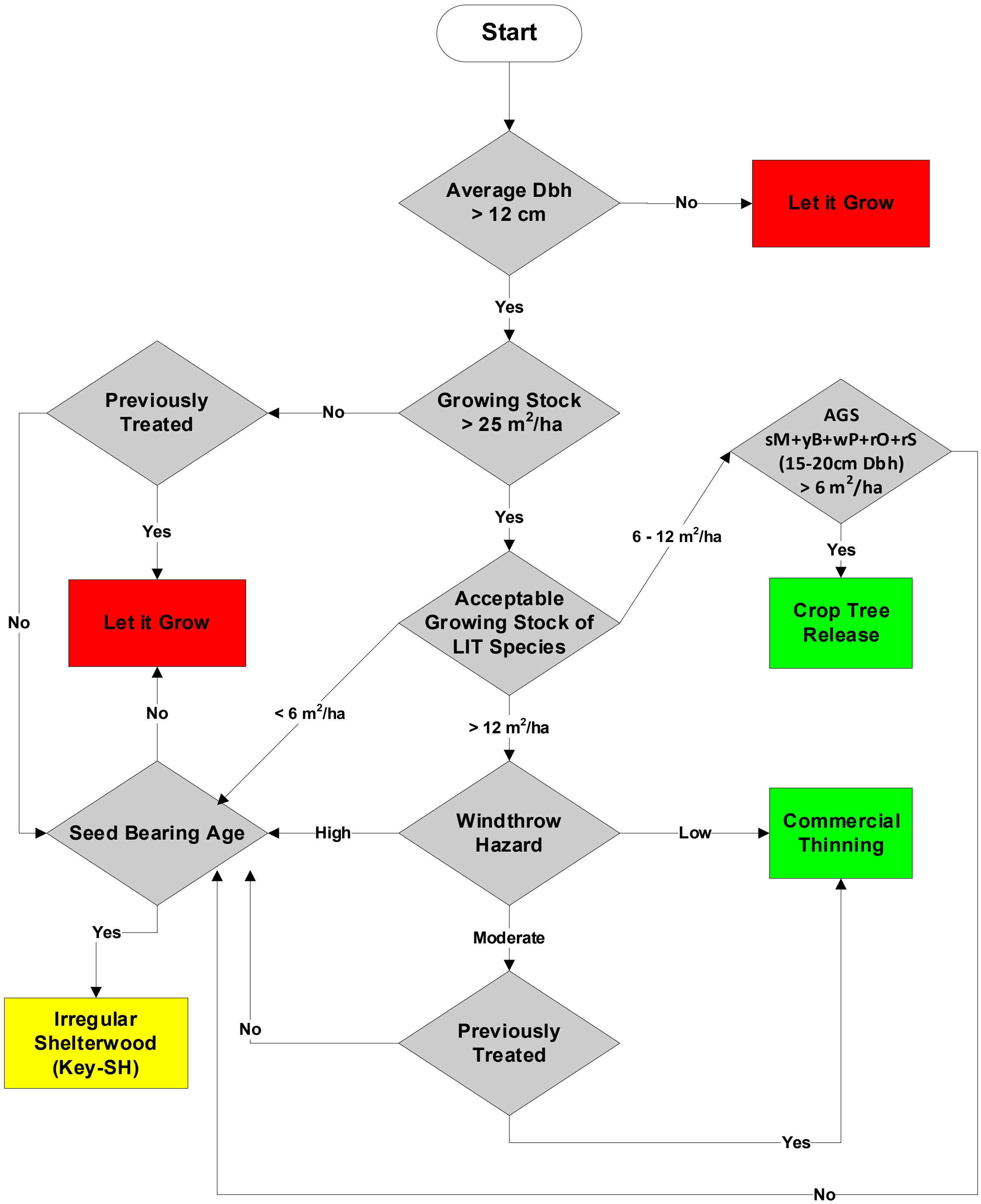
Silvicultural Prescriptions

- Let it grow – Let the stand grow and re-evaluate later.
- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees should be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Pre-commercial Thinning (PCT) – Stands that have high levels of AGS uniformly distributed (on average at least every 3 m) are appropriate for pre-commercial thinning.

[11] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[12] **LIT** species: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

Mixedwood
Sub-Key CT Commercial Thin



SUB-KEY MW-CT – Commercial Thin

Instructions and Definitions for

Decision Diamonds

- **Average Dbh > 12 cm** – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- **Growing Stock > 25 m^2/ha** – Is the basal area (of trees with Dbh Class ≥ 10 cm) greater than 25 m^2/ha?
- **Previously Treated** – Has the stand been pre-commercially thinned, planted or commercially thinned?
- **Acceptable Growing Stock of LIT species** – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[13]) of Long-Lived Intermediate–Tolerant species (LIT[14])? Is it less than 6 m^2/ha, between 6 and 12 m^2/ha, or greater than 12 m^2/ha?
- **AGS^F sM + yB + wP + rO + rS (15–20 cm Dbh) > 6 m^2/ha** – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees (in the 15 or 20 cm Dbh class) greater than 6 m^2/ha?
- **Windthrow Hazard** – Is the windthrow hazard low, moderate, or high (refer to Table 3)?
- **Seed-Bearing Age** – Is the overstory dominated by trees that have reached full seed-bearing age (Table 1)?

Silvicultural Prescriptions

- **Crop-Tree Release** – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees should be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- **Commercial Thinning (CT)** – If high levels of AGS and adequate merchantable basal area exist, uniformly thin the stand. The objective of this treatment is to harvest lower quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. The stand should be left until it grows back the volume removed and becomes fully stocked (called "catch-up"). This will take on average 15–20 years when removing 1/3 of the basal area from the area between trails. The objective of this treatment is not to regenerate the stand although regeneration could be produced especially when carried

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[13] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

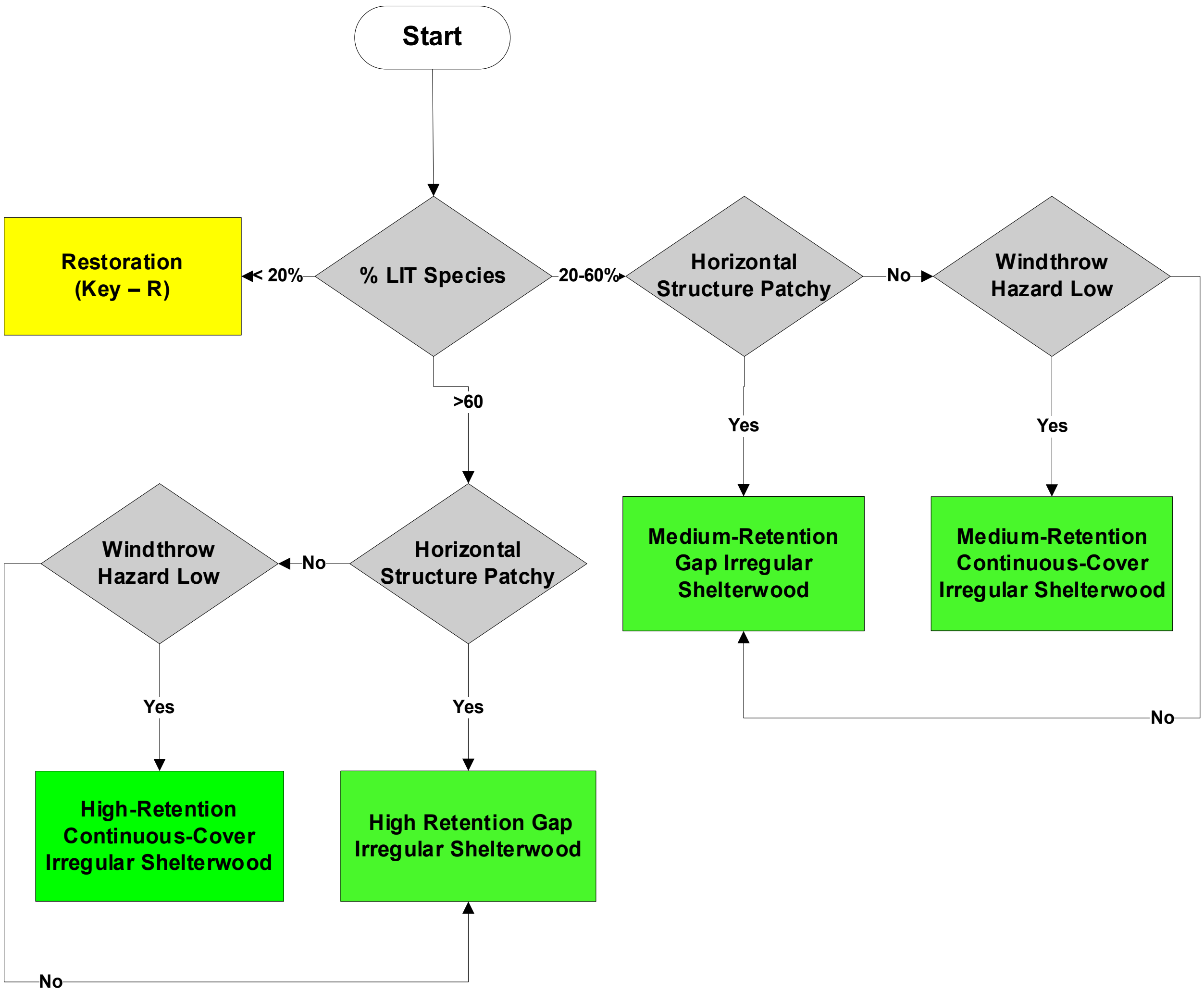
[14] **LIT species**: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash.

out in older stands. Retain any large legacy trees that are likely older remnants of the previous stand.

- **Let it grow** – Let the stand grow and re-evaluate later.

Mixedwood

Sub Key IR – Irregular Shelterwood



SUB-KEY MW-IR – Irregular Shelterwood

Instructions and definitions for

Decision Diamonds

- **% LIT[15] Species** – What is the percentage of LIT species by basal area? Is it < 20%, between 20 and 60%, or > 60%?
- **Horizontal Structure Patchy** – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.
- **Windthrow Hazard Low**– Is the windthrow hazard low (Table 3)?

Silvicultural Prescriptions

- **Medium-Retention Continuous-Cover Irregular Shelterwood** – Retain 1/2 of live, standing trees by basal area, distributed throughout the site. See "Retention Objectives" in the section of this guide called, "Retention".
- **High-Retention Continuous-Cover Irregular Shelterwood** – Retain 2/3 of live, standing trees by basal area, distributed throughout the site. See "Retention Objectives" in the section of this guide called "Retention".
- **All Continuous-Cover Irregular Shelterwoods** – Although retention trees will be distributed throughout the site, distribution will likely be irregular, with some areas having higher retention than others. Refer to "Irregular Shelterwood" in the section of this guide called, "Silvicultural Systems" for further details and objectives. The retention levels will be similar to that of a selection prescription, except that here, the residual diameter distribution is less important than recruiting LIT regeneration and retaining a diversity of tree species and sizes. There should be no gaps greater than 0.1 ha in the residual stand. If this is not feasible, use a gap-based prescription.
- **Medium-Retention Gap Irregular Shelterwood** – Leave 1/2 of the area, removing the rest of the stand in small, distributed gaps.
- **High-Retention Gap Irregular Shelterwood** – Leave 2/3 of the area, removing the rest of the stand in small, distributed gaps.
- **All Gap Irregular Shelterwoods** – Identify areas within the stand suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or advance regeneration. Create gaps with conditions suitable for or releasing preferred regeneration. Leave areas of predominantly younger AGS. Harvest small gaps distributed throughout the site. The size and distribution of these gaps does not necessarily need to be uniform. Create gaps of a maximum size of 0.2 hectares. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 of the basal area distributed in the smaller gaps (0.1 ha) with up to 1/5 in larger gaps (0.2ha) A certain portion of this retention is designated as permanent reserves (Table 4). See the "Silvicultural Systems" and "Retention" sections for further details and objectives.

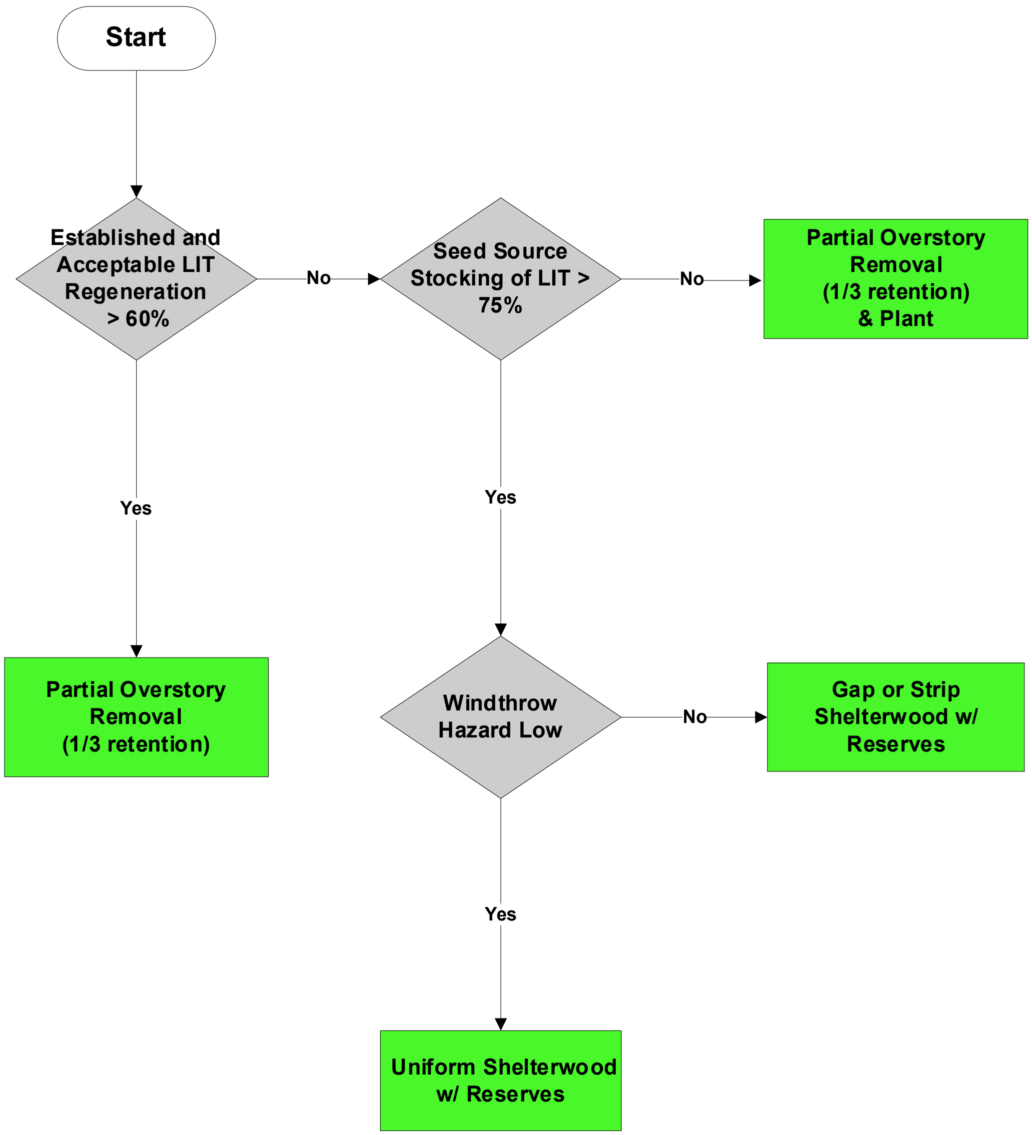
Maximum Gap Dimensions and Required Retention within Gap

Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

[15] **LIT species** – Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash.

Mixedwood

Sub Key R – Restoration



SUB-KEY MW-R – Restoration

Instructions and definitions for

Decision Diamonds

- **Established and Acceptable LIT Regeneration > 60%** – Is the stocking to acceptable established[16] of Long-lived Intermediate to Tolerant species (LIT[17]) regeneration greater than 60% (at 2.4 m spacing)?
- **Windthrow Hazard Low** – Is the windthrow hazard low (refer to Table 3)?
- **Seed Source Stocking of LIT > 75%** – Is the stocking (to 20 m spacing) of seed source trees of Long-lived Intermediate to Tolerant (LIT[BB]) species greater than 75%?

Silvicultural Prescriptions

- **Partial Overstory Removal and Plant** – Where inadequate seed sources of LIT species exists, leave 1/3 of the basal area for Biodiversity. Under-plant species suited to the Ecosite (Table 7). Weed if necessary. This retention should be distributed across the site. A certain portion of this retention is designated as permanent reserves (Table 4)
- **Partial Overstory Removal** – Leave 1/3 of the basal area. This retention should be distributed across the site. A certain portion of this retention is designated as permanent reserves (Table 4)
- **Uniform Shelterwood with Reserves (Establishment Cut)** – Uniformly thin overstory to produce light conditions suited for intermediate to tolerant shade-tolerant late-succession species. Two-thirds of the basal area is to be retained from between extraction trails, when regenerating shade tolerant species (sugar maple, red spruce, or eastern hemlock). If intermediate shade tolerant species such as yellow birch, white ash, red oak or white pine is to be regenerated, retain 1/2 of the basal area from the area between extraction trails. Care must be taken to leave wind firm trees of seed-bearing age of intermediate to tolerant shade-tolerant, late-succession species as a seed source for natural regeneration. Designate permanent reserve trees according to Table 4.
- **Gap or Strip Shelterwood with Reserves (Establishment Cut)** – A gap shelterwood is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. Gap: Small groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate the desired species. Openings are to be up to 0.2 ha and up to 1/2 of the area is to be harvested in gaps. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this reserve is to be designated as permanent reserves (Table 4) Strip: Harvest stand in 2-stages. In the first stage, harvest trees in a strip 1 tree height in width

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[16] Regeneration is considered **established** when taller than 30 cm, rooted in mineral soil and capable of withstanding increased light and heat due to complete overstory removal. All trees greater than 30 cm tall and less than 9cm in Dbh are considered regeneration. All regenerating commercial tree species (Table 1) are considered **acceptable** provided they are not poorly formed, have umbrella type crowns or have live crown ratios less than 1/3.

[17] **LIT** species - Long-lived Intermediate to Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

leaving 1/10 of the basal area as reserves with a certain portion of these designated as permanent reserves. At this time, thin a strip equal in width adjacent to the cut strip, leaving 2/3 of the basal area. After regeneration has been established, cut the thinned strips (Release Cut, Partial Overstory Removal), leaving 1/5-1/3 of the basal area distributed throughout the stand with a certain portion designated as permanent reserves (Table 4). One-fifth of the basal area will be left in Edaphic Acadian ecosites and 1/3 left in Zonal Acadian ecosites.

Old Field (OF)

Forest Group Characteristics

The old field forest group (OF) consists of forested sites established on abandoned agricultural land. They often have organic, enriched soils, are smooth from former tilling, and cleared of rocks. In some old field sites, formerly grazed land is not always smooth or cleared of rocks. Old-field vegetation types are usually dominated by softwoods. The old fields were often fertile hardwood sites originally occupied by shade-tolerant hardwoods. Hints identifying old-field stand origins include the occurrence of the occasional tolerant hardwood mixed with early colonizers, such as white spruce. These sites are medium to rich in fertility and in the fresh to moist range. They typically are less complex ecosystems of one tree species, most frequently white spruce. Tamarack sometimes occurs on moister sites, white pine occurs most frequently in western Nova Scotia, balsam fir most frequently in the Nova Scotia uplands, and trembling aspen most frequently in lowland ecoregions.

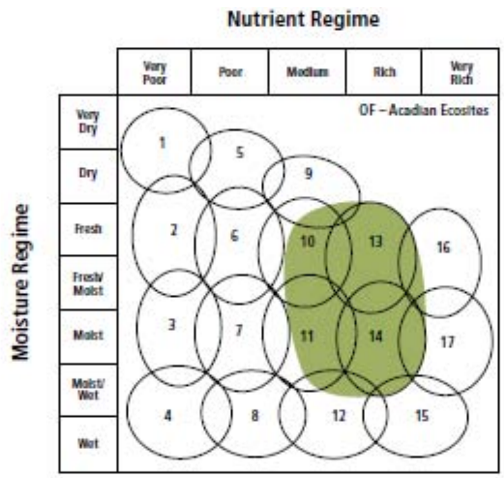


Figure 16. Acadian Ecosites where OF types are found

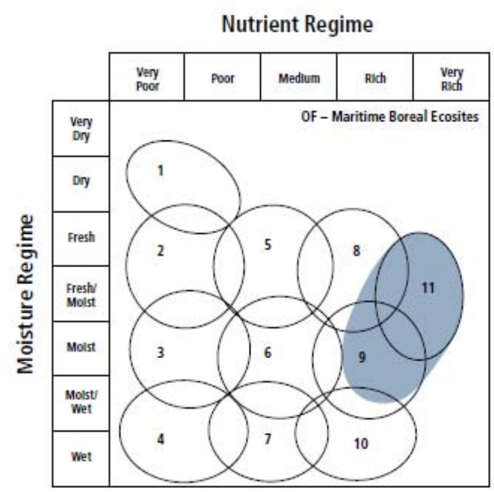


Figure 17. Maritime Boreal Ecosites where OF types are found

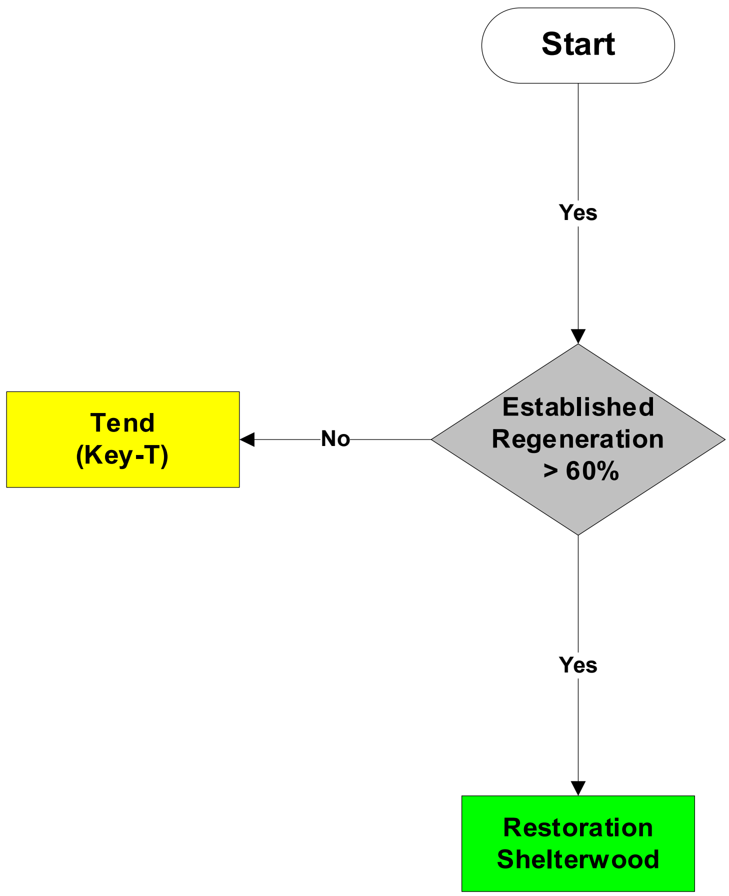
Silvicultural Considerations

Old fields are even-aged, early successional stands but often contain remnants of their original stand type, especially where seed-source trees are nearby. Old fields that contain adequate remnant seed source for regenerating shade-tolerant and long-lived species, such as sugar maple, could benefit from a shelterwood harvest or planting to accelerate the succession towards its original condition although soil/site conditions have been altered making restoration a challenge. Shelterwood treatments have not been successful in regenerating white spruce when it appears in pure stands on old fields.

White spruce growing on old-field sites is typically shorter-lived than white spruce found growing in forest sites. White spruce does not typically form pure stands in other forest groups, except for CO2 (White spruce – Balsam fir / Foxberry – Twinflower), CO7 (White spruce / Bayberry), HL2 (White spruce / Wood aster) and SH10 (White spruce – Balsam fir / Broom moss). Old-field white spruce is especially susceptible to bark beetle at a relatively young age and can quickly succumb to severe infestations.

These sites may be a natural choice for high production forestry, as the natural site composition and processes have already been altered by farming. Site preparation, planting, and weed control could be used if insufficient seed sources for long-lived, tolerant trees are present or advance regeneration occurs.

Old Field
Key M - Main



KEY OF-M – Main

Instructions and Definitions for

Decision Diamonds

- Established Regeneration > 60% – Is the stocking to established regeneration[18] greater than 60% (at 2.4 m spacing)?

Silvicultural Prescriptions

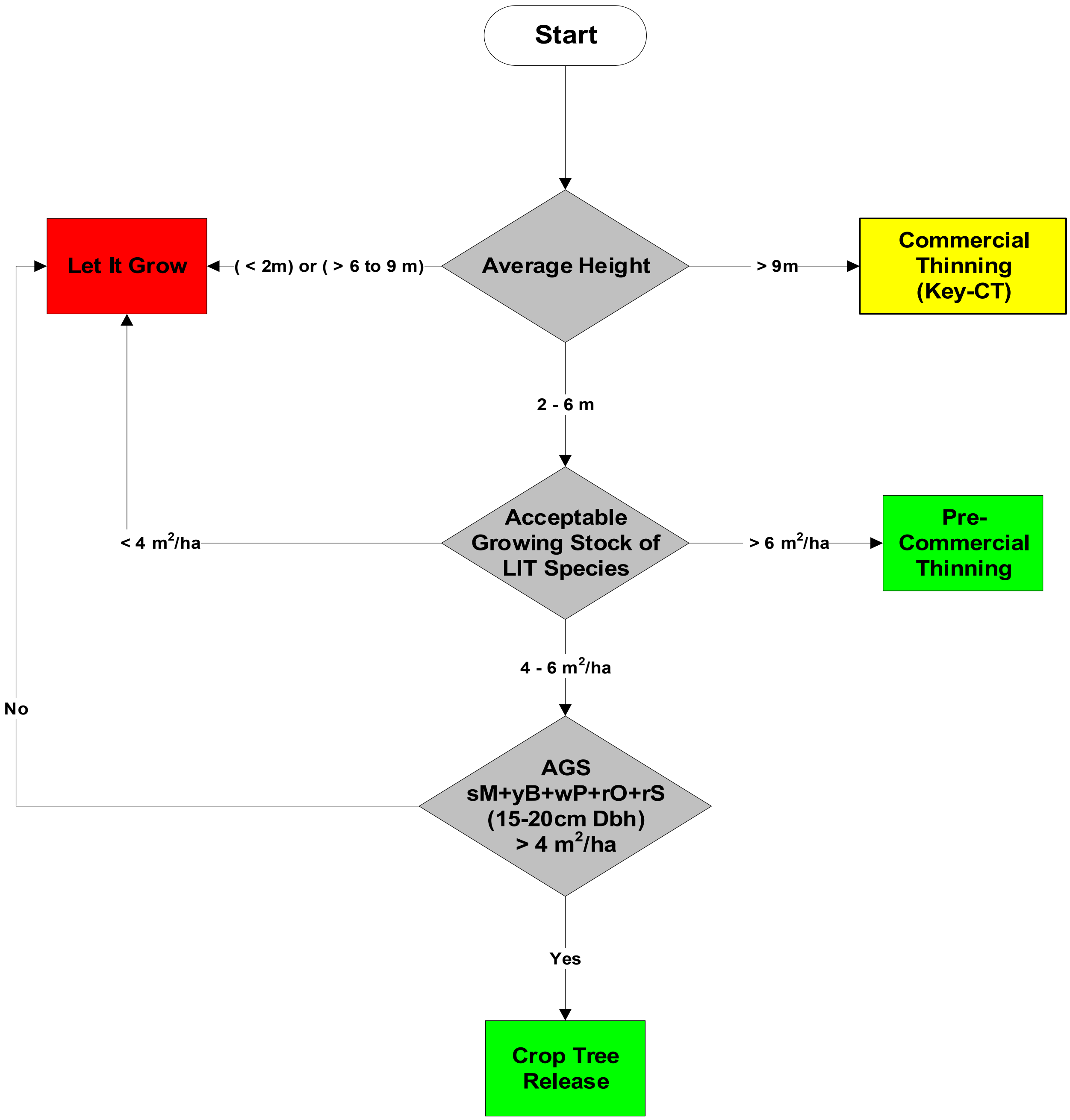
- Restoration Shelterwood – Either Uniform Shelterwood with Reserves or Gap Shelterwood with Reserves, to be determined in consultation with IRM staff.

  Uniform Shelterwood with Reserves – Uniformly thin overstory to produce light conditions suited for intermediate to tolerant shade-tolerant late-succession species. Two-thirds of the basal area is to be retained from between extraction trails, when regenerating shade tolerant species (sugar maple, red spruce or eastern hemlock). If intermediate shade tolerant species such as yellow birch, white ash, red oak or white pine is to be regenerated, retain ½ of the basal area from the area between extraction trails. Care must be taken to leave wind firm trees of seed-bearing age of intermediate to tolerant shade-tolerant, late-succession species as a seed source for natural regeneration. Designate permanent reserve trees according to Table 4.

  Gap or Strip Shelterwood with Reserves – A gap shelterwood with reserves is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. Gap: Small groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate or release desired species. Maximum openings are to be 0.2ha and up to 1/2 of the area is to be harvested in gaps. Leave 1/10-1/5 basal area retention in gaps for reserves with a certain portion of this designated as permanent reserves (Table 4). Ten percent retention is left in smaller opening (0.1 ha) and up to 1/5 in larger openings (0.2 ha) Strip: Harvest stand in 2-stages. In the first stage, cut trees in a strip up to 1 tree height in width leaving 1/10 of the basal area distributed through the cut strip (a certain portion of these is designated as permanent reserves (Table 4). At this time, thin a strip equal in width adjacent to the cut strip, leaving 2/3 basal area retention. After regeneration has been established, cut the thinned strips, leaving 1/5-1/3 of basal area distributed retention with some as permanent reserves (Table 4). One-fifth is to be left in Edaphic Acadian ecosites and 1/3 in Zonal Acadian ecosites.

[18] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

Old Field
Sub-Key T - Tend



SUB-KEY OF-T – Tend

Instructions and Definitions for

Decision Diamonds

- Average Height – What is the average height of the stand in metres? Is it less than 2 m, between 2 and 6 m, greater than 6 m to 9 m, or greater than 9 m?
- Acceptable Growing Stock of LIT Species – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[19]) of Long-Lived Intermediate–Tolerant (LIT[20]) species? Is it less than 4 m^2/ha, between 4 and 6 m^2/ha, or greater than 6 m^2/ha?
- AGS[F] sM + yB + wP + rO +rS (15–20 cm Dbh) > 4 m^2/ha – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 4 m^2/ha?

Silvicultural Prescriptions

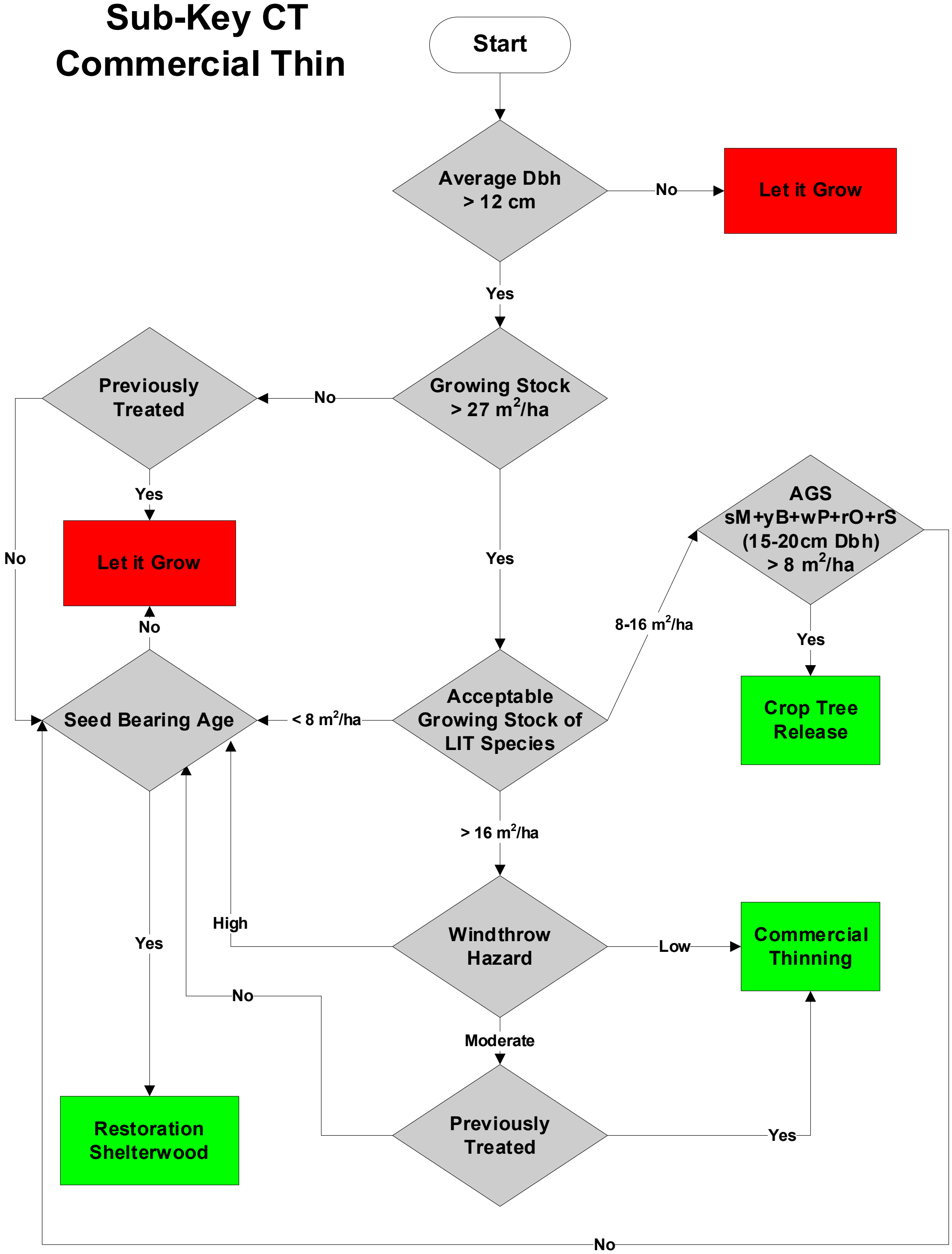
- Let it grow – Let the stand grow and re-evaluate later.
- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Pre-commercial Thinning (PCT) – Stands that have high levels of AGS uniformly distributed (on average at least every 3 m) are appropriate for pre-commercial thinning.

[19] AGS: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[20] **LIT species**: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

Old Field

Sub-Key CT
Commercial Thin



SUB-KEY OF-CT – Commercial Thinning

Instructions and Definitions for

Decision Diamonds

- Average Dbh > 12 cm – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- Growing Stock > 27 m^2/ha – Is the basal area (of trees ≥ 10 cm Dbh class) greater than 27 m^2/ha?
- Previously Treated – Has the stand been pre-commercially thinned, planted, commercially thinned, or partially harvested?
- Acceptable Growing Stock of LIT species – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[21]) of Long-Lived Intermediate–Tolerant species (LIT[22])? Is it less than 8 m^2/ha, between 8 and 16 m^2/ha, or greater than 16 m^2/ha?
- AGS[F] sM + yB + wP + rO +rS (15–20 cm Dbh) > 8 m^2/ha – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 8 m^2/ha?
- Windthrow Hazard – Is the windthrow hazard low, moderate, or high (refer to Table 3)?
- Seed-Bearing Age – Is the overstory dominated by trees that have reached full seed-bearing age (Table 1)?

Silvicultural Prescriptions

- Let it grow – Let the stand grow and re-evaluate later.
- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Commercial Thinning (CT) – If high levels of AGS and adequate merchantable basal area exist, uniformly thin the stand. The objective of this treatment is to harvest lower quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. The stand should be left until it grows back the volume removed and becomes fully stocked (called "catch-up"). This will take on average 15–20 years when removing 1/3 of the basal area from the area between trails. The objective of this treatment is <u>not</u> to regenerate the stand although natural regeneration is sometimes produced, especially when carried out in older stands.

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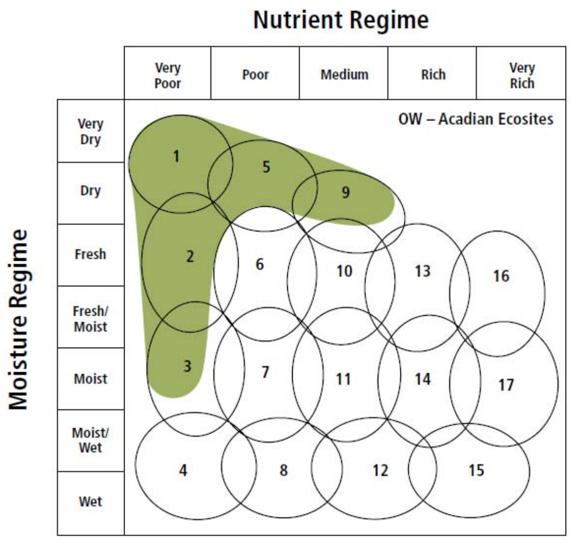
[21] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[22] **LIT species**: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

- Restoration Shelterwood – Either Uniform Shelterwood with Reserves or Gap Shelterwood with Reserves, to be determined in consultation with IRM staff.

  Uniform Shelterwood with Reserves – Uniformly thin overstory to produce light conditions suited for intermediate to tolerant shade-tolerant late-succession species. Two-thirds of the basal area is to be retained from between extraction trails, when regenerating shade tolerant species (sugar maple, red spruce or eastern hemlock). If intermediate shade tolerant species such as yellow birch, white ash, red oak or white pine is to be regenerated, retain 1/2 basal area from the area between extraction trails. Care must be taken to leave wind firm trees of seed-bearing age of intermediate to tolerant shade-tolerant, late-succession species as a seed source for natural regeneration. Designate permanent reserve trees according to Table 4.

  Gap or Strip Shelterwood with Reserves – A gap shelterwood is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. Gap: Small groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate the desired species. Openings are to be up to 0.2ha and 1/2 of the area is to be harvested in gaps. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this retention is designated as permanent reserves (Table 4). Strip: Harvest stand in 2-stages. In the first stage, cut trees in a strip 1 tree height in width leaving 1/10 as reserves with a certain portion of these designated as permanent reserves. At this time, thin a strip equal in width adjacent to the cut strip, leaving 2/3 of the basal area. After regeneration has been established, cut the thinned strips (Release Cut, Partial Overstory Removal), leaving 1/5-1/3 basal area retention for permanent reserves with the designated portion of permanent reserves (Table 4). One-fifth is to be left in Edaphic Acadian ecosites and 1/3 in Zonal Acadian ecosites.



Forest Group Characteristics

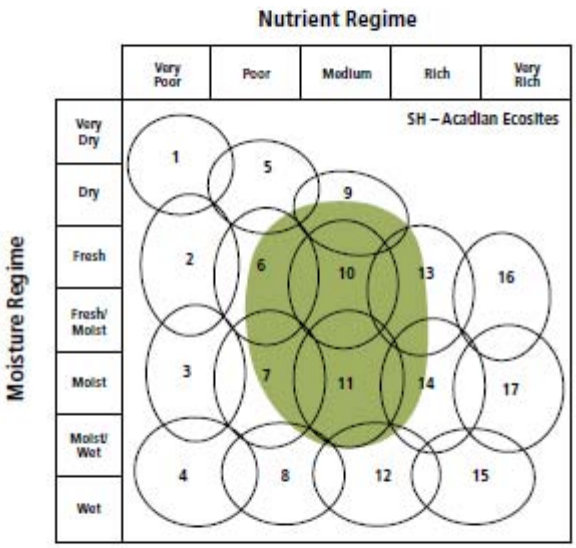
The Open Woodland (OW) forest group is characterized by sites that naturally limit growth and tree density. Open Woodlands have less than 30% crown closure and are characterized by exposed bedrock, surface stoniness and frequent wildfires. OW forest types have low productivity, often with stunted growth, and occur on very poor or very dry sites. Fertility is limited due to conditions such as shallow soils and talus slopes (Neily et al., 2013). A variety of tree species grow in these types, including most frequently pines, black spruce, and red oak.

OW openings within larger forested systems support biodiversity elements not found elsewhere, including many rare plants (e.g. endangered Rockrose, Atlantic Coastal Plain species), lichens, birds, and small mammals (e.g. Gaspé and long tailed shrews, rock vole). Open habitats with sparse vegetation offer important nest sites for ground-nesting birds, including species at risk, such as the Common Nighthawk and Eastern Whip-poor-will (*Nova Scotia Endangered Species Act* 1998). Many of the animal, plant and lichen species in OW types remain undocumented.

OW vegetation types are either uncommon to Nova Scotia or unique to Nova Scotia or the Maritimes. The vegetation type "Red pine-White pine/ Broom crowberry/ Grey reindeer lichen (OW4)" is uncommon in NS and not found anywhere else in the world (Neily and Parsons, 2017).

Harvesting in Open Woodlands is not prescribed by this guide and should not occur due to their unique habitat features and biodiversity.

Open Woodland Forest Group
No Decision Key — No Prescriptions



Forest Group Characteristics

Spruce–hemlock vegetation types contain mid- to late-successional stands. The late-successional types are dominated by long-lived, shade-tolerant red spruce and/or eastern hemlock. These stands can form uneven-aged characteristics between stand replacement disturbances. The mid-successional SH types are dominated by shorter-lived species, such as balsam fir and white spruce, usually in even-aged stands. The SH forest group occurs on medium fertility and fresh to moist sites.

Silvicultural Considerations

Spruce–hemlock types generally occur on medium fertility sites and are mainly dominated by red spruce. Spruce–pine (SP) vegetation types, on the other hand, are associated with black spruce on poor sites. Since red spruce is long-lived and more tolerant of shade than black spruce, it is more suited to uneven-aged silvicultural systems. Red spruce hybridizes with black spruce, complicating the selection of the appropriate keys. This will have implications on prescribing the appropriate silvicultural treatment. If hybrid spruces are found on medium fertility sites, they are to be treated like red spruce, using the SH guide applies. When hybrids are found on poor sites (e.g., high cover of ericaceous[23] vegetation and bracken fern), they are to be treated as black spruce where the SP guidelines apply. For information on identifying black spruce, red spruce, and their hybrids, refer to Manley (1971).

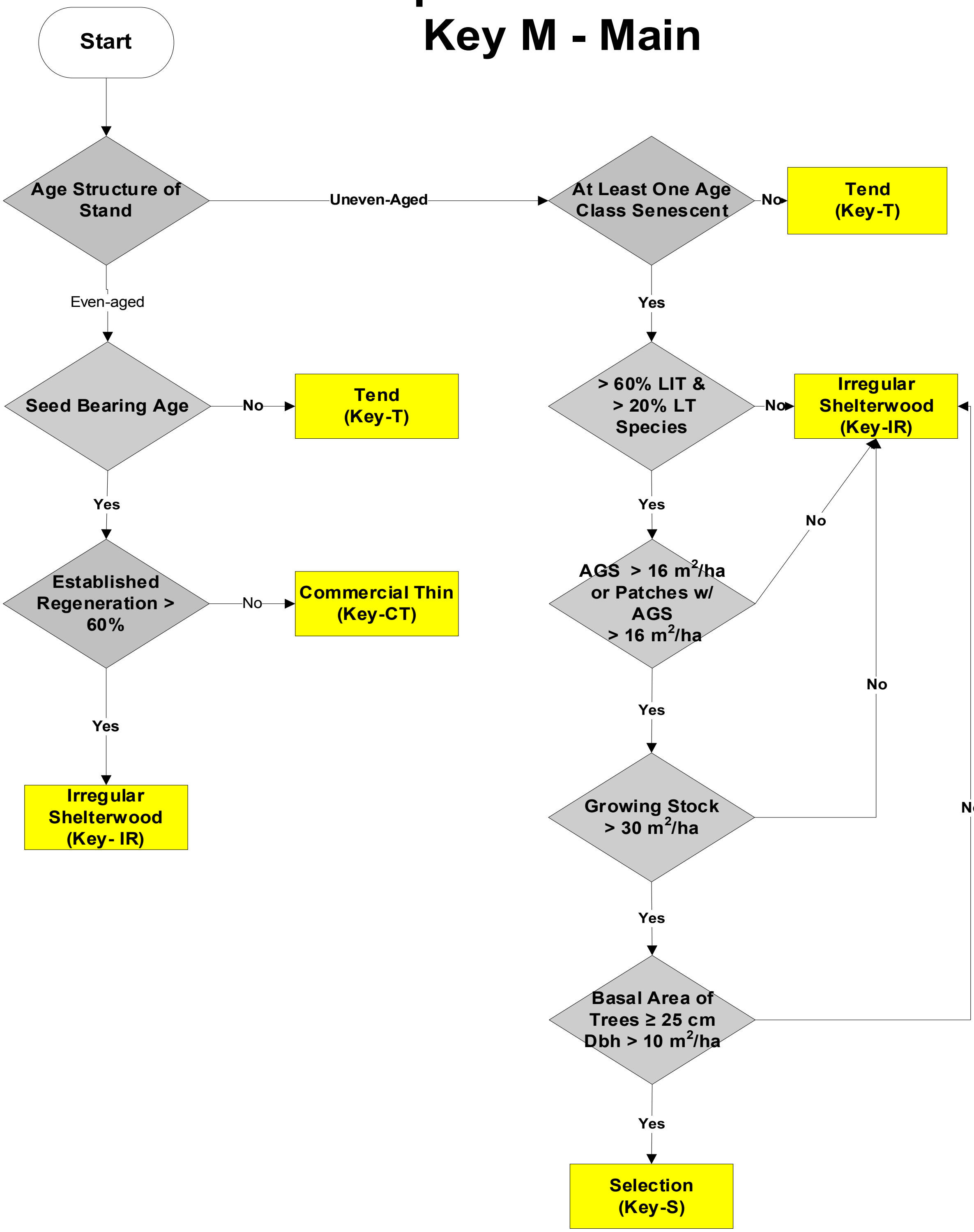
Caution is required in carrying out partial harvesting methods, such as shelterwood, commercial thinning and selection, in SH stands because of their susceptibility to windthrow. Red spruce, hemlock, balsam fir and white spruce are shallow rooting species. When growing on shallow, stony phase or wet soils, or on exposed sites, they are especially susceptible to blowdown. In all cases, where partial harvesting is carried

[23] **Ericaceous species**: plants in or related to the heath family (*Ericaceae*). Usually found on acidic (nutrient poor) soils, species include lambkill (*Kalmia angustifolium*) and *Vaccinium* species such as blueberry, rhodora (*Rhododendron canadense*), and huckleberry (*Gaylussacia baccata*).

out for this vegetation type un-thinned buffers should be considered along stand boundaries as well as favouring gap silviculture systems.

In almost all SH stands, balsam fir and red maple are found. When regenerating SH stands by removing overstorys, early successional species such as balsam fir and red maple are favoured because of their prolific seeding and, in the case of red maple, vigorous sprouting. Competition control is necessary to regenerate late-successional species like red spruce and eastern hemlock when regenerating with low retention levels. This can be accomplished with weeding and/or cleaning stands.

Spruce Hemlock
Key M - Main



KEY SH-M – Main

Instructions and Definitions for

Decision Diamonds

- Age Structure of Stand – Is the stand uneven-aged or even-aged. A uneven-aged stand has at least two age classes. Each age-class must be at least pole sized (> 20 years of age), with age-classes separated by at least 20 years.
- Seed-Bearing Age – Is the overstory dominated by trees that have reached full seed-bearing age (Table 1)?
- Established Regeneration > 60% – Is the stocking to established regeneration[24] greater than 60% (at 2.4 m spacing)?
- At Least One Age Class Senescent – Does this uneven-aged stand have any age-class that is past the onset of senescence (see Table 1)?
- > 60% LIT & > 20% LT Species – Is the stand made up of more than 60% Long-Lived Intermediate–Tolerant (LIT) species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash? Does it have more than 20% Long-Lived Tolerant (LT, Table 1) species, including red spruce, eastern hemlock, and sugar maple (as a percentage of stand basal area)?
- AGS > 16 m^2/ha or Patches w/ AGS > 16 m^2/ha – Is the basal area of acceptable growing stock (AGS[25]) greater than 16 m^2/ha, or does the stand have patches of mature trees to be harvested intermixed with patches of smaller AGS worthy of tending? The amount of AGS in the unharvested patches must be greater than 16 m^2/ha.
- Growing Stock > 30 m^2/ha – Is the basal area (of trees in Dbh class ≥ 10cm) greater than 30 m^2/ha?
- Basal Area of Trees ≥ 25 cm Dbh > 10 m^2/ha – Is the basal area (of trees Dbh class ≥ 25 cm) greater than 10 m^2/ha of trees ≥ 25 cm Dbh?

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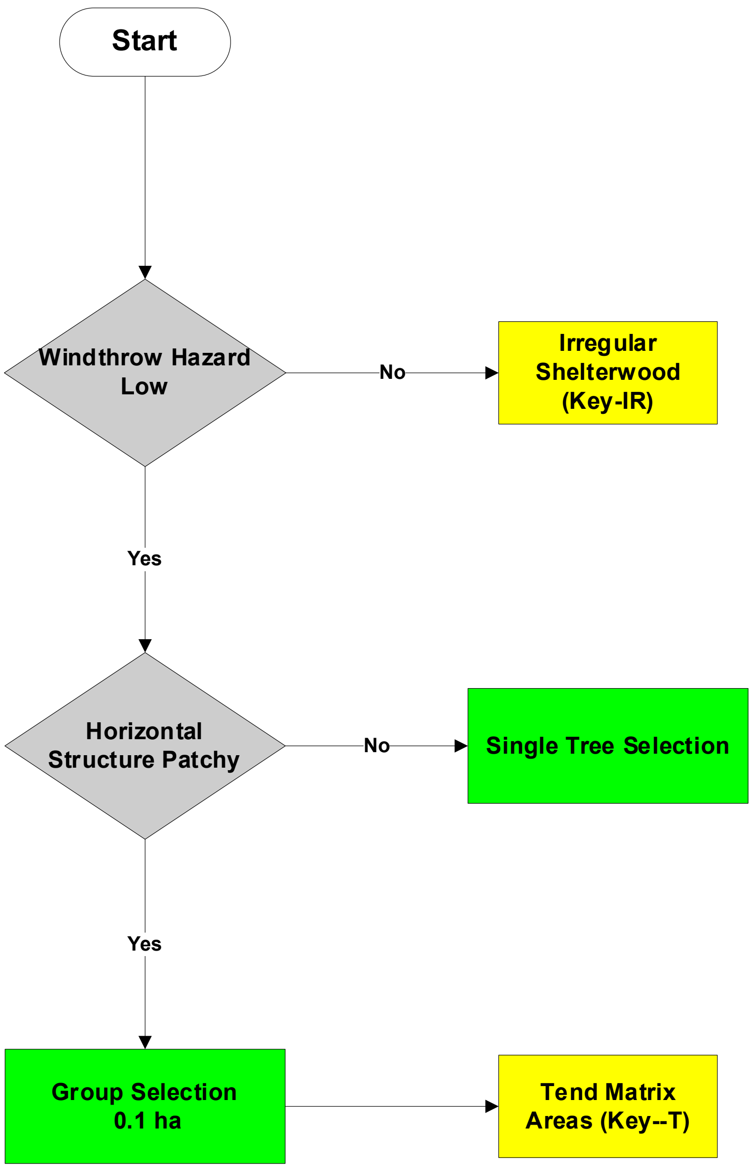
[24] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

[25] AGS: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest. See PTA section for more details.

Spruce Hemlock
Sub-Key S – Selection



SUB-KEY SH-S – Selection

Instructions and Definitions for

Decision Diamonds

- Windthrow Hazard Low – Is the windthrow hazard low (refer to Table 3)?
- Horizontal Structure Patchy – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.

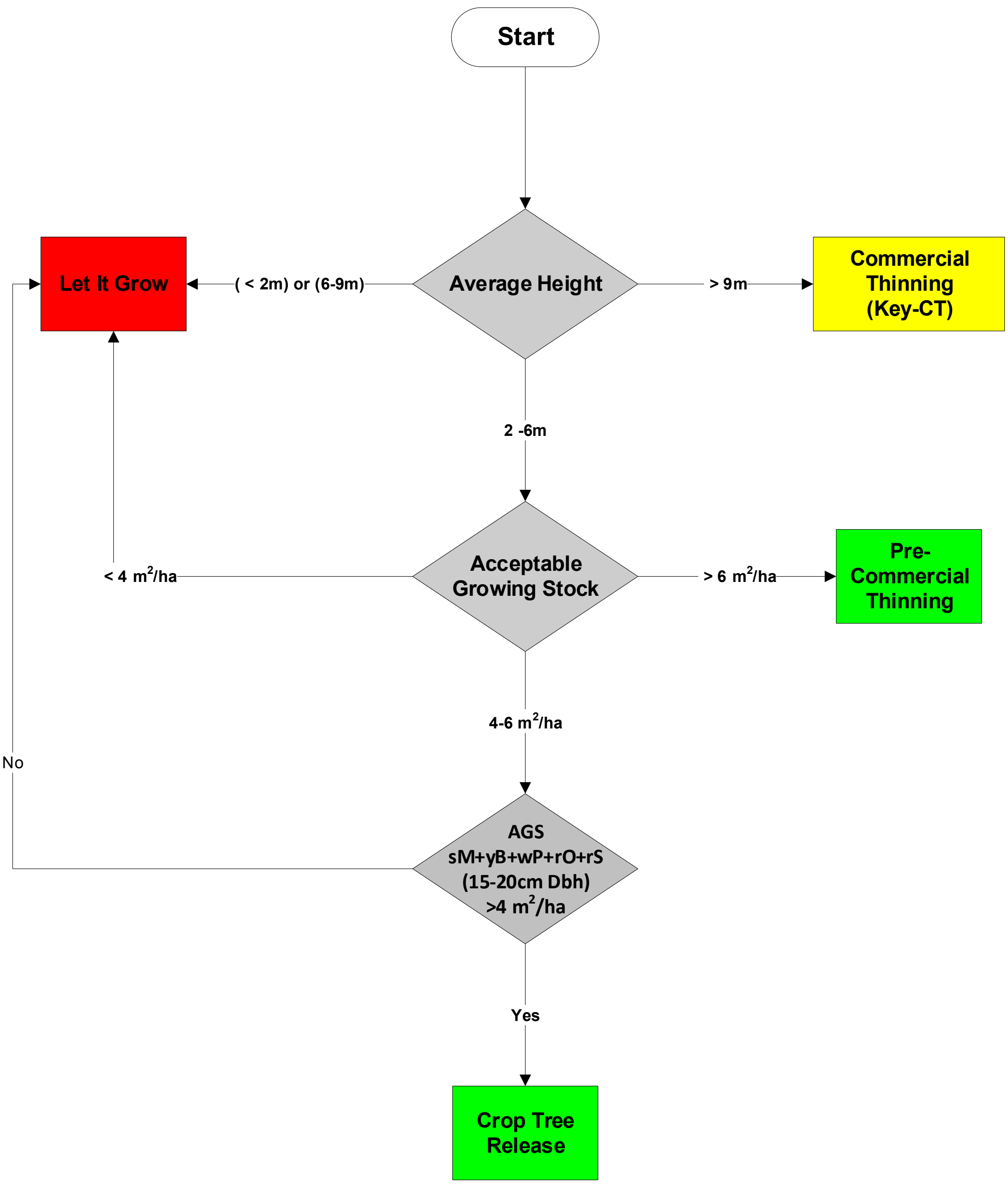
Silvicultural Prescriptions

- Single Tree Selection – This method involves a thinning across all size classes throughout the stand. This is done to create a diameter class distribution suitable for sustaining a periodic harvest over relatively short harvesting cycles (10–20 years). The objective is to create conditions suitable for regeneration of preferred species at each entry, while also improving the growing stock by releasing the highest quality trees. Basal area removals of 1/3 from the area between extraction trails is recommended. Trail widths should be minimized and distance between trails maximized to avoid windthrow. Shade-tolerant regeneration, such as of red spruce, eastern hemlock, and sugar maple, is favoured.
- Group Selection – This method involves identifying areas within the stand that are suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or advance regeneration. Gaps sized to create conditions suitable for natural seeding or releasing preferred regeneration are created. Maximum gap dimension is 0.1 hectares. Predominantly AGS areas are to be left in areas between gaps. They can be tended using pre-commercial thinning, commercial thinning, or crop-tree release methods. Intermediate shade-tolerant regeneration of white pine, white spruce (forest), yellow birch, and red oak is favoured. Reserves left in the groups will amount to 1/10 distributed basal area with a certain portion designated as permanent reserves (Table 4).

Maximum Gap Dimensions and Required Retention within Gap

Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

Spruce Hemlock
Sub-Key T - Tend



SUB-KEY SH-T – Tend

Instructions and Definitions for

Decision Diamonds

- **Average Height** – What is the average height of the stand in metres? Is it (i) less than 2 m or between 6m and 9 m, (ii) between 2 and 6 m, or (iii) greater than 9 m?
- **Acceptable Growing Stock** – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[26])?
- **AGS^F sM + yB + wP + rO +rS (15–20 cm Dbh) > 4 m^2/ha** – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 4 m^2/ha?

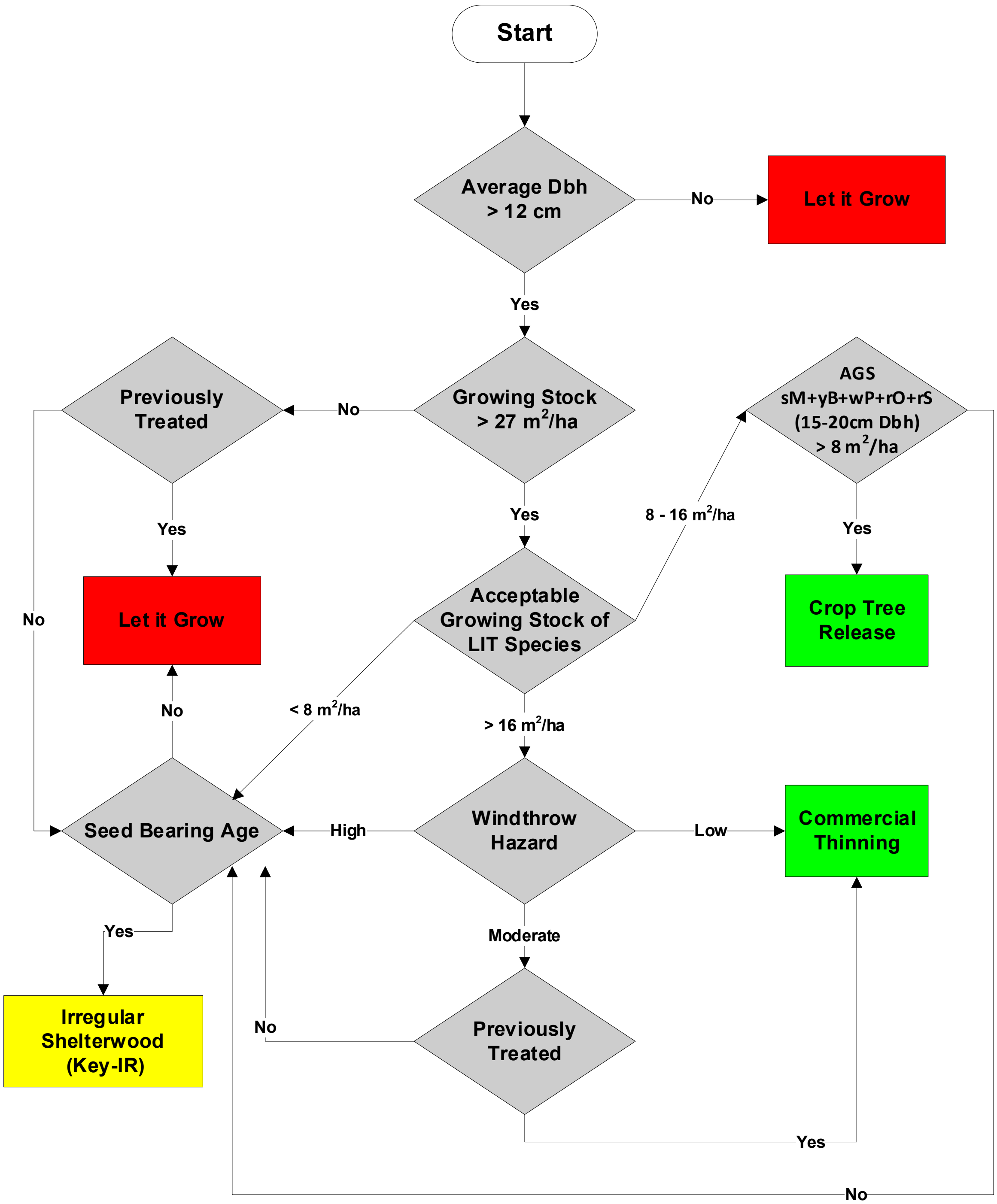
Silvicultural Prescriptions

- **Crop-Tree Release** – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees should be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- **Pre-commercial Thinning (PCT)** – Stands that have high levels of AGS uniformly distributed (on average at least every 3 m) are appropriate for pre-commercial thinning.
- **Let it grow** – Let the stand grow and re-evaluate later.

[26] AGS: Acceptable Growing Stock (AGS) trees are healthy have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

Spruce Hemlock

Sub-Key CT Commercial Thin



SUB-KEY SH-CT – Commercial Thinning

Instructions and Definitions for

Decision Diamonds

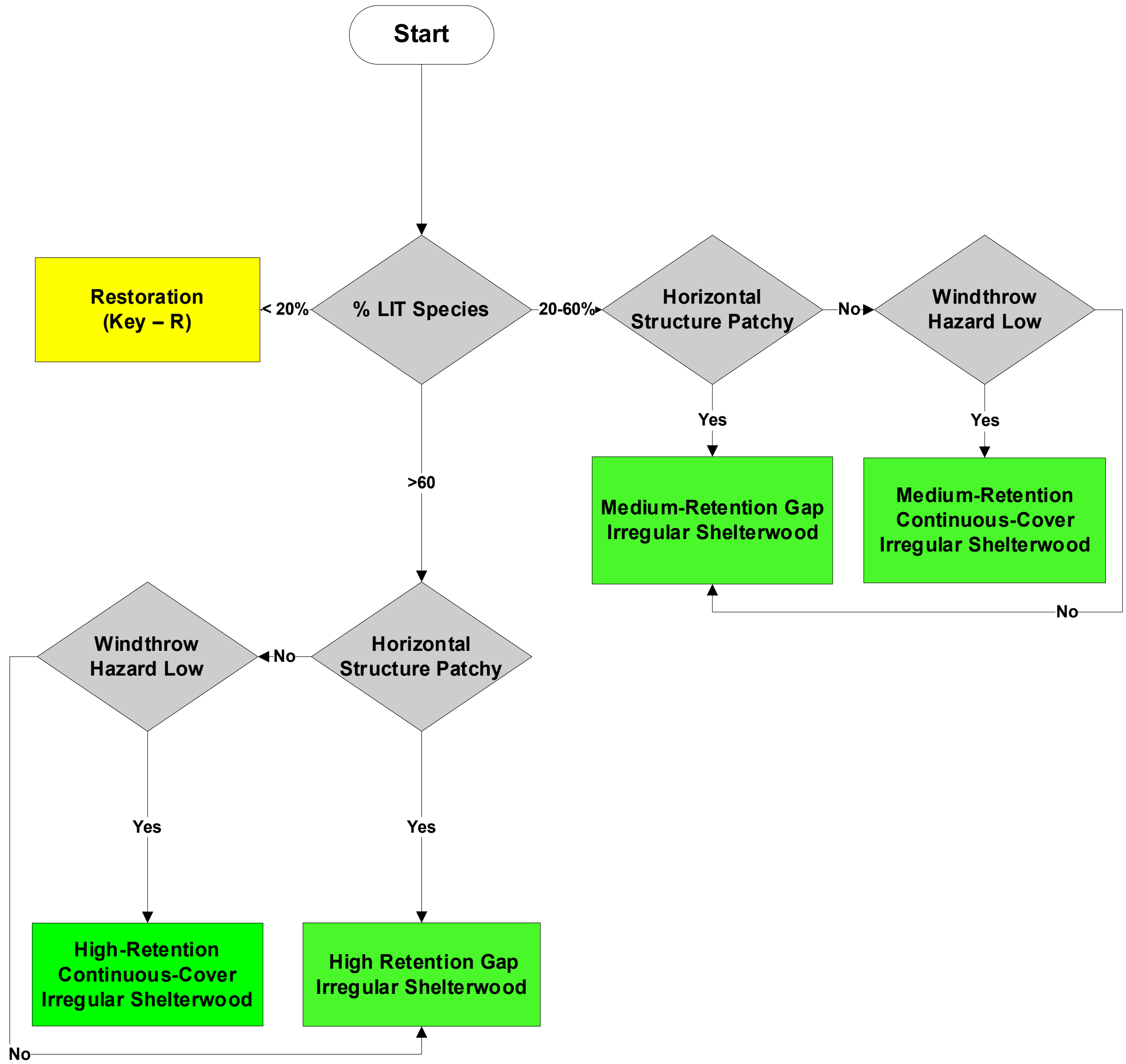
- Average Dbh > 12 cm – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- Growing Stock > 27 m^2/ha – Is the basal area (of trees ≥ 10 cm Dbh class) greater than 30 m^2/ha?
- Previously Treated – Has the stand been pre-commercially thinned, planted or commercially thinned?
- Acceptable Growing Stock of LIT species – What is the basal area in m^2/ha of Acceptable Growing Stock (AGS[27]) of Long-Lived Intermediate–Tolerant species (LIT[28]). Is it less than 8 m^2/ha, between 8 and 16 m^2/ha, or greater than 16 m^2/ha?
- AGS[F] sM + yB + wP + rO +rS (15–20 cm Dbh) > 8 m^2/ha – Is the Acceptable Growing Stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 8 m^2/ha?
- Windthrow Hazard – Is the windthrow hazard low, moderate, or high (Table 3)?
- Seed-Bearing Age – Is the overstory dominated by trees that have reached full seed-bearing age (Table 4)?

Silvicultural Prescriptions

- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Commercial Thinning (CT) – If high levels of AGS and adequate merchantable basal area exist, uniformly thin the stand. The objective of this treatment is to harvest lower quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. The stand should be left until it grows back the volume removed and becomes fully stocked (called “catch-up”). This will take on average 15–20 years when removing 1/3 of the basal area from the area between trails. The objective of this treatment is not to regenerate the stand although natural regeneration could occur especially after being carried out in older stands. Retain any large legacy trees that are likely older remnants of the previous stand.
- Let it grow – Let the stand grow and re-evaluate later.

[27] AGS: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.
[28] **LIT species**: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash.

Spruce Hemlock
Sub Key IR – Irregular Shelterwood



SUB-KEY SH-IR – Irregular Shelterwood

Instructions and definitions for

Decision Diamonds

- **% LIT[29] Species** – What is the % of LIT species by basal area? Is it < 20%, between 20 and 60% or greater than 60%?
- **Horizontal Structure Patchy** – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.
- **Windthrow Hazard** – Is the windthrow hazard low, moderate, or high (Table 3)?

Silvicultural Prescriptions

- **Medium-Retention Continuous-Cover Irregular Shelterwood** – Retain 1/2 of live, standing trees by basal area, distributed throughout the site.

- **High-Retention Continuous-Cover Irregular Shelterwood –** Retain 2/3 of live, standing trees by basal area, distributed throughout the site.

- **All Continuous-Cover Irregular Shelterwoods** – Although retention trees will be distributed throughout the site, distribution will likely be irregular, with some areas having higher retention than others. Refer to "Irregular Shelterwood" in the section of this guide called, "Silvicultural Systems" for further details. Retention objectives are found in the "Retention" section. The retention level is similar to that of a selection prescription, except that here, the residual diameter distribution is less important than recruiting LIT regeneration and retaining a diversity of tree species and sizes. There should be no gaps greater than (0.1 ha) in the residual stand. If this is not feasible, use a gap-based prescription. Permanent reserve trees are to be designated (Table 4) to be retained.

- **Medium-Retention Gap Irregular Shelterwood** – Leave 1/2 of the area, cutting small gaps distributed throughout the site with a maximum size of 0.2 ha.

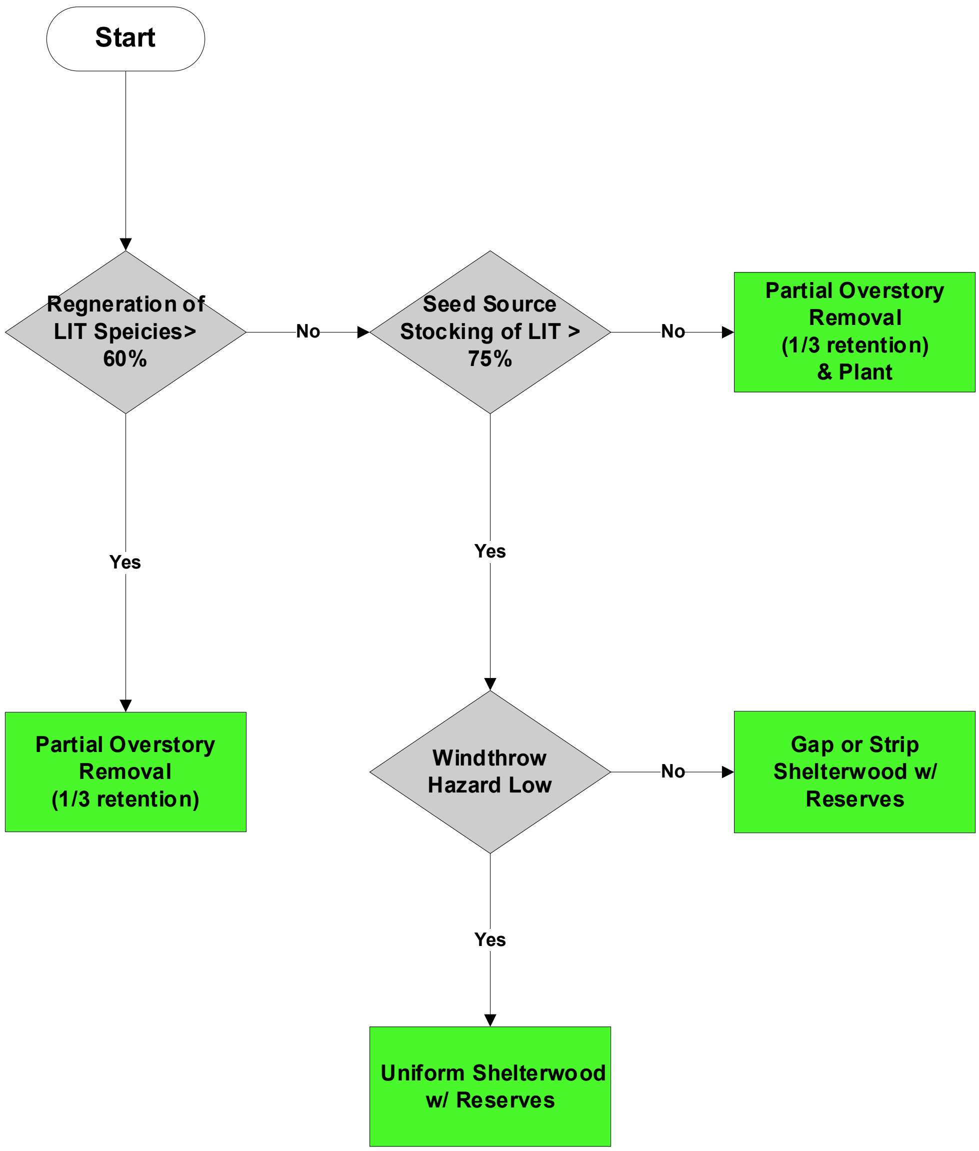
- **High-Retention Gap Irregular Shelterwood** – Leave 2/3 of the area, cutting the rest of the stand in small gaps distributed throughout the site.

- **All Gap Irregular Shelterwoods** – Identify areas within the stand suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or have advance regeneration. Establish gaps to create conditions suitable for natural seeding or release of preferred regeneration. Leave areas of predominantly younger AGS. Harvest small gaps distributed throughout the site. The size and distribution of these gaps does not necessarily need to be uniform. Leave maximum-sized gaps of 0.2 hectares. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this retention is designated as permanent reserves (Table 4). This retention is to be distributed through the gap and to consist of windfirm trees as much as possible. See the "Irregular Shelterwood" and "Retention" sections for further details and objectives.

Maximum Gap Dimensions and Required Retention within Gap								
Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

[29] **LIT species** – Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash

Spruce Hemlock
Sub Key R – Restoration



SUB-KEY SH-R – Restoration

Instructions and definitions for

Decision Diamonds

- Regeneration of LIT Species > 60% – Is the stocking to acceptable established[30] of Long-lived Intermediate to Tolerant species (LIT[31]) regeneration greater than 60% (at 2.4 m spacing)?
- Windthrow Hazard Low – Is the windthrow hazard low (refer to Table 3)?
- Seed Source Stocking of LIT > 75% – Is the stocking (to 20 m spacing) of seed source trees of Long-lived Intermediate to Tolerant (LIT[BB]) species greater than 75%?

Management Prescriptions

- Partial Overstory Removal and Plant – Where inadequate seed sources of LIT species exist, leave 1/3 of the basal area for Biodiversity. Under-plant species suited to the Ecosite (see Planting Table and Restoration section for recommendations). Weed if necessary. This retention should be distributed across the site. A certain portion of this retention must be designated as permanent reserves (Table 4).
- Partial Overstory Removal – Where inadequate regeneration of LIT species exist, leave 1/3 of the basal area. This retention should be distributed across the site. A certain portion of this retention must be designated as permanent reserves (Table 4).
- Uniform Shelterwood with Reserves (Establishment Cut) – Uniformly thin overstory to produce light conditions suited for intermediate to tolerant shade-tolerant late-succession species. Two-thirds of the basal area is to be retained from between extraction trails, when regenerating shade tolerant species (sugar maple, red spruce, or eastern hemlock). If intermediate shade tolerant species such as yellow birch, white ash, red oak or white pine is to be regenerated, retain 1/2 of the basal area from the area between extraction trails. Care must be taken to leave wind firm trees of seed-bearing age of intermediate to tolerant shade-tolerant, late-succession species as a seed source for natural regeneration. Designate permanent reserve trees according to Table 4.
- Gap or Strip Shelterwood with Reserves (Establishment Cut) – A gap shelterwood is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. Gap: Small groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate the desired species. Openings are to be up to 0.2 ha and up to 1/2 of the area is to be harvested in gaps. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this reserve is to be designated as permanent reserves (Table 4) Strip: Harvest stand in 2-stages. In the first stage, harvest trees in a strip 1 tree height in width leaving 1/10 of the basal area as reserves with a certain portion of these designated as permanent reserves. At this time, thin a strip equal in

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[30] Regeneration is considered **established** when taller than 30 cm, rooted in mineral soil and capable of withstanding increased light and heat due to complete overstory removal. All trees greater than 30 cm tall and less than 9cm in Dbh are considered regeneration. All regenerating commercial tree species (Table 1) are considered **acceptable** provided they are not poorly formed, have umbrella type crowns or have live crown ratios less than 1/3.

[31] **LIT** species - Long-lived Intermediate to Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

width adjacent to the cut strip, leaving 2/3 of the basal area. After regeneration has been established, cut the thinned strips (Release Cut, Partial Overstory Removal), leaving 1/5-1/3 of the basal area distributed throughout the stand with a certain portion designated as permanent reserves (Table 4). One-fifth of the basal area will be left in Edaphic Acadian ecosites and 1/3 left in Zonal Acadian ecosites.

Spruce Pine Decision Keys (SP)

Forest Group Characteristics

The frequency of stand-level natural disturbances such as windthrow and fires, usually maintains a cycle of even-aged forests in spruce–pine (SP) stands. These stand-level-disturbances are often intense leaving scattered residuals. This forest group can have a two-aged structure if the longer-lived white pine occurs, when the interval between disturbances is longer than usual. Evidence of gap dynamics and understory recruitment is not common (Neily et al., 2013).

In all cases Spruce-Pine Vegetation Types lead to an edaphic climax dominated by black spruce when found on Acadian ecosites. Some of the SP types can be found on Maritime boreal ecosites.

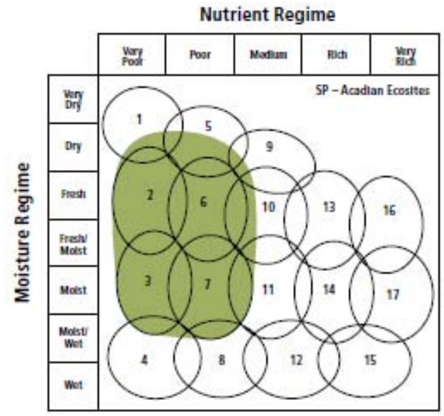


Figure 18. Acadian Ecosites where SP Vegetation Types are found

Vegetation types in the SP forest group are often associated with sandy soils, shallow soils over bedrock and outcrops, and stony sites. A wide range of soil moisture levels can be found, and fertility is generally poor throughout. SP vegetation types cover a range of successional stages, but typically lead to an edaphic[32] climax dominated by black spruce, white pine, or red oak.

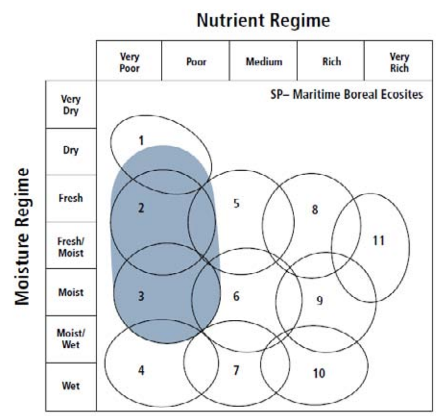


Figure 19. Maritime Boreal Ecosites where SP Vegetation Types are found

Silvicultural Considerations

Spruce–pine stands are suited to even-aged or 2 age-class silviculture systems. These systems can include partial overstory removal, shelterwood with reserves and irregular shelterwoods. Stand tending (PCT, Crop Tree Release) and commercial thinning can also be prescribed to improve stand timber quality and overall stand health on the more productive ecosites and to enhance biodiversity.

Since SP types occur primarily on very poor to poor ecosites, limited returns from plantation establishment, are expected. Natural regeneration should be considered the first choice for re-establishment of an SP forest stand. Those SP types dominated by black spruce are especially susceptible to windthrow because of their shallow rooting and poor windfirmness (Table 4). Caution is warranted if conducting commercial thinning or shelterwood treatments in this forest group. If stands are productive enough to support red spruce–hemlock, the spruce–hemlock (SH) forest silvicultural decision keys should be used.

In the SP group, fire and windthrow can occur frequently as stand-level natural disturbances, resulting in the establishment of a new stand.

[32] “**Edaphic**” refers to the influence of soil and site conditions on plant growth. It is used to express the dominance of site over climate in vegetation development. An edaphic climax forest community cannot progress to the zonal (normal) climatic climax because of local limitations in site condition.

Succession on these low fertility ecosites is less complex, for stand-level disturbances create even-aged or two-aged forests of similar species. Attempts to suppress the chances of fire in the ecosystem require forest managers to consider duff thickness management and ericaceous vegetation control in their prescriptions.

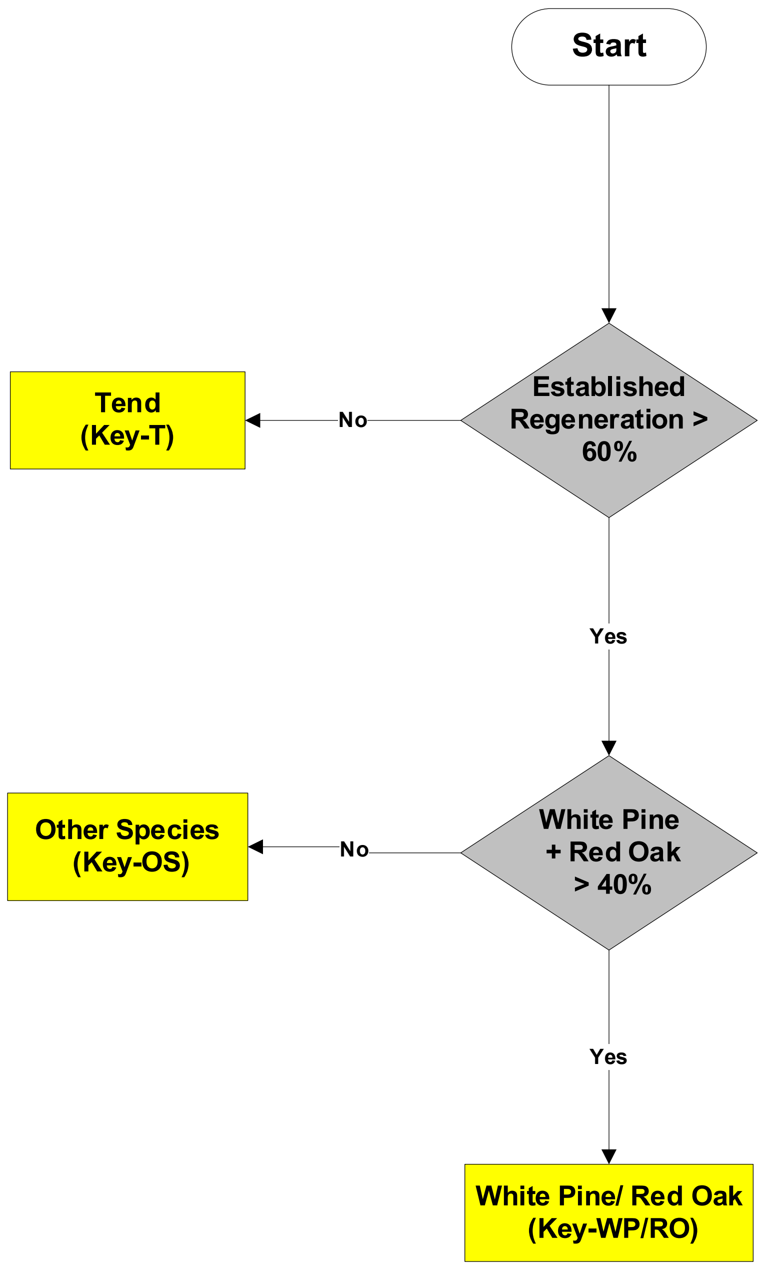
Hybridized Spruce

Red spruce and black spruce will produce hybrid offspring with traits of both species. The potential for hybridization occurs where ecosites AC6 and AC7 overlap with ecosites AC10 and AC11. Hybridized spruce is less nutrient-demanding than red spruce.

For these decision keys it is important to recognize hybrid spruce and call them either black or red based on site indicators as a different mix of silviculture systems are prescribed in the SP keys where black spruce is prevalent compared to the Spruce-Hemlock (SH) keys where red spruce is prevalent, These prescription differences recognize that SP vegetation types have different natural disturbance regimes than occur in SH types and therefore justify a different mix of silviculture systems. Hybrid spruce growing on lower fertility sites (such as those associated with soils derived from coarse sandstones and granites, soils shallow-to-bedrock, or soils rapidly or imperfectly drained) should be identified as black spruce. A significant coverage of ericaceous species[33] and bracken fern or an abundance of white pine may also indicate less fertile sites where hybrid spruce should be called black spruce. When these conditions are absent and the ground flora indicates a richer site, the hybrid spruce should be called red spruce and the SH key used.

[33] **Ericaceous species:** plants in or related to the heath family (*Ericaceae*). Usually found on acidic (nutrient poor) soils, species include lambkill (*Kalmia angustifolium*) and *Vaccinium* species such as blueberry, rhodora (*Rhododendron canadense*), and huckleberry (*Gaylussacia baccata*).

Spruce Pine
Key M - Main



KEY SP-M – Main

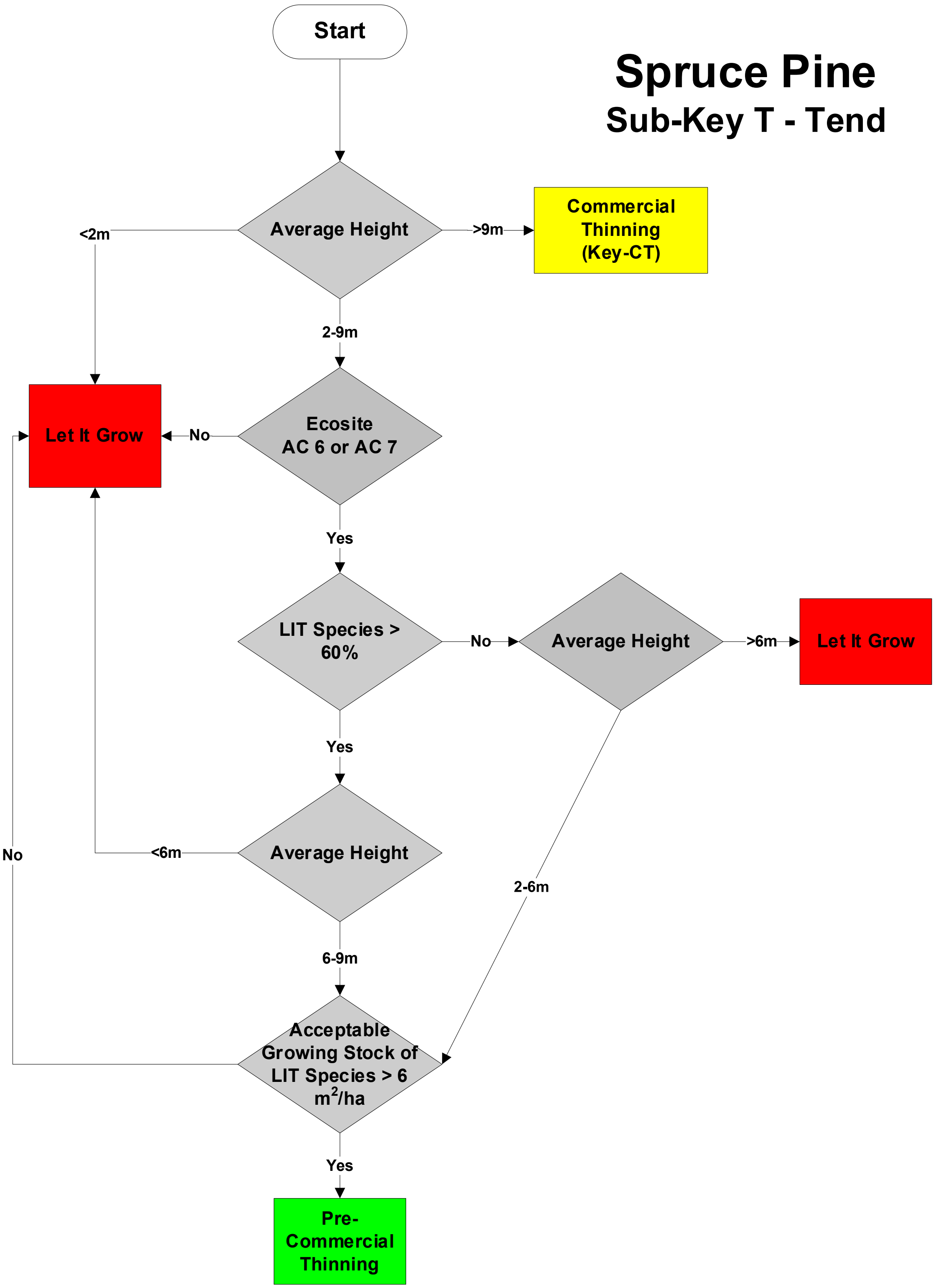
Instructions and Definitions for

Decision Diamonds

- Established Regeneration > 60% – Is the stocking to established regeneration[34] greater than 60% (at 2.4 m spacing)?
- White Pine + Red Oak > 40% – Is the stand made up of more than 40% white pine and red oak combined, as a percentage of stand basal area?

[34] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

Spruce Pine
Sub-Key T - Tend



SUB-KEY SP-T – Tend

Instructions and Definitions for

Decision Diamonds

- Average Height – What is the average height of the stand in metres?
- Ecosite AC6 or AC7 – Is the site predominately AC6 – Fresh Poor / Black spruce-White pine or AC7 – Moist-Poor / Back spruce-White pine (Neily et al., 2013)LIT[35] Species > 60% – Is the stand made up of more than 60% LIT species (as a percentage of stand basal area)?
- Acceptable Growing Stock of LIT Species > 6 m^2/ha– Is the basal area of acceptable growing stock (AGS[36]) of Long-Lived Intermediate–Tolerant (LIT[37]) species greater than 6 m^2/ha?

Silvicultural Prescriptions

- Pre-commercial Thinning (PCT) – Stands that have high levels of AGS uniformly distributed (on average at least every 3 m) are appropriate for uniform pre-commercial thinning.
- Let it grow – Let the stand grow and re-evaluate later.

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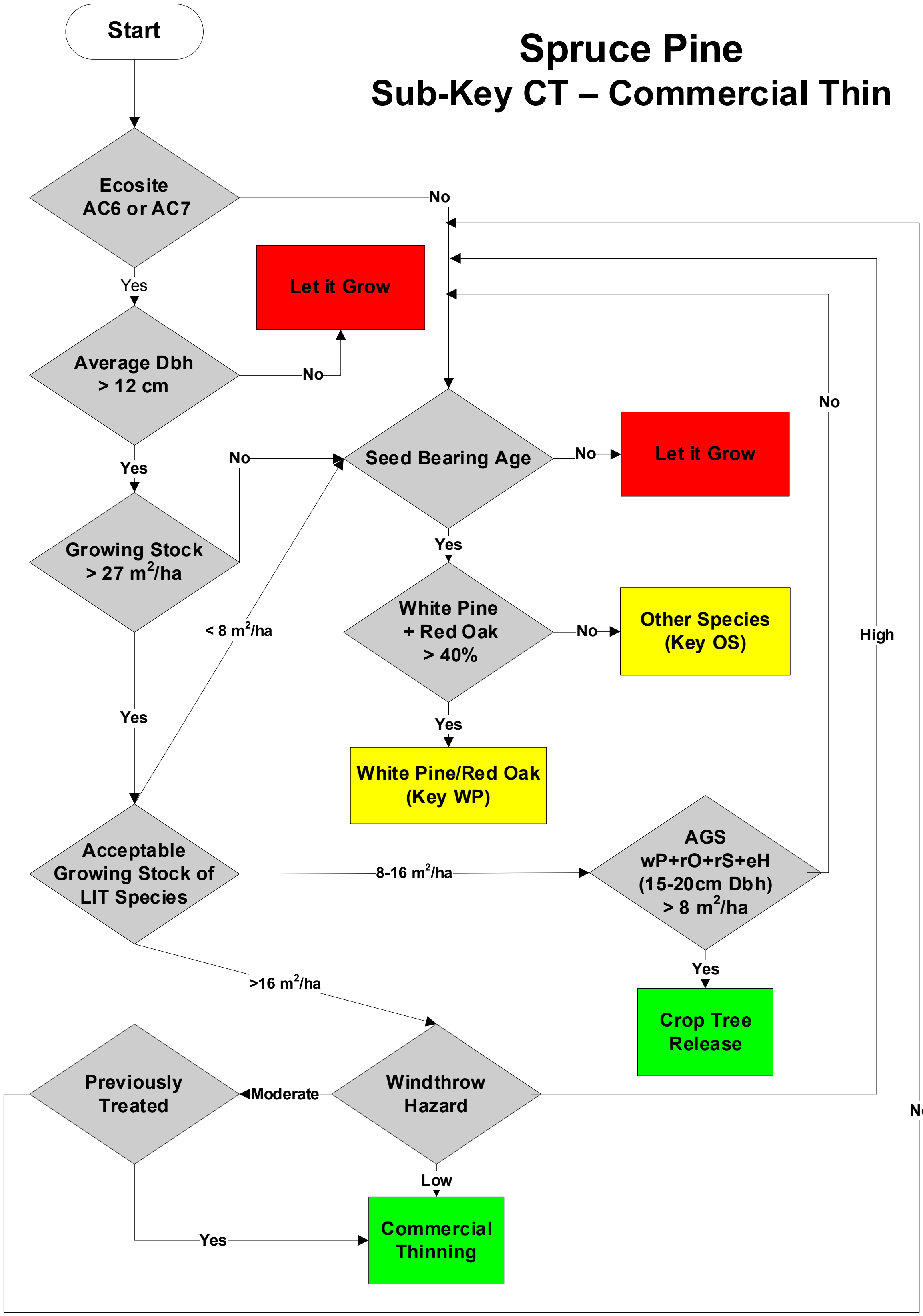
[35] **LIT species** – Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash

[36] AGS: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[37] **LIT** species: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

Spruce Pine
Sub-Key CT – Commercial Thin



SUB-KEY SP-CT – Commercial Thinning

Instructions and Definitions for

Decision Diamonds

- **Ecosite AC6 or AC7** – Is the site predominately AC6 – Fresh Poor / Black spruce-White pine or AC7 – Moist-Poor / Back spruce-White pine (Neily et al., 2013)
- **Growing Stock > 27 m^2/ha** – Is the basal area (of trees ≥ 10 cm Dbh class) greater than 27 m^2/ha?
- **Average Dbh > 12 cm** – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- **Acceptable Growing Stock of LIT Species** – What is the basal area in m^2/ha of acceptable growing stock (AGS[38]) of Long-Lived Intermediate–Tolerant (LIT[39]) species? Is it less than 8 m^2/ha, between 8 and 16 m^2/ha, or greater than 16 m^2/ha?
- **AGS^F wP + rO + rS + eH (15–20 cm Dbh) > 8 m^2/ha** – Is the Acceptable Growing Stock (AGS) basal area of white pine, red oak, red spruce and eastern hemlock trees in the 15 or 20 cm Dbh class greater than 8 m^2/ha?
- **Windthrow Hazard** – Is the windthrow hazard low, moderate, or high (Table 3)?
- **Seed-Bearing Age** – Is the overstory dominated by trees that have reached full seed-bearing age (Table 4)?
- **White Pine + Red Oak > 40%** – Is the stand made up of more than 40% red oak and white pine combined by basal area?
- **Previously Treated** – Has the stand been pre-commercially thinned, planted or commercially thinned?

Silvicultural Prescriptions

- **Let it grow** – Let the stand grow and re-evaluate later.
- **Crop-Tree Release** – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form, and have high-value potential. Trees should be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- **Commercial Thinning (CT)** – If high levels of AGS and adequate merchantable basal area exist, uniformly thin the stand. The objective of this treatment is to harvest lower quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. The stand should be left until it grows back the volume removed and becomes fully stocked (called "catch-up"). This will take on average 15–20 years when removing 1/3 of the basal area from the area between trails on average sites. Catch-up will be slower on poorer sites or if more basal area is removed. The best opportunities for an economically viable commercial thinning occur on more productive ecosites capable of

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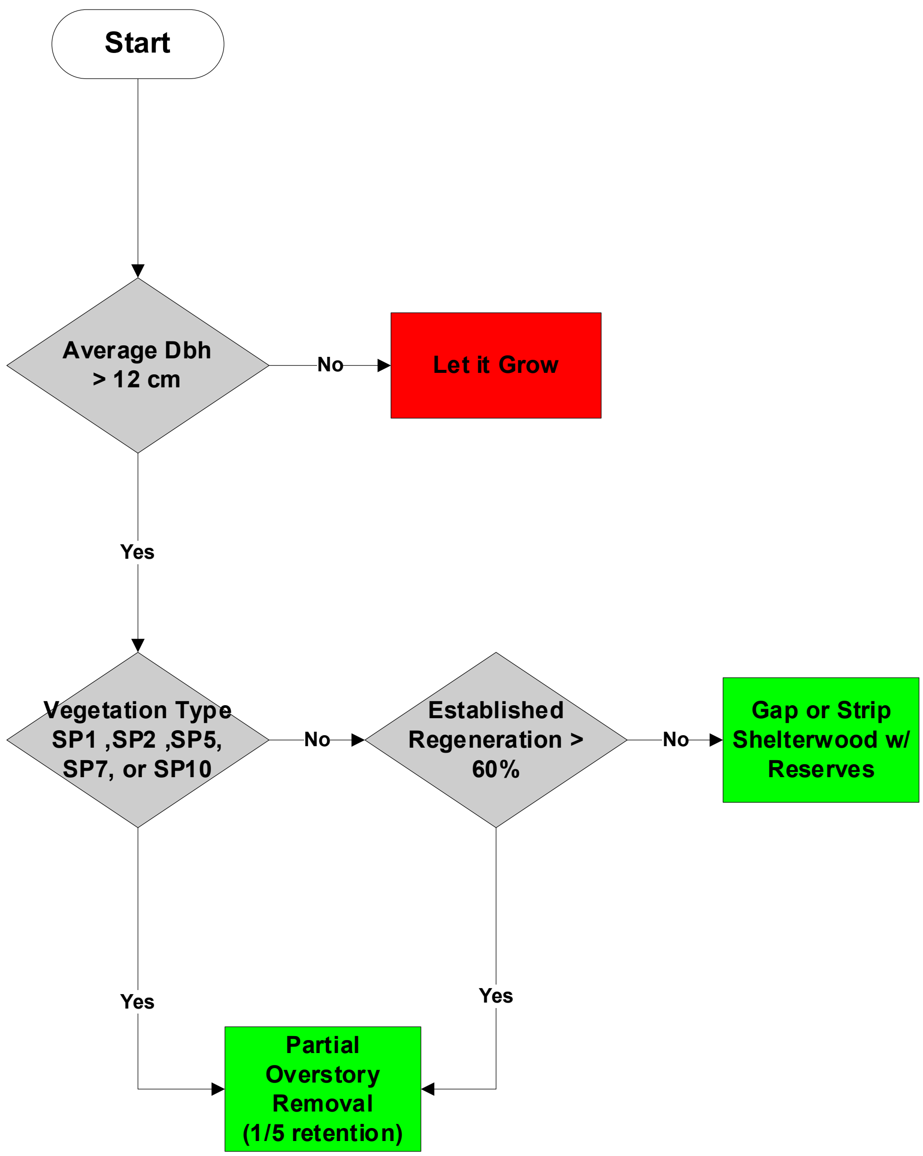
[38] AGS: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[39] **LIT**: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, and white ash (Table 1).

recapturing harvested volume from the thinning in a reasonable amount of time. Windthrow is a concern in all partially harvested stands, especially where soils are imperfectly to poorly drained or shallow-to-bedrock. Pine (except jack pine) and oak are deeper rooted than black spruce and less susceptible to windthrow. Commercial thinning is not recommended in eastern larch because of its naturally lower stocking levels and the self-thinning characteristics of this species. The objective of this treatment is not to regenerate the stand although sometimes natural regeneration is produced with this treatment, especially when carried out in older stands.

Spruce Pine
Sub-Key OS
Other Species



SUB KEY SP-OS – Other Species

Instructions and Definitions for

Decision Diamonds

- **Average Dbh > 12 cm** – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- **Vegetation Types SP1, SP2, SP5, SP7 or SP10** – Is the stand dominated by one of the following Vegetation Types: SP1 – Jack pine / Bracken – Teaberry, SP2 – Red pine / Blueberry / Bracken, SP5 - Black spruce / Lambkill / Bracken, SP7 – Black spruce / False holly / Ladies' tresses sphagnum, SP10- Tamarack / Wild raisin / Schreber's moss (Neily et al,, 2013)
- **Established Regeneration > 60%** – Is the stocking to established regeneration[40] greater than 60% (at 2.4 m spacing)?

Silvicultural Prescriptions

- **Let it grow** – Let the stand grow and re-evaluate later.
- **Partial Overstory Removal** – Retain 1/5 of the basal area distributed through the site to meet Biodiversity objectives. Leave a certain portion of this retention as permanent reserves (Table 4). This retention should be left in clumps to prevent blowdown. It is important to note that site preparation may be required in conjunction with this treatment as severe ericaceous competition may prevent adequate stocking to natural regeneration. Burning is one method that could be used to site prepare as this is the natural disturbance regime agent associated with stands dominated by black spruce on Edaphic sites. Mechanical site preparation may be required if burning is not appropriate or an available method.
- **Gap or Strip Shelterwood with Reserves** – A gap shelterwood is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. **Gap**: Groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate the desired species. Gaps up to 0.3 ha and amounting to 1/2 of the stand area are to be created. Retain 1/10-1/5 distributed clumps in these gaps with 1/10 left in the smaller gaps (0.1-0.2 ha) up to 1/5 in larger gaps (0.2-0.3 ha). A designated portion of this retention is considered permanent reserves (Table 4). **Strip**: Harvest stand in 2-stages. In the first stage, harvest trees in a strip up to 1 tree height in width while leaving 1/10 of the basal area as reserves in the strips. At this time, thin a strip equal in width adjacent to the cut strip, leaving 2/3 of the basal area. After regeneration has been established, carry out a release cut (Partial Overstory Removal), cutting the thinned strips, leaving 1/5 retention in cut strips with a certain portion designated as permanent reserves (Table 4). It is important to note that site preparation may be required in conjunction with this treatment as severe ericaceous competition may prevent adequate stocking to natural regeneration. Burning is one method that could be used to site prepare as this is the natural disturbance regime associated with stands dominated by black spruce on Edaphic dry sites. Mechanical site preparation may be required if burning is not appropriate or an available method.

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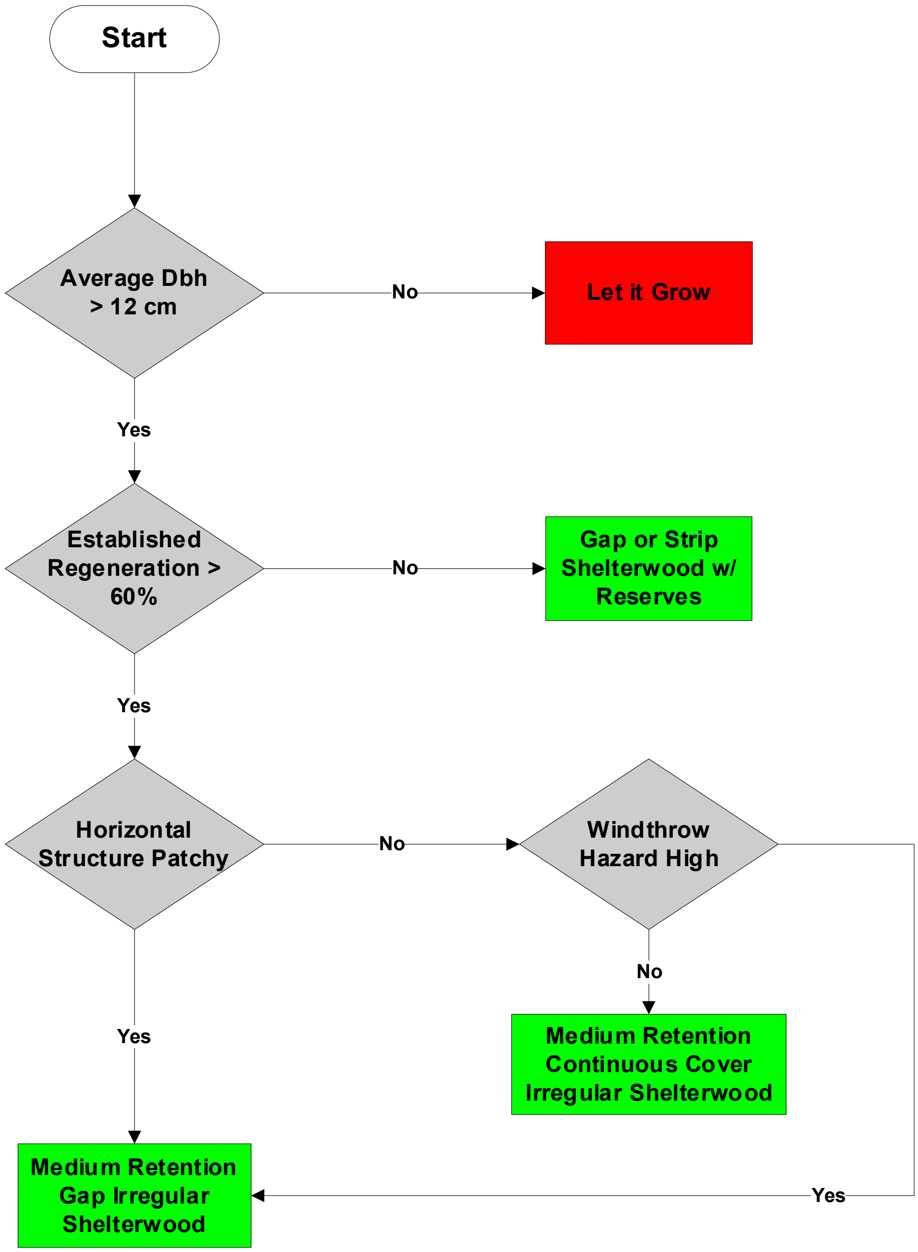
[40] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

Spruce Pine

Sub-Key WP/RO – White Pine/ Red Oak



SUB-KEY SP-WP – White Pine

Instructions and Definitions for

Decision Diamonds

- Average Dbh > 12 cm – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- Established Regeneration > 60% – Is the stocking to established regeneration[41] greater than 60% (at 2.4 m spacing)?
- Horizontal Structure Patchy – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.
- Windthrow Hazard High – Is the windthrow hazard high (Table 3)?

Silvicultural Prescriptions

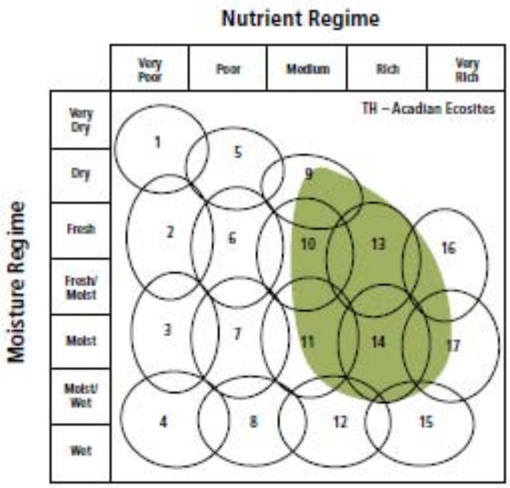
- Gap or Strip Shelterwood with Reserves – A gap shelterwood is preferred for biodiversity reasons. Strip shelterwoods will be considered with special permission as a user defined prescription. Gaps: Small groups of trees are cut uniformly throughout the stand without tending the unharvested areas. The main objective is to create the conditions to regenerate the desired species. Gaps are to be up to 0.2 ha covering 1/2 of the area. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). A certain portion of this retention is designated as permanent reserves (Table 4). Strip: Harvest stand in 2-stages. In the first stage, harvest trees in a strip up to 1 tree height in width while leaving 1/10 retention, with a certain portion designated as permanent reserves (Table 4). At this time, thin a strip equal in width adjacent to the cut strip, leaving 2/3 of the basal area. After regeneration has been established, perform a release cut (Partial Overstory Removal) cutting the thinned strips, leaving 1/5 of the basal area distributed as reserves with a certain portion designated as permanent reserves (Table 4).
- Medium-Retention Continuous-Cover Irregular Shelterwood – Retain 1/2 of the live basal area, distributed throughout the site. Although retention trees will be distributed throughout the site, distribution will likely be irregular, with some areas having higher retention than others. Refer to "Irregular Shelterwood" in the section of this guide called, "Silvicultural Systems" for further details and objectives. Permanent reserves trees must be designated as part of the retentions (Table 4). See the "Retention" section for retention tree objectives.
- Medium-Retention Gap Irregular Shelterwood – Leave 1/2 of the area, removing the rest of the stand in small gaps distributed throughout the site.

Identify areas within the stand suitable for harvesting or regeneration because they are predominantly mature, contain non-

Maximum Gap Dimensions and Required Retention within Gap								
Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

[41] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

commercial trees or have advance regeneration. Establish gaps to create conditions suitable for natural seeding or releasing preferred regeneration. Leave areas of predominantly younger AGS. Harvest small gaps distributed throughout the site. The size and distribution of these gaps does not necessarily need to be uniform. Leave gaps of up to 0.2 hectares. Retain 1/10-1/5 distributed live trees in these gaps with 1/10 left in the smaller gaps (0.1 ha) up to 1/5 in larger gaps (0.2ha). Permanent reserves are to be left as part of these reserves (Table 4). This retention is to be distributed through the harvest groups and to consist of windfirm trees as much as possible. See the “Irregular Shelterwood” and “retention” sections for further details and retention objectives.



Forest Group Characteristics

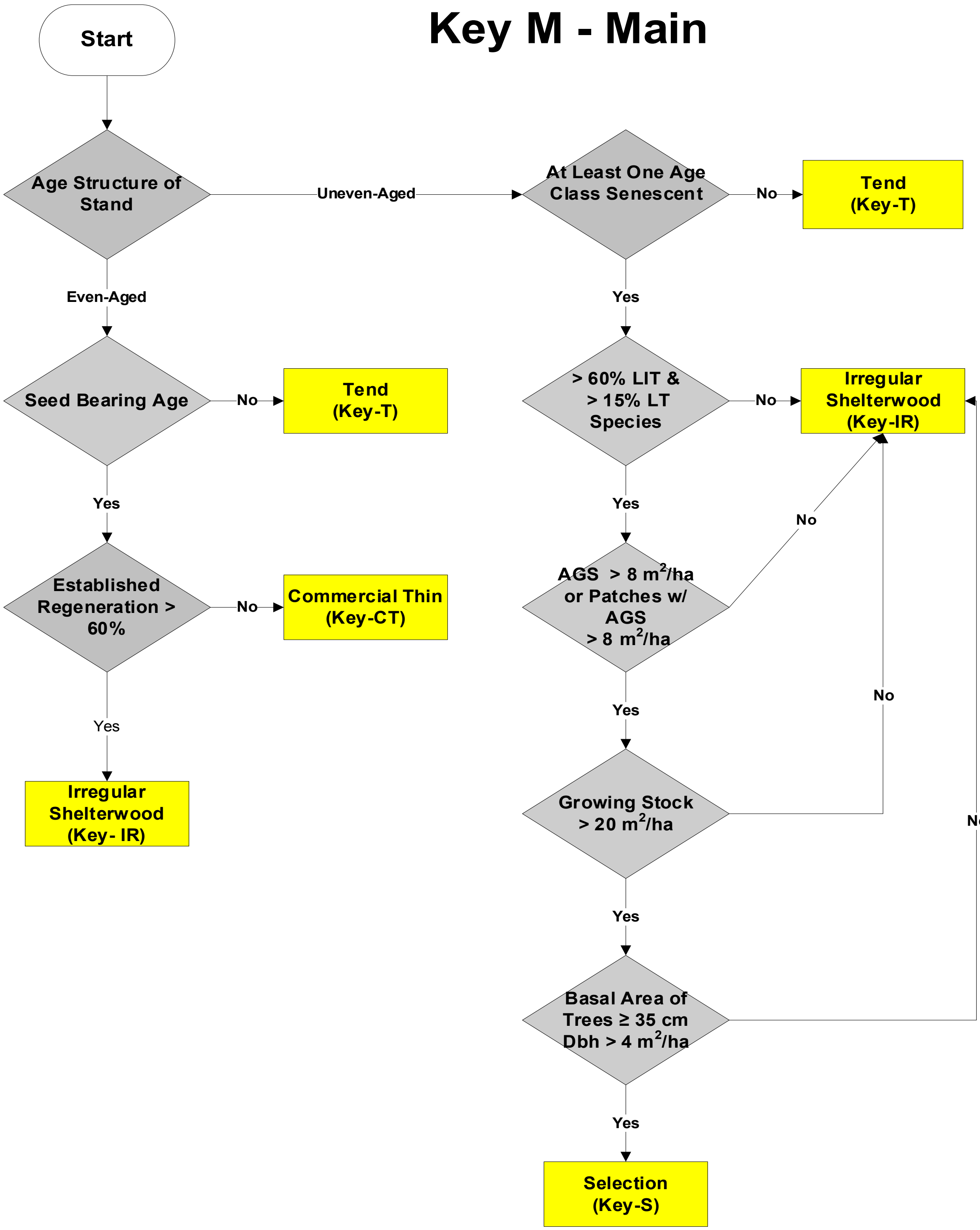
Tolerant hardwood (TH) vegetation types include mostly late-successional stands. Most TH types are dominated by moderate to shade-tolerant, long-lived, deep-rooted species such as sugar maple, yellow birch, and white ash. Tolerant hardwoods usually grow in rich, well-drained, deep soils, with a moisture condition ranging from fresh to moist. Late-successional uneven-aged stands are common because of the relatively low frequency of stand replacing events and the predominance of gap replacement disturbances. In mid-successional TH stands the shorter-lived and moderate-shade-tolerant species, such as red maple, red oak, and yellow birch, are dominant. The species content of TH stands is often influenced by slope position. A drier crest and upper slope are more frequently occupied by beech. Sugar maple tends to thrive in mid-slope positions, while lower slopes tend to be occpied by a mixture of red maple and softwoods along with tolerant hardwoods. In riparian areas sugar maple frequently occurs along with white ash.

Silvicultural Considerations

Tolerant hardwoods (yellow birch, sugar maple, and white ash) account for 28% of the hardwood volume (39 million m^3) growing in Nova Scotia (Townsend, 2004). Part of this tolerant hardwood volume (4 %) has high value for sawlogs and veneer (Keys et al., 2007). Although the proportion of hardwoods suitable for high-value products is low at present, with proper management it can be increased. To accomplish this, silvicultural practices must be compatible with production of quality sawlogs on appropriate sites. Clearcutting high-quality young growing stock and, or high-grading the best logs, leaving poor quality stems, reduces the future health and potential for growing quality timber and could move stands into earlier successional stages.

High beech content can impede sugar maple regeneration. Beech suckers proliferate after harvest and are very shade-tolerant, giving the beech a competitive advantage over the slower-growing sugar maple. Beech has been relegated to a low-quality, short lived species because of the high incidence of beech bark disease in Nova Scotia. In situations where beech is prevalent, consideration should be given to harvesting the overstory in small patches and preparing the site to create mineral soil microsites favourable to faster-growing and less shade-tolerant yellow birch. Beech has high value for biodiversity if producing mast. Mature mast trees are to be retained. Disease-free beech trees should also be retained,

Tolerant Hardwood
Key M - Main



KEY TH-M – Main

Instructions and Definitions for

Decision Diamonds

- Age Structure of Stand – Is the stand uneven-aged or even-aged. A uneven-aged stand has at least two age classes. Each age-class must be at least pole sized (> 20 years of age), with age-classes separated by at least 20 years.
- Seed Bearing Age – Is the overstory dominated by trees that have reached full seed-bearing age (Table 1)?
- Established Regeneration > 60% – Is the stocking to established regeneration[42] greater than 60% (at 2.4 m spacing)?
- At Least One Age Class Senescent – Does this uneven-aged stand have any age-class that is past the onset of senescence (see Table 1)?
- > 60% LIT & > 15% LT Species – Is the stand made up of more than 60% Long-Lived Intermediate–Tolerant (LIT) species, including red spruce, eastern hemlock, white pine, white spruce, sugar maple, yellow birch, red oak, red maple, and white ash? Does it consist of more than 15% Long-Lived Tolerant (LT) species, including red spruce, eastern hemlock, and sugar maple (as a percentage of stand basal area)?
- AGS > 8 m^2/ha or Patches w/ AGS > 8 m^2/ha – Does the stand have 8 m^2/ha of acceptable growing stock (AGS[43]), or does it have patches of mature trees to be harvested, intermixed with patches of smaller acceptable growing stock worthy of tending? The amount of AGS must be greater than 8 m^2/ha.
- Growing Stock > 20 m^2/ha – Is the basal area (of trees in Dbh class ≥ 10cm) greater than 20 m^2/ha?
- Basal Area of Trees ≥ 35 cm Dbh > 4 m^2/ha – Is the basal area (of trees Dbh class ≥ 25 cm) greater than 4 m^2/ha of trees ≥ 35 cm Dbh?

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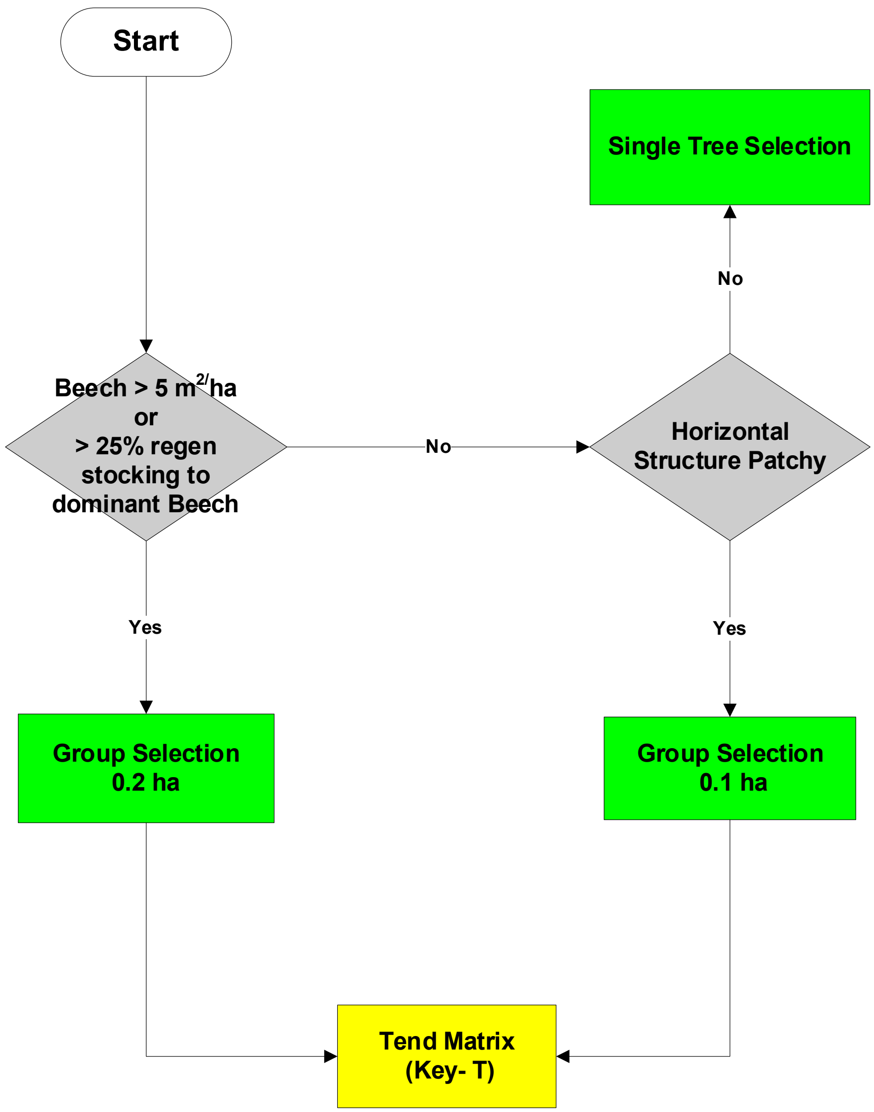
[42] To be considered regeneration, trees must be taller than 30 cm and less than 9 cm in diameter at breast height. Regeneration is considered **established** when a tree is taller than 30 cm, rooted in mineral soil, and capable of withstanding increased light and heat following complete overstorey removal. All regenerating commercial tree species (Table 1) are included.

[43] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

Tolerant Hardwood
Sub-Key S – Selection



SUB-KEY TH-S – Selection

Instructions and Definitions for

Decision Diamonds

- Beech > 5 m^2/ha or regeneration > 25% stocked to dominant Beech – Is beech growing stock greater than 5 m^2/ha, or is dominant regeneration stocking to beech greater than 25%?
- Horizontal Structure Patchy – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.

Silvicultural Prescriptions

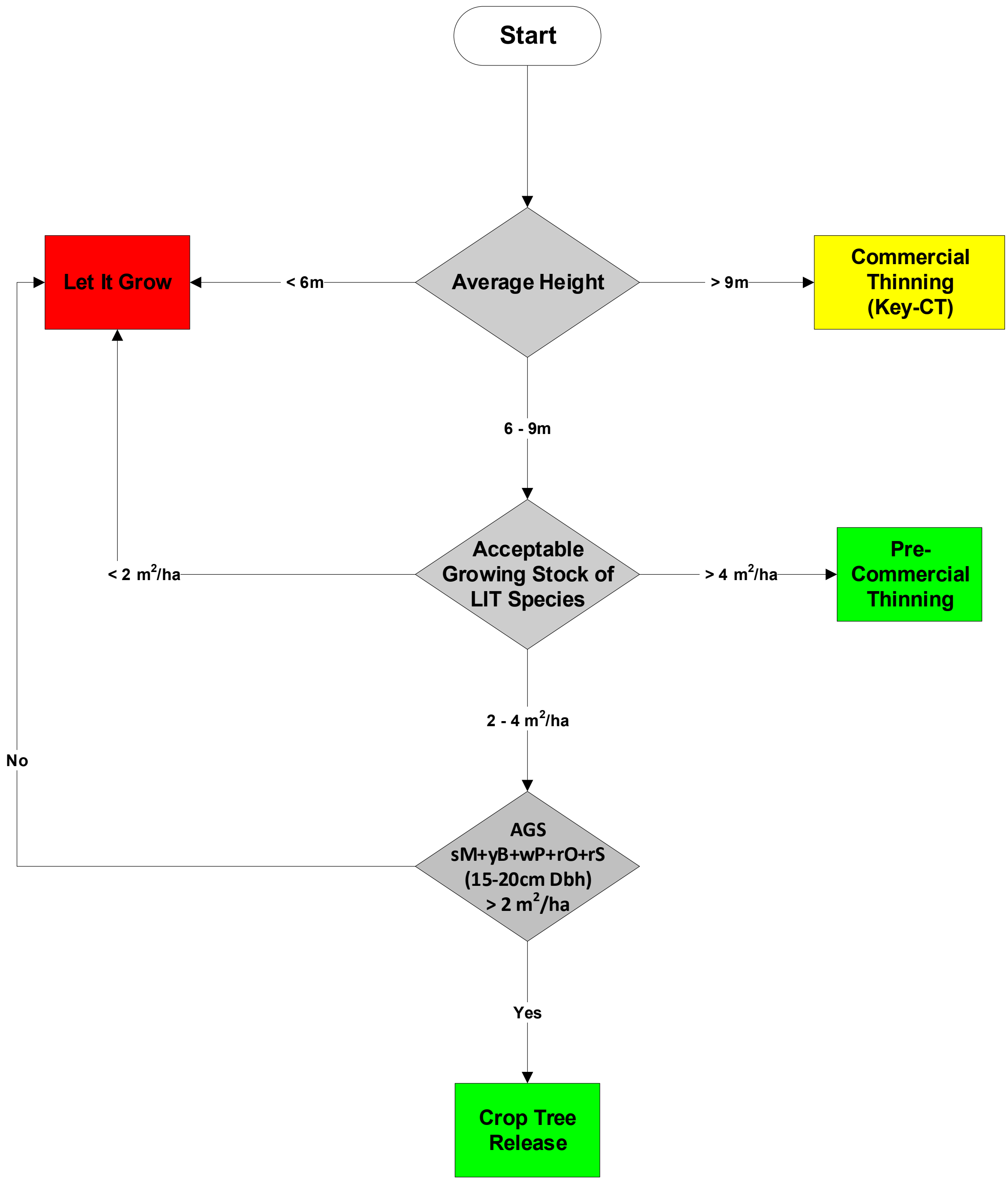
- Single Tree Selection – This method involves a thinning across all size classes throughout the stand. to create a age class distribution suited to sustaining a periodic harvest over relatively short harvesting cycles (10–20 years). The objective is to create conditions suitable for regeneration of preferred species at each entry, while also improving the growing stock by releasing the highest quality trees. Basal area removals of 1/3 from areas between extraction trails are recommended. Shade-tolerant species regeneration, such as of beech and sugar maple, is favoured. Where the proportion of beech is high, it will dominate sugar maple under high-shade conditions. A certain portion of these reserves are designated as permanent (Table 4).

Maximum Gap Dimensions and Required Retention within Gap								
Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	(%)
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10

- Group Selection – Group Selection involves identifying areas within the stand that are suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or have advance regeneration. These areas are to be harvested to create conditions suitable for preferred regeneration. Predominantly AGS areas are to be left. Areas outside harvest gaps can be tended using either pre-commercial thinning, commercial thinning, or crop-tree release methods (Lamson and Leak, 2000). Beech Dominant – Where beech is dominant, larger openings are prescribed (0.2 ha), leaving 1/5 of the basal area as distributed reserve trees. A certain portion of these reserves are designated as permanent (Table 4). Sugar Maple – Where beech is not dominant form smaller gaps (0.1 ha), leaving 1/10 of the basal area as distributed reserve trees within them. A certain portion of these reserves are designated as permanent (Table 4). Sugar maple will be favoured in these situations.

Tolerant Hardwood

Sub-Key T - Tend



SUB-KEY TH-T – Tend

Instructions and Definitions for

Decision Diamonds

- Average Height – What is the average height of the stand in metres?
- Acceptable Growing Stock of LIT Species – What is the basal area in m^2/ha of acceptable growing stock (AGS[44]) of Long-Lived Intermediate–Tolerant species (LIT[45])? Is it less than 2 m^2/ha, between 2 and 4 m^2/ha, or greater than 4 m^2/ha?
- AGS^F sM + yB + wP + rO + rS (15–20 cm Dbh) > 2 m^2/ha – Is the acceptable growing stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15 or 20 cm Dbh class greater than 2 m^2/ha?

Silvicultural Prescriptions

- Let it grow – Let the stand grow and re-evaluate later.
- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous trees of good form and have high-value potential. Trees should be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m (30ft) apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Pre-commercial Thinning (PCT) – Stands that have high levels of AGS uniformly distributed (on average at least every 3 m) are appropriate for uniform pre-commercial thinning.

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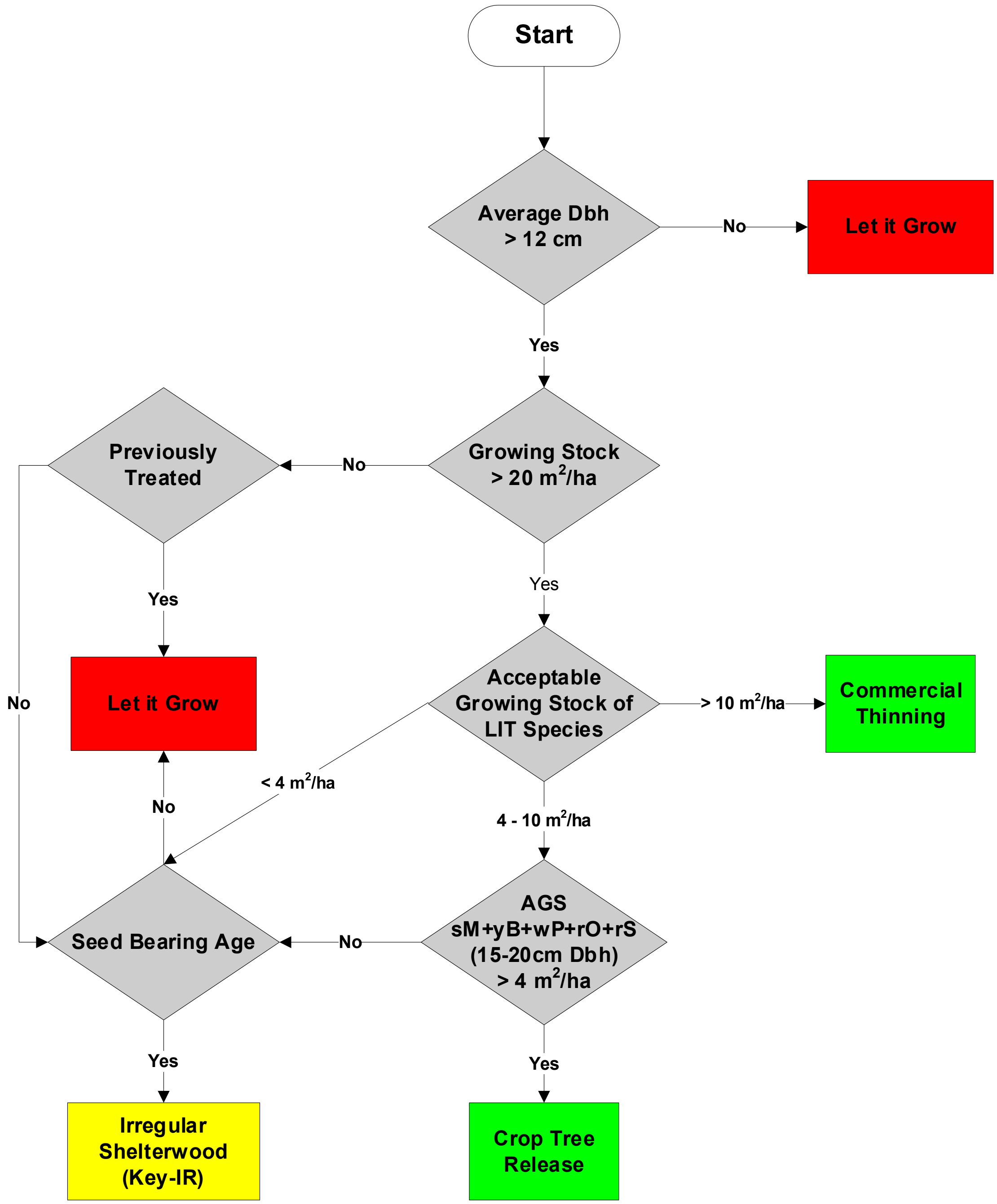
[44] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[45] **LIT:** Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, red maple, and white ash (Table 1).

Tolerant Hardwood
Sub-Key CT – Commercial Thin



SUB-KEY TH-CT – Commercial Thinning

Instructions and Definitions for

Decision Diamonds

- Average Dbh > 12 cm – Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- Growing Stock > 20 m^2/ha – Is the basal area (of trees Dbh class ≥ 10 cm) greater than 20 m^2/ha?
- Previously Treated – Has the stand been pre-commercially thinned, planted, commercially thinned, or partially harvested?
- Acceptable Growing Stock of LIT Species – What is the basal area in m^2/ha of acceptable growing stock (AGS[46]) of Long-Lived Intermediate–Tolerant (LIT[47]) species? Is it less than 4 m^2/ha, between 4 and 10 m^2/ha, or greater than 10 m^2/ha?
- AGS[F] sM + yB + wP + rO +rS (15–20 cm Dbh) >4 m^2/ha – Is the acceptable growing stock (AGS) basal area of sugar maple, yellow birch, white pine, red oak and red spruce trees in the 15–20 cm Dbh class greater than 4 m^2/ha?
- Seed-Bearing Age – Is the overstory dominated by trees that have reached full seed-bearing age (Table 1)?

Silvicultural Prescriptions

- Crop-Tree Release – Where there are moderate levels of sugar maple, yellow birch, white pine, red spruce and/or red oak AGS, release trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous trees of good form and have high-value potential. Trees must be self-pruned for at least the length of one sawlog or be manually pruned. Released trees must be at least 10 m (30ft) apart. Cut only trees touching the crowns of crop trees; leave remaining trees standing.
- Commercial Thinning (CT) – If high levels of AGS and adequate merchantable basal area exist, uniformly thin the stand. The objective of this treatment is to harvest lower quality merchantable trees and leave well-formed, healthy trees of preferred long-lived species to accelerate their growth. The stand should be left until it grows back the volume removed and becomes fully stocked (called "catch-up"). This will take on average 15–20 years when removing 1/3 of the basal area from the area between trails. The objective of this treatment is not to regenerate the stand although regeneration could result from this treatment, especially when carried out in older stands. Retain any large legacy trees that are likely older remnants of the previous stand.
- Let it grow – Let the stand grow and re-evaluate later.

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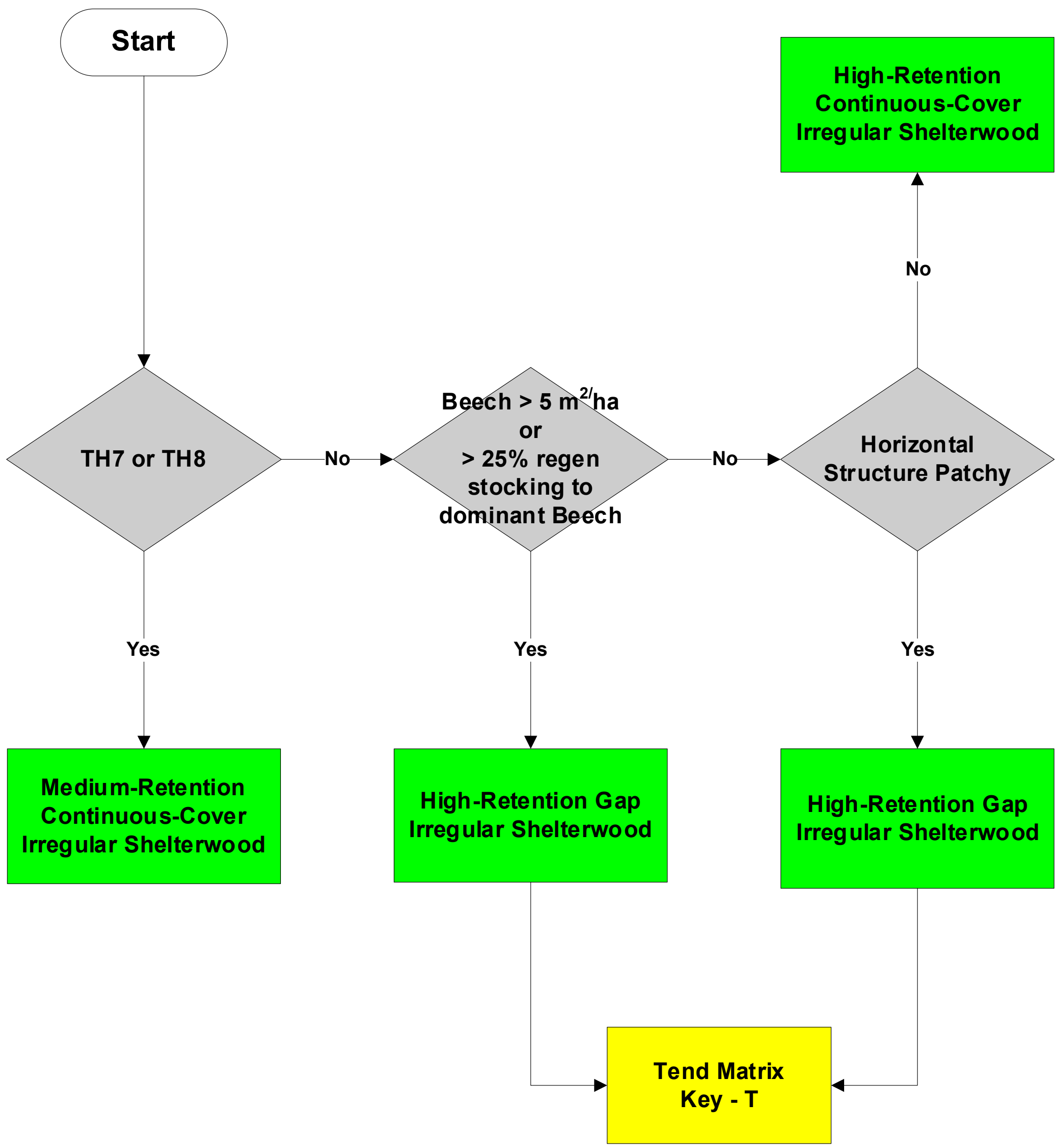
[46] **AGS**: Acceptable Growing Stock (AGS) trees are healthy, have the potential to produce high-value stems capable of meeting sawlog (hardwoods or softwoods) or studwood (softwood) specifications in the future, and are able to thrive after thinning until the time of the next harvest.

[47] **LIT**: Long-Lived Intermediate–Tolerant species, including red spruce, eastern hemlock, white pine, white spruce (forest), sugar maple, yellow birch, red oak, red maple, and white ash.

Tolerant Hardwood
Sub-Key IR – Irregular Shelterwood



SUB-KEY TH-IR – Irregular Shelterwood

Instructions and definitions for

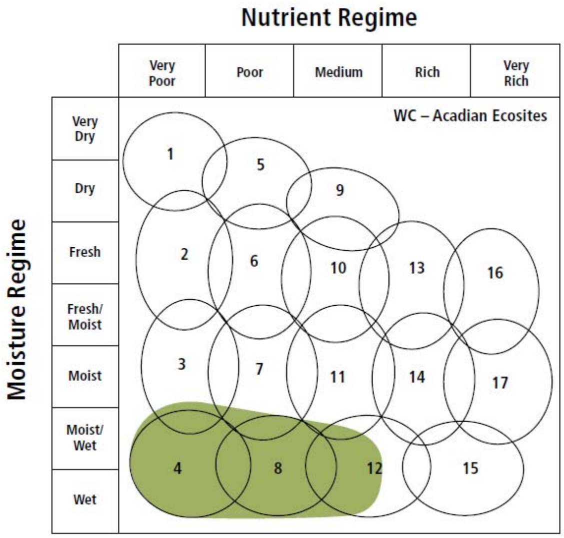
Decision Diamonds

- **TH7 or TH8** = Is the stand dominated by the TH7 (Yellow birch – White birch /Evergreen wood fern) or the TH8 Vegetation Type (Red Maple – Yellow Birch / Striped Maple) (Neily et al., 2013)?
- **Beech > 5 m^2/ha or regeneration > 25% stocked to dominant Beech** – Is beech growing stock greater than 5 m^2/ha or dominant regeneration stocking to beech greater than 25%?
- **Horizontal Structure Patchy** – Does the stand consist of areas with different age-classes. This condition must predominate in the stand.

Silvicultural Prescriptions

- **Medium-Retention Continuous-Cover Irregular Shelterwood** – Retain 1/2 of live, standing trees by basal area, distributed throughout the site.
- **High-Retention Continuous-Cover Irregular Shelterwood** – Retain 2/3 of live, standing trees by basal area, distributed throughout the site.
- **All Continuous-Cover Irregular Shelterwoods** – Although retention trees will be distributed throughout the site, distribution will likely be irregular, with some areas having higher retention than others. Refer to the “Silvicultural Systems” and “Retention” sections for further details and objectives. The retention levels are similar to that of a selection prescription, except that here, the residual diameter distribution is less important than recruiting LIT regeneration and retaining a diversity of tree species and sizes. Permanent reserve trees must be left (see Table 4)
- **High-Retention Gap Irregular Shelterwood** – Leave 2/3 of the area, removing the rest of the stand in small gaps distributed throughout the site. Identify areas within the stand suitable for harvesting or regeneration because they are predominantly mature, contain non-commercial trees or contain advance regeneration. Establish gaps that create conditions suitable for natural seeding or release of preferred regeneration. Leave areas of predominantly younger AGS. Cut small gaps distributed throughout the site. The size and distribution of these gaps does not necessarily need to be uniform. Leave maximum-sized gaps of 0.1 hectares. Retain 1/10 distributed live tree basal area in these gaps with a designated portion as permanent reserves (Table 4). This retention is to consist of windfirm trees as much as possible. See the “Silvicultural Systems” and “Retention” sections for further details and retention objectives. Where high levels of Beech occur, the maximum gap size is 0.2 hectares. Where gaps of this size are left, 1/5 basal area reserves must be left distributed in the gaps with a certain portion as permanent reserves (Table 4)

Maximum Gap Dimensions and Required Retention within Gap								
Area		Circular Radius			Square Side Length			Retention
(ha)	(acre)	(m)	(ft)	# of tree heights	(m)	(ft)	# of tree heights	(%)
0.20	½	25	83	2	45	147	3	1/5
0.10	¼	18	59	1.5	32	104	2	1/10



Forest Group Characteristics

The wet coniferous (WC) forest group is characterized by sites with water near or at surface level most of the year. The moisture regime is typically wet, with poorly to very poorly drained soils. Fertility is also a challenge on most of these sites (very poor to medium fertility; Neily et al., 2013).

Black spruce is the dominant species in most cases, but on some of the nutrient poor to medium sites red spruce, balsam fir, and eastern hemlock occur. On the poorer and wetter sites tamarack may dominate. In all cases, trees have limited rooting space because of moisture conditions. Some of the black spruce sites have limited cover because of site conditions. Cover increases in the relatively richer WC stands dominated by red spruce, balsam fir, and hemlock.

WC forests types support many rare and at-risk species, including a third of the NS birds listed at-risk both nationally and provincially, notably the Canada Warbler,Rusty Blackbird, and Olive-Sided Flycatcher (Brazner and MacKinnon 2020; EC 2015a; 2015b; 2016a). The Olive-sided Flycatcher and the Canada Warbler are experiencing ongoing steep population declines, especially in the eastern portion of their range in New Brunswick and Nova Scotia (GC 2002, ECCC 2017). Population decline appears to be directly related to habitat loss (CCFM 2019). Direct threats to these species include conversion of forested wetlands, forest harvesting, and anthropogenic changes in surface hydrology of wetlands (EC 2015a; 2015b; 2016).

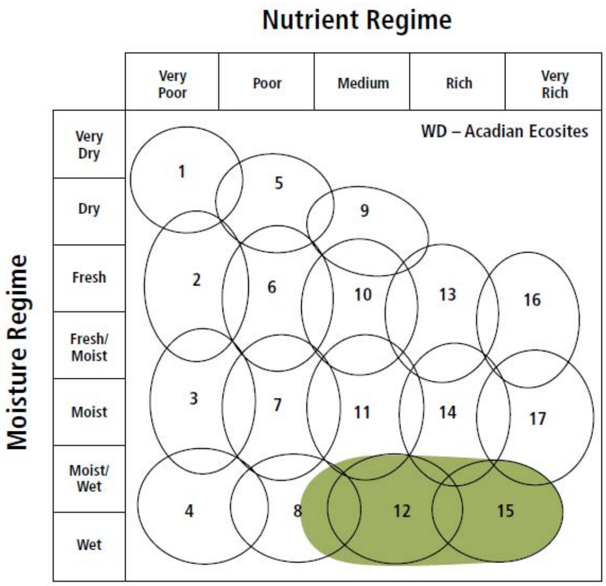
Other species of conservation concern supported by WC forest types include many species of rare plants (e.g. showy lady's slipper; meadow horsetail; Atlantic Coastal Plain species) and at-risk lichens, such as Voles Ears lichen and the Atlantic population of the Boreal Felt Lichen (ECCC 2020). The only extant Atlantic populations of Boreal Felt Lichen occur in Nova Scotia and surveys of historic sites have documented a 90% decline in the known populations in recent decades (Maas and Yetman, 2002). This decline has been attributed to air pollution, acid rain and habitat loss due to forestry and development.

As WC forests remain cooler than surrounding forest types during the warm summer months, they offer necessary thermal shelter for the survival of endangered Mainland Moose (NSDNR 2007). Moose are susceptible to thermoregulatory stress in late winter and summer and will attempt to reduce their core body temperature by seeking cover (Renecker and Hudson 1986; Schwab and Pitt, 1991; Broders et al 2012; McCann et al. 2013). Wet coniferous stands facilitate access to moose aquatic feeding areas.

WC forests are important to ecosystem function as they regulate water flow, provide filtration, and recharge groundwater. Vegetation in WC forests types is slow growing, potentially supporting dwarfed old growth trees, and is susceptible to changes in hydrology following soil disturbance. The rise in the water table, often known by the term “watering-up”, in response to reduced transpiration and interception following harvesting in forested wetlands is a well-known occurrence that has been documented and studied worldwide (see Dube and Plamondon, 1995). This rise in the water table has been found to disrupt natural regeneration of softwood and hardwoods, with lower growth rates, lower stem densities and stand conversion to fast growing early successional species (Roy et al 1999).

Harvesting in Wet Coniferous sites is not prescribed by this guide and should not occur due to their high biodiversity value, the probability of impacting species-at-risk, and the possibility these sites will not reforest but rather transition to another wetland type, such as marsh or shrub swamp, due to rising water tables and soil damage post-harvest (Dube and Plamondon, 1995; Roy et al. 1999; Marcotte et al. 2008).

Wet Coniferous Forest Group
No Decision Key — No Prescriptions



Forest Group Characteristics

This wet deciduous forest group (WD) is characterized by sites with water near or at surface level most of the year. The moisture regime is thus typically wet, resulting in poorly to very poorly drained soils. Wet deciduous types grow in medium to very rich sites, although sometimes nutrient availability is limited by standing water and saturated soils. On other wet deciduous sites, seepage water increases fertility, resulting in moderate to high nutrient availability (Neily et al., 2013).

Red maple is the dominant species in most cases, sometimes in a mixedwood situation. White ash and trembling aspen can dominate on some sites.

In all cases, rooting space is limited by moisture conditions. In most cases, WD vegetation types have moderate to high crown closure.

Wet deciduous forests (WD) are characterized by sites with water near or at surface level most of the year and are typically dominated by red maple, white ash or trembling aspen with an understory of ferns, sedges and mosses.

WD forests are biodiversity hotspots and provide habitat for many species of rare or at-risk species of lichens, amphibians (e.g. yellow and blue spotted salamander), reptiles (e.g. wood turtles, ribbon snakes), mammals (e.g. moose, water shrew), plants (e.g. black ash, meadow horsetail) and birds (Brazner and MacKinnon 2020). Mixed-wood swamps (e.g. WD8 Red Spruce-Red Maple) tend to have the highest avian diversity of all forest types, followed by primarily deciduous wetlands (Brazner and Achenbach 2019). Population declines of at-risk forest birds, including the Canada Warbler (EC 2016a) appear to be directly related to habitat loss and forest fragmentation (CCFM 2019; Westwood et al 2019). Direct threats to wetland forest birds include conversion of forested wetlands, forest harvesting, and anthropogenic changes in surface hydrology of wetlands (EC 2016). WD forests also support many species of long-distance migratory birds protected under the *Migratory Birds Convention Act*, cavity nesting birds (e.g. Chimney Swift COSEWIC 2018), and aerial insectivores (e.g. Eastern Wood Peewee; COSEWIC 2012), which are of conservation concern due to their precipitous declines in recent decades.

WD forest types (i.e. WD1, WD2, WD3, WD4 and WD6) support Black Ash, an at-risk tree species legally protected under the *Nova Scotia Endangered Species Act 1998*. Black Ash also has significant importance to the Mi'kmaq of NS as cultural keystone species (NSDNR 2015). Black Ash is widespread in NS, but rare, with few seed-bearing trees and less than 1000 individual trees (NSDNR 2015). The species is primarily threatened bylogging and wood harvesting and invasive non-native species (COSEWIC 2018). Alterations to wetland hydrology due to damage to inflows or outflows and increases in water levels due to tree removal and soil disturbance pose a significant threat to Black Ash.

The rise in the water table, often known by the term "watering-up", in response to reduced transpiration and interception following harvesting in forested wetlands is a well-known occurrence that has been documented and studied worldwide (see Dube and Plamondon 1995). This rise in the water table has been found to disrupt natural regeneration of softwood and hardwoods, with lower growth rates, lower stem densities and stand conversion to fast growing early successional species (Roy et al 1999). Harvesting in Wet Deciduous sites is not prescribed by this guide and should not occur due to their high biodiversity value, the probability of impacting species-at-risk (Brazner and Mackinnon 2020), and the possibility these sites will not reforest but rather transition to another wetland type, such as marsh or shrub swamp, due to rising water tables and soil damage post-harvest (Dube and Plamondon, 1995; Roy et al. 1999).

Wet Deciduous Forest Group
No Decision Key — No Prescriptions

Glossary

Acceptable Growing Stock (AGS): Trees that are healthy, with potential to produce high value stems capable of meeting sawlog (hardwoods and softwoods) or studwood (softwoods) specifications in the future, and that have the ability to thrive after harvest until the next harvest. For details refer to the AGS section in Appendix I.

Advance regeneration: Trees in the understorey that are in their development stage (seedling/sapling). This includes all regenerating trees.

All-aged: A forest stand that includes four or more effective cohorts (age classes) of trees (Ashton and Kelty, 2018),

Azonal ecosite: A site with conditions that would not potentially support establishment of a zonal climax forest. The opposite of Zonal also see Azonal and Edaphic (Neily et al. 2013)

Azonal (Edaphic) climax: Climax communities which are mainly a function of local extremes in site conditions (e.g. low nutrient sites, dry sites, wet sites and floodplain sites). Also called Azonal sites. (Neily et al. 2013)

Age class: Trees within a given range of ages, e.g., 10-20 years old (Ashton and Kelty, 2018). See **Cohort.**

Basal area: Surface area of the cross-section of the trunks of standing trees, measured at a height of 1.3 metres from the ground on the uphill side of the tree.

Biodiversity: "..the variability and interdependence among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems, and among the ecological complexes of which such living organisms are a part, and includes genetic diversity, diversity within and between species and diversity of ecosystems and ecological processes" in the proposed *Nova Scotia Biodiversity Act*.

Blowdown: See **Windthrow**.

Catch-up: Period of time after a commercial thinning during which the volume removed has regrown.

Cavity tree: Live or dead trees that contain hollows (or cavities) in the trunk or limbs, or that show signs of decay that may lead to the formation of cavities. that would be used by wildlife for nesting and reproduction. This includes large trees with cavities at the base that will provide den and overwintering sites for mammals.

Clearcutting

1. Method of regeneration: Stands that originate as a single age class that have been established following a complete harvest and site treatment that creates a lethal disturbance. Reproduction is from seeds germinating after the clearing operation either coming from outside the stand (e.g. disseminated by wind, small birds, bats) or in situ (e.g. buried seed bank, serotiny), (Ashton and Kelty, 2018).

2. Clearcut Harvest - Nova Scotia Dept. of Lands and Forestry definition: A harvest, after which less than 60% of the area is sufficiently occupied with trees taller than 1.3 m (https://novascotia.ca/natr/strategy/pdf/Clearcut_Definition.pdf) (NSDNR 2012a).

Climax vegetation: Vegetation communities that are relatively long-lasting and self-replacing (Kimmins, 1987)

Coarse Woody Material (CWM): Dead wood larger than 7.5 cm in diameter and lying horizontally at 45 degrees or less. It is measured using line transect sampling to estimate volume (m^3/ha). Also referred to as Coarse Woody Debris (CWD)

Cohort: all trees that had been established at a specific time, usually following a forest disturbance. The ages of trees in a cohort can vary as they establish following a disturbance (adapted from Ashton and Kelty, 2018). These cohorts can be assigned an age class. See **Age class.**

Commercial thinning (CT): Treatment applied in a uniformly distributed stand that contains mostly merchantable trees of Acceptable Growing Stock (AGS) to increase the growth of the residual stand with the highest potential value, for restoration of late succession species and/or timber..

Connectivity: The degree of linkage among similar habitat patches across a landscape.

Conservation zone: A zone of the triad in which no harvesting is permitted; includes all legally protected areas (and those proposed), as well as areas protected by policy, such as Old Forests.

Core habitat: Specific areas of habitat essential for the long-term survival and recovery of endangered or threatened species (NS ESA s. 3 (b).

COSEWIC: Committee on the Status of Endangered Wildlife in Canada

Critical habitat: "Habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species". (SARA s. 2(1))

Crop-tree release (silvicultural): A tending treatment in which a few (AGS) trees with high value potential for ecological or timber objectives, leaving the rest of the stand untouched.

Crown (tree): The part of a tree bearing live branches and foliage (leaves or needles).

Crown closure (tree): The degree to which the forest floor is shaded by tree crowns. Complete crown closure occurs when the crowns of trees touch and block nearly all or all sunlight from reaching the forest floor.

Crown land: All or any part of land under the administration and control of the Minister of Lands and Forestry (Forests Act, s 3(d)).

Diameter at breast height (Dbh): The diameter of a standing tree, including bark, at breast height (1.3 m above ground) on the uphill side of the tree.

Diversity tree: trees unusual in context, representing a small portion of the stand, or providing for diversity within the stand (e.g. ironwood tree, black cherry, or a large yellow birch in a softwood stand).

Dwelling (wildlife): A place or area occupied or habitually occupied by one or more individuals, including a nest, nest shelter, hibernaculum or den (NS ESA s. 13 1 c).

Ecological forestry: The management of the forest based on maintaining or restoring the ecological functions in an ecosystem in which biodiversity is an important consideration.

Ecological Land Classification (ELC): An approach to categorizing and delineating areas of land and water having similar characteristic combinations, of physical environment (such as climate, geomorphic processes, geology, soil, and hydrologic function) and biological community (plants, animals, microorganisms, and potential natural communities), in varying scales (NSDNR 2017b).

Ecological matrix: A zone, within the triad model, in which conservation and timber production objectives are both applicable and combined.

Ecosite: A unit that represents ecosystems that have developed under a variety of conditions and influences but have similar moisture and nutrient regimes. An ecosite is associated with a finite range of soil and site conditions and a finite range of Vegetation Types that grow naturally under those conditions (Keys, Neily and Quigley 2010). They are determined by combining vegetation and soil types. See **Forest Ecosystem Classification**.

Ecosystem: Self-sustaining community that consists of a dynamic set of living organisms interacting with each other and with their environment (ECCC 2013).

Ecosystem-based management: A planning approach that considers the composition, structure, functions, and processes of ecological communities occurring across landscapes. It strives to provide representation of these ecological communities while integrating human economic and social demands (NSDNR 2017b).

Edaphic (Azonal) climax: Climax communities which are mainly a function of local extremes in site conditions (e.g. low nutrient sites, dry sites, wet sites, and floodplain sites). (Neily et al. 20113)

Edaphic: Refers to the influence of soil and site conditions on plant growth. Is used to express the dominance of site over climate in vegetation development (Neily et al. 2013).

Endangered species: Species that face imminent extinction or extirpation (ESA, s 3, 13(1)).

ESA: Nova Scotia Endangered Species Act, 1998.

Established regeneration: Trees in the understory, present before a harvest, that are in their development stage (seedling/sapling), are greater than 30 cm tall, and are up to merchantable size (9 cm Dbh).

Even-aged: Stand that consists of mainly one cohort (age class). It is neither multi-aged nor all-aged. See **multi-aged** or **all-aged**.

Extraction trail: A temporary pathway used to haul felled trees or logs to a landing to be loaded and transported to a milling facility. . Also referred to as a forwarding trail or skid trail.

Felling: Or "falling," the process of cutting trees down, leaving a stump (e.g.,"manual felling," "hand falling").

Forest Ecosystem Classification (FEC): The standard classification system used in Nova Scotia that describes ecosites, vegetation types, forest groups, and soil types at a stand (NSDNR 2017b). (https://novascotia.ca/natr/forestry/veg-types/)

Forest group: Groups of forest vegetation types described in the FEC (see above) with similar species composition, site conditions, and successional pathways (Keys, Neily and Quigley, 2010).

Forwarding trail: See **Extraction Trail.**

Gap shelterwood (silvicultural): A type of shelterwood harvest treatment wherein small groups of trees are cut uniformly throughout a stand, without tending the unharvested areas, when amounts of Acceptable Growing Stock (AGS) are insufficient. The main objective is to create conditions that will regenerate desired species (McGrath 2018a, 23).

Group selection: A silvicultural system involving the identification of areas within the forest stand that are suitable for harvesting or regeneration because they are predominately mature, contain non-commercial trees or areas with advance regeneration. This is an all-aged silvicultural system whose objective is to create or maintain four or more age-classes.

Habitat (wildlife): "All land, water, or air where the plant, animal, or other organism lives" (NSESA, s 3(i)). See **Dwelling** (defined in Species at Risk Act).

Harvest Mean Annual Increment (HarMAI): Amount of timber harvested from a forest, measured in merchantable volume per area in a year (e.g., 3 m^3/ha/yr).

Harvest (timber): Forestry operation that removes primary forest products from an area of forest land but does not include the removal of Christmas trees or the removals of a forestry operation whose primary purpose is to convert the land to a non-forestry use (WHWP Regulations, s 2(e)).

High-grading (selective harvesting): The act of selectively harvesting with a focus on removing only the best quality and formed trees, leaving the poorest quality trees to continue to grow.

High-production forests: A zone of the triad in which timber production is the priority and is achieved through intensive forest management practices such as plantation establishment and maintenance.

Hot planting: Tree planting immediately following completion of a harvest operation

Legacy tree and clump: Uncut trees or clumps of trees left within harvest plan areas to provide present and future wildlife trees and a reservoir for organisms to survive until the forest matures (NSDNR n.d.(b)).

Live Crown Ratio (LCR): The amount of living tree crown as compared to the total height of a tree, expressed as a percentage or ratio.
Refer to "Acceptable Growing Stock (AGS) and Unacceptable Growing Stock (UGS)" in Appendix

Marking (tree): The manual process of marking selected trees to be cut or left during a harvest (NSDNR n.d.(b)).

Mast trees. Mast trees are those that contain fruit. The best mast trees include red oak and beech, but may also include beaked hazelnut, wild apple trees and large cone-bearing conifers.

Mature climax: A forest stand in which 30 percent or more of the oldest basal area is in trees 80–125 years old, at least half of the basal area is composed of climax species, and total crown closure is a minimum of 30 percent (NSDNR 2012e).

Merchantable wood: Any tree or portion of a tree that meets product specifications for any current internal or external markets a company deals in, including firewood.

MBCA: Migratory Birds Convention Act, 1994

Multi-aged: Stand that has two or three effective age classes (or cohorts) (Ashton and Kelty, 2018).

Natural disturbance: A disruption to the forest ecosystem caused by the action of natural forces (e.g., fire, insects, wind, landslides) occurring in a discrete event of sufficient intensity to significantly change stand structure and development (NSDNR 2012e).

Nest trees: Large trees containing or capable of supporting raptor nests that range in size from 50 cm to >1 m in diameter.

NSNBM: Nova Scotia's Nutrient Budget Model

Old forest: Any stand or collection of stands containing old growth or mature climax conditions (NSDNR 2012e).

Old growth: A forest stand in which 30 percent or more of the basal area consists of trees 125 years or older, at least half of the basal area is composed of climax species, and total crown closure is a minimum of 30 percent (NSDNR 2012e).

Overstory: The upper portions of the canopy in a vegetation community.

Partial overstory removal: A regeneration treatment where the mature overstory is removed except for reserve trees.

Patch: A unit of land with largely similar biological or physical characteristics.

Permanent reserves: Trees retained to meet biodiversity, future course wood material and seed for natural regeneration objectives. They will not be harvested in the future and will be replaced after dying.

Pre-Commercial Thinning (PCT): Treatment applied when a stand is immature—therefore un-merchantable—wherein the higher quality trees of preferred species are spaced (by cutting lower-quality stems) to accelerate diameter growth, improve stand composition and restore late succession species (McGrath 2018a, 19-20).

Pre-salvage cutting: Harvest cuttings designed to anticipate damage by removing highly vulnerable trees of commercial timber value (Ashton and Kelty, 2018).

Regeneration (artificial): Direct seeding or planting (NSDNR n.d.(b)), typically recommended if, after two growing seasons following a clearcut, adequate natural regeneration has not established (McGrath 2018a, 27-28).

Regeneration (natural): Trees naturally coming into a forest stand through sprouting, suckering, or seed dispersal from trees as disseminated by wind, birds, or animals (NSDNR n.d.(b)).

Retention: Trees left after a harvest to meet several objectives, including biodiversity, growing stock, seed source, shade and aesthetics.

Riparian area: The strip of vegetated area growing along the edge of a watercourse forming a transition zone between the water and the upland vegetation (also known as Riparian zone)

Rutting: The creation of depressions made by the tires/tracks of vehicles such as skidders, bulldozers, log trucks, and pickup trucks. It occurs when the soil strength is not sufficient to support the applied loads from vehicle traffic.

Salvage cutting: Harvest cuttings done to save commercial timber in dead or damaged trees (Ashton and Kelty, 2018).

SARA: Federal Species at Risk Act, 2002

Scarify, scarification: A silvicultural treatment used to prepare a site (called “site prep”) for regeneration by mixing mineral soils and the forest floor, creating better micro-sites for seedlings. Scarification can be carried out when harvesting during extraction or by bringing in specialized equipment such as “mounders”.

Seed-tree harvest (harvesting): A harvest treatment in which 15 to 35 windfirm seed trees per hectare are left uniformly distributed across a stand to create a seed source from desirable species in order to adequately and naturally regenerate the stand after harvest (McGrath 2018a, 26)..

Seeps and seepage wetlands: Small wetlands (often less than an acre or two) that generally occur where groundwater comes to the surface. Soils at these sites remain saturated for some portion or all of the growing season and often stay wet throughout the winter.

Self-pruning (Branch shedding): A natural process in which trees lose their lower branches on the stem as light becomes less available because of canopy closure.

Self-thinning: A natural process in which individual trees begin to die as they are outcompeted for sunlight, nutrients, and water by neighbouring trees.

Shelter patch: Area of forest retained in or adjacent to a harvest plan area to provide shelter for wildlife.

Silviculture: The science and art of cultivating forests and, more particularly, the theory and practice of controlling the establishment, composition, constitution, and growth of forests (Forests Act, s 3(s)).

Silvics: The study of the life history and characteristics of forest trees, especially as they occur in stands and with reference to environmental influences.

Single-tree selection: A silvicultural system involving thinning across all size (diameter) classes throughout a forest stand to create a class distribution suitable for sustaining a periodic harvest of suitable trees over relatively short harvesting cycles (10 to 20 years).

Slash: Branches and other woody material left on a site after logging.

Snags: Dead standing trees larger than 10 cm Dbh and standing at 45 degrees or more. They are measured using prism point sampling to estimate density (trees/ha) and basal area (m^2/ha).

Soil compaction: The increase in soil density resulting from loads applied to the soil surface.

Soil productivity: The capacity of soil, in its normal environment, to support plant growth.

Soil type: Soils differentiated based on texture, drainage, fertility, and depth, all of which influence site productivity and other management interpretations (Keys, Neily and Quigley 2010).

Special Management Practice (SMP): A process or action that outlines specific best management practices for protecting wildlife species and their habitat.

Special Management Zone (SMZ): Area of forest required to be established adjacent to a watercourse to protect the watercourse and bordering wildlife habitat from the effects of forest operations (WHWP Regulations, s 2(g)).

Species-at-risk (SAR): A species determined to have been extirpated, vulnerable, threatened, or endangered (NS ESA, s 3, 13(1)) or of special concern (SARA, s2(1))

Stand: The basic management unit for the application of silvicultural decisions and treatments; stands are therefore the basic unit of land use planning in forests. Stands are defined by differences in age, composition, stocking and site productivity (Ashton and Kelty, 2018)

Stocking: Percentage of an area occupied by well-spaced trees relative to an optimum or desired level of density. Stocking for standing trees is usually expressed in basal area or the percentage of the full stocking basal area. Regeneration stocking is usually expressed as the percentage of an area that is occupied by well-spaced regeneration.

Strip shelterwood: Silvicultural system where narrow strips are cut to produce shade requirements that will minimize regeneration of pioneer species (e.g., aspen, red maple, white birch) while creating conditions for the regeneration of shade intermediate-tolerant species (e.g., sugar maple, yellow birch) (McGrath 2018a, 23).

Sustainable Mean Annual Increment (SusMAI): The sustainable amount of merchantable volume a site can sustain per hectare each year based on soil site productivity constraints based on the Nova Scotia Nutrient Budget Model (NSNBM).

Thinning: Partial removal of trees from a stand to decrease the density of a forest, reduce competition for sunlight, water, and nutrients, and give the remaining trees added growth space.

Threatened (species): A species that is likely to become endangered if the factors affecting its vulnerability are not reversed (ESA, s 3, 13(1)).

Triad model: A zoning strategy for forest management that sets all-natural areas (forested and non-forested ecosystems) into one of three zones with specific values to be achieved in each. It is made up of a Conservation zone (biodiversity focused, no timber management), an Ecological Matrix (where conservation and timber production objectives are both applied and combined) and High Production Forestry (timber-focused).

Unacceptable Growing Stock (UGS): Trees not considered Acceptable Growing Stock. (McGrath 2018a, 9-14). See Acceptable Growing Stock (AGS) and further information in Appendix I.

Understory: Plants growing under a canopy formed by others, notably herbaceous and shrub vegetation under a tree canopy.

Uneven-aged: A stand that is either two-aged, multi-aged or all-aged.

Uniform shelterwood (harvesting): Type of shelterwood treatment where overstory trees are uniformly thinned to open the forest floor and create light conditions that help with natural seedling regeneration (McGrath 2018a, 23).

Unmerchantable trees: Trees that are either below product specification size or quality, making them unusable for timber products.

Unmerchantable wood: Trees or portions of a tree that do not meet product specifications for any current internal or external markets.

Vegetation Type (VT): A fine-scaled classification of forest communities described in Nova Scotia's *Forest Ecosystem Classification* (NSDNR 2012e).

Vernal pool: Small (typically less than 0.5 ha), shallow wetlands that lack permanent inlet or outlet streams and often dry out in summer. They provide critical breeding habitat for frogs, salamanders, insects, and fairy shrimp, as well as feeding and drinking sites for birds, mammals, turtles, and other wildlife (NSE 2011).

Vulnerable (species): A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events (ESA, s 3, 13(1)).

Wildlife: Any species of vertebrate that is wild by nature and hence not normally dependent on man to directly provide its food, shelter, or water (Forests Act, s 3(t)).

Wildlife corridor: Intact trees and vegetation of 50 m width or more that cross clearcut harvest areas to connect forest stands and reduce the impact of habitat fragmentation (NSDLF 1985).

Windthrow: A disturbance wherein a tree or trees have been uprooted by the wind; or a tree so uprooted. Also known as "blowdown timber" (Keys, Neily, and Quigley 2010).

Zonal ecosite: A site with conditions that could potentially support establishment of a zonal climax forest (Neily et al, 2013).

Zonal climax (sites): Climax communities which are mainly a function of regional climate conditions. These occur on sites with *at least* average moisture and nutrient conditions (also called zonal sites). This results when a forest community reflects regional climate norms and is not unduly affected by local extremes in site conditions (Neily et al. 2013).

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Appendix I.

Stand Information Requirements for Using the Silvicultural Guide for the Ecological Matrix, as Collected in the Pre-Treatment Assessment (PTA)

Pre-treatment assessment (PTA) is mandated by the *Code of Forest Practice* (NSDNR, 2012) to be performed prior to silvicultural operations on Crown land. The PTA is a ground-based cruising system designed to collect site, stand and biodiversity conditions in order to produce an ecosystem-based treatment recommendation using *The Silvicultural Guide for the Ecological Matrix* (SGEM).

For details on PTA data collection protocol and the data collection, compilation, and summary computer application refer to McGrath (2017, http://novascotia.ca/natr/forestry/programs/timberman/pdf/PTA5_Methods.pdf).

A data collection, compilation and reporting computer application has been developed to increase efficiency in collecting, recording, storing and interpreting the data for use in formulating harvest plans on Crown land.

The PTA program automates the prescription selection process based on the SGEM. The data is stored in a database that enables adaptive management—this provides on-going improvements to treatment prescriptions and applications.

This program incorporates volume cruise and compilation capabilities. The PTA field collection cruise also provides an opportunity for gathering information on biologically and ecologically sensitive features for use as part of the harvest plan. These are identified in, *Forest Ecosystem Classification for Nova Scotia* (FEC) - *Part III: Soil Types* (Neily et al., 2013) and *A Field Guide to Forest Biodiversity Stewardship* (Neily and Parsons, 2017).

Some key elements assessed for the PTA are discussed below. For a detailed description of the soil, vegetation and ecosite information collected in the PTA, refer to the FEC manual (Neily et al., 2013). Some elements of the PTA system are discussed earlier in this document, specifically in the "Silvics of Common Nova Scotia Trees" and "Windthrow Hazard" sections.

PTA Assessment and Biodiversity

Recognizing stand-level biodiversity features is an important aspect of the pre-treatment assessment and is essential for biodiversity conservation and silviculture planning.

Biodiversity depends on both stand structure and specific habitat features. These structural features play critical roles:

1) assisting species with low dispersal abilities or those that require live canopy survival into the future

2) providing mature or old growth habitat for shelter, nesting, denning, foraging and perching

3) promoting species colonization and dispersal.

Identification and reporting of trees with biodiversity values is part of the pre-treatment assessment.

To ensure the retention of key biodiversity components, the PTA system will record stand-level ecosystem elements, including species composition, stand structure, standing tree and coarse woody material (CWM) volumes, tree characteristics for determining abundance of wildlife trees, and other biodiversity values. These ecosystem meso-filter elements are recorded in the PTA to establish pre-treatment conditions and to enable the monitoring of success in retaining these elements post-treatment.

Stand Features to Promote Biodiversity

Stand structure and the shrub layer: The arrangement and complexity of forest vegetation has direct impacts on the availability of food and shelter for wildlife. A diverse stand structure provides a greater variety of foliage, seeds, berries, and flowers and increases the productivity of the forest food supply used by insects, birds, bats, and other wildlife.

Increased vertical complexity enhances the potential for biodiversity, with different species occupying habitats from the canopy down to lower levels. Variation in horizontal stand structure with canopy gaps allows for the lower shrub layers and understory vegetation to develop. The overall biodiversity of a forest ecosystem is heavily dependent on a healthy and diverse understory plant community, as many animal species depend on understory plants for food, cover, nest sites and other needs. Shrubs offer an important food source in the form of berries, buds and seeds, and host a wide range of insects—which are in turn consumed by birds, reptiles, amphibians and mammals. Many species of birds are only found in understory shrubs, which provide essential habitat for their nesting and foraging.

Vertical stand structure refers to the number of layers and their height within each stand. Vertical stand structure is to be recorded at each point in the PTA (each layer separated by at least 2 m).

Horizontal stand structure will also be recorded at each point. It refers to the patchiness of the stand with areas of different height classes.

Coarse woody material (CWM) also called Coarse Woody Debris (CWD): Deadwood larger than 7.5 cm in diameter and lying horizontally at 45 degrees or less. CWM is a critical component contributing to biodiversity conservation and long-term ecosystem productivity by acting as a storage sink for the slow release of water and nutrients. The shaded environment offered by CWM provides habitat for many species of insects, birds, amphibians, and mammals. All downed coarse woody material, especially larger pieces, should remain intact wherever possible. Larger fallen deadwood provides important denning sites for small to medium mammals.

Coarse woody material includes logs, branches, roots, and stumps retained after harvest (Photo: L. Doucette)

Coarse wood material naturally occurring in the habitat was avoided during harvest. (Photo: L. Doucette)

Reserve Trees

Legacy Tree – Yellow Birch

Some trees retained after a harvest are left for their biodiversity value. The reserve trees should be allocated about half as aggregated clumps and half as dispersed trees. Currently the Nova Scotia Wildlife Habitat and Watercourse Protection (WHWP) Regulations require that legacy tree clumps be left to provide cover and habitat for biodiversity. Retention left as part of this guide includes legacy tree clumps under the WHWP regulations.

Biodiversity values fall under one or more of the categories in the list below. Except for diversity trees, descriptions and biodiversity values of the various wildlife trees can be found in *A Field Guide to Forest Biodiversity Stewardship* (Neily and Parsons, 2017).

The following will be measured as part of the PTA:

Legacy Tree – White Pine

Super canopy trees: Trees that project above the tops of dominant and co-dominant canopy trees within a stand. They are the tallest and tend to be the largest trees in girth, with heavy branches and multi-stemmed tops. Super-canopy trees provide habitat for species that require tall trees that are free from obstruction. Many species of raptors (e.g. Bald Eagles) use super canopy trees for nesting and to perch on while hunting. (See Raptor nest trees in this section) White pine, red spruce and white spruce are the most common super canopy species.

Legacy trees: Mature trees that survive natural disturbance events or are retained as residual stems following a silvicultural operation. Legacy trees can serve as refugia for wildlife moving within unfavorable habitat, and in time can become cavity trees.

Cavity trees provide habitat for nesting birds and overwintering mammals

Broken snags or live trees may form hollows at the top and offer valuable habitat as cavity trees

Tall snag trees serve as observation perches for birds to use while hunting and defending territories

Insects colonise the dead wood in snags and provide foraging opportunities for wildlife, such as woodpeckers

Cavity Trees: Live or dead standing trees that contain hollows or cavities in the trunk or limbs, or that show signs of decay that may become cavities. Cavity trees are crucial to the lives of many species for reproduction and shelter. These include forest birds (e.g., owls, boreal chickadee, endangered chimney swifts) and mammals (e.g., endangered bats). Large trees with cavities at the base provide denning and overwintering sites for mammals.

Snag trees: Standing, dead trees, often missing a top or most of the smaller branches, that serve as habitat for many wildlife species. Birds use snags for nesting, perching, and as roosts from which to hunt, and feed off insects within the dead wood. When choosing permanent reserves, dead cavity trees are preferred over dead trees with no cavities. Snags must be ≥ 10 cm DBH.

Mast trees: Mast is the fruit of woody plants that provides food for wildlife, in the form of nuts, cones, seeds, fruit and berries. Mast is high in fat and protein and provides essential food for species preparing to migrate, hibernate, or to use as a cached food source overwinter. Mast trees include red oak and beech beaked hazelnut, wild apple trees and large cone-bearing conifers.

Diversity trees: Trees that are unusual in context, representing a small portion of the stand, or providing for diversity within the stand (e.g., an ironwood tree, an uncankered beech, or a large yellow birch in a softwood stand).

Raptor Nest Trees: Most species of raptor (eagles, hawks, falcons) build large stick nests. Large trees that are capable of supporting raptor nests should be retained. Nests range in size from 50 cm in diameter for a broad-winged hawk to >1 m for a bald eagle. White pine is preferred for some of the largest nesters, including bald eagle and osprey. These species prefer to be above the canopy and will often nest in super canopy trees. Most raptors will return to the same nest year after year. Eagles and most other raptors nest earlier than other species of birds, and nests may be active from February 1 to August 31. It is a violation of the *Nova Scotia Wildlife Act* to disturb raptor nests. Special Management Practices exist for Bald Eagle nests in Nova Scotia. https://www.novascotia.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_Bald_Eagle_Nests.pdf

Mast trees provide vital sources of fat and protein for wildlife in the form of acorns, conifer cones and other nuts and seeds.

Goshawk nest in Yellow Birch, Guysborough County

Goshawk nest in the lowest fork of a White Pine, Guysborough County

Goshawk Nest Trees: Goshawks differ from other raptors in that they build large stick nests lower in the canopy, often in the first fork of a large tree. Goshawks forage under the canopy, thus need a wide buffer of at least 200 m retained around active nests to provide foraging habitat. Goshawks are more sensitive to disturbance than most other species of raptor and will return to the same nest each year. Yellow birch is preferred but they will also build nests in large white pines. Goshawk nests appear 'messy' and are formed of long, thick sticks that may include live conifer twigs. The goshawk nesting period is from March 1 to August 15. It is a violation of the *Nova Scotia Wildlife Act* to disturb raptor nests.

Essential Habitat Features

Some wildlife species require specific habitat features for all or part of their life cycle in order to survive. Many of these essential habitat features are fragile and easily disturbed or altered. These features are in limited supply and are irreplaceable in the short-term. They must be retained on the landscape and suitable buffer distances applied to ensure their protection. PTA practitioners should be able to recognize and record essential habitat features as part of their assessment.

The *Field Guide to Forest Biodiversity Stewardship* (Neily and Parsons, 2019) describes these essential habitat features as 'special habitats'. Specific stewardship actions to protect these habitats, including legal requirements, Crown Forest Policy and Best Management Practices are described in greater detail in the field guide and described briefly here:

Caves: Caves provide shelter to a great array of biodiversity and may support species that live their entire lifespan underground. They also supply hibernacula for bats and other species of mammals and reptiles to overwinter. Any naturally created hollow extended underground, or openings in rock faces caused by erosion or mining should be protected to the greatest extent possible. A 100 m buffer should be applied to caves between November 1 and April 30 to avoid disturbance to hibernating animals. Caves are often found in Karst forest types.

Dens: Dens are used by many species of mammals for shelter and overwintering. Dens may include cavities in live or dead standing trees, under the root bole of fallen trees, in caves, natural openings in rock fissures or rock piles, and burrows or excavations in the soil. Dens are especially vulnerable to disturbance during spring and early summer if the den is being used to raise offspring. Leaving undisturbed buffers around den sites will protect the site and allow its continued use. It is a violation of the *Nova Scotia Wildlife Act* to destroy, disturb, or damage the den of a furbearer.

Hibernacula: Hibernacula provide warm shelter for wildlife to survive over winter. They include abandoned mines, caves, hollow trees, and small woodland ponds used by turtles and frogs. Waking hibernating wildlife can have fatal consequences. The disruption causes animals to use up fat reserves that they need as fuel to stay in hibernation until spring. Disturbance can also cause wildlife to abandon the protection of the hibernacula, potentially ending in fatality if suitable alternative shelter cannot be found quickly. It is a violation of the *Nova Scotia Endangered Species Act* to destroy or disturb the hibernaculum of an endangered or threatened species. A 100 m buffer should be applied to caves and abandoned mine sites between November 1 and April 30 to avoid disturbance to hibernating animals. Large cavity trees shall be retained for future use by wildlife species as per the retention guidelines. Forestry operations shall avoid operations near woodland ponds to protect overwintering turtles and frogs.

Deer wintering areas (DWA): Deer wintering areas are forested locations where white-tailed deer congregate to avoid harsh winter conditions. DWAs are typically conifer stands that provide shelter from wind and are often located on south-facing slopes to maximize sun exposure. DWAs must also be near accessible browse, often in stand openings or at forest edges. DWAs can be identified in winter by the presence of deer trails, scat, and other deer signs. Known DWAs are identified in a GIS layer created by NSDLF and available on the Provincial Landscape Viewer https://nsgi.novascotia.ca/plv/. The *Special Management Practices for White-tailed Deer Wintering Areas* https://www.novascotia.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_White-tailed_Deer.pdf provide the Crown Forest Policy and complete guidelines for harvests within DWAs.

Den site under a root bole of a fallen tree suitable for use by a medium to large mammal.

Deer trails in heavily used deer wintering areas are still visible in the warmer months. They typically wind through dense conifer stands.

Great Blue Heron Colonies: Herons nest in colonies, with nests in clear view at the tops of large dead trees adjacent to wetlands. Herons are extremely sensitive to disturbance and habitat alteration during the breeding and nesting season (March to August). *Special Management Practices for Heron Colonies* must be followed for forestry operations in Nova Scotia and include a 1 km no-disturbance buffer around colonies during the breeding season https://novascotia.ca/natr/wildlife/habitats/terrestrial/pdf/SMP_HeronColonies.pdf . It is a violation of the *Nova Scotia Wildlife Act* to disturb Great Blue Heron nests. Great Blue Herons are also protected under the international *Migratory Birds Convention Act*.

Talus, Cliffs, Banks and Rocky Outcrops: Talus slopes and rock outcrops may seem devoid of wildlife, but these sparsely vegetated areas provide a diversity of microhabitats that offer protection for wildlife from weather conditions and predators. They provide homes for snakes and small mammals and support unique species of mosses, lichens and other rare plants. Buffers of standing trees and vegetation should be retained around these structures to protect soil escarpments from increased erosion.

Seeps and Springs: Seeps and springs are places where groundwater escapes through the forest floor and floods the soil for part of the growing season. They can remain unfrozen for long periods during the winter due to the warming effect of groundwater, which stays above freezing all year. Thus, they are reliable sources of fresh water for birds and mammals throughout winter and provide hibernacula for amphibians in the unfrozen ground. Seepages discovered during PTAs should be marked and identified on harvest plans so that ground disturbances near and upslope of seeps and springs is avoided. Placing retention patches around seeps and springs will protect these habitat features and enhance the habitat value of the retained trees.

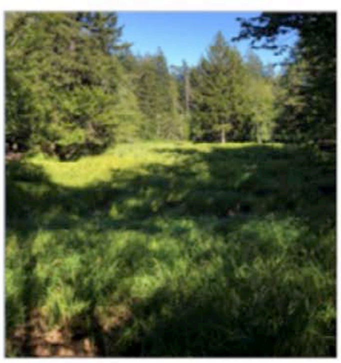
Vernal Pools: Vernal pools are small, shallow wetlands with no permanent inlet or outlet streams. Because predatory fish have no access, the pools provide vital habitat for amphibians (e.g. spotted salamanders, wood frogs) and invertebrates (e.g., fairy shrimp) to reproduce and lay eggs. Vernal pools are deepest in spring and usually retain water for at least two months. They are typically well shaded by overstory vegetation, which maintains cool temperatures and slows drying. The perimeters of vernal pools should be marked in spring when they are in a fully flooded state. Buffers of undisturbed trees and vegetation shall be maintained around vernal pools to provide shaded conditions and protect these sensitive habitats from sedimentation.

Beaver Ponds: The flooded habitat that is created by the construction of dams by beavers regulates water flow, enriches soil, and increases aquatic productivity. The resulting flooded forest provides new wetland habitat and increases the number of snags and cavity trees available as biodiversity trees. It is a violation of the *Nova Scotia Wildlife Act* to disturb or damage the den or dam of a beaver. Beaver ponds meet the definition of permanent standing or slow moving water, thus Special Management Zones must be applied under the *Wildlife Habitat and Watercourses Protection Regulations.*

http://www.registrelep-sararegistry.gc.ca/default_e.cfm

A natural spring impacted by an ATV trail

This wetland was formed by a beaver dam constructed several years earlier.



Vernal Pool

Vernal Pool – York Redoubt

Species at Risk

One of the most important biodiversity considerations in the PTA process are Species at Risk (SAR). All Species at Risk are protected under the *Nova Scotia Endangered Species Act* and/or the federal *Species at Risk Act*.

It is a violation of the *Nova Scotia Endangered Species Act* to kill, injure, possess, disturb, take or interfere with an endangered or threatened species, or to destroy, disturb or interfere with the specific dwelling place or area occupied or habitually occupied by one or more individuals or populations of an endangered or threatened species. Several of Nova Scotia's Species at Risk also fall under the protection of the federal *Species at Risk Act* or the international *Migratory Birds Convention Act*.

There are many Species at Risk that live in forested habitats in Nova Scotia. The species list and their status can be found at: https://novascotia.ca/natr/wildlife/species-at-risk/. The list is updated at least annually, and PTA practitioners must be aware of the most up to date information on Species at Risk in their geographic area.

Recovery or management plans exist for all species listed as at-risk in NS. The plans provide detailed information on the habitat requirements and threats to the species. For species whose 'core habitat' has been designated under the *Nova Scotia Endangered Species Act*, practitioners must respect any regulation made with respect to that core habitat. Core habitat refers to specific areas of habitat essential for the long-term survival and recovery of endangered or threatened species. Regulations may control, restrict, or prohibit activities that may adversely affect the endangered or threatened species within core habitat. Similar, species that are listed at risk federally under the *Species at Risk Act*, may have designated critical habitat identified in the federal recovery strategy or in an action plan. Nova Scotia has committed to avoiding the approval of activities that may destroy Critical Habitat on Crown land as defined by Environment and Climate Change Canada (NSDLF 2019).

Special Management Practices (SMPs) have been developed to provide direct guidance for the protection of essential habitat features in NS, including deer wintering areas, bald eagle and heron nests, and habitats for several species-at-risk.
https://novascotia.ca/natr/wildlife/habitats/terrestrial/. These SMPs should be strictly adhered to during harvest planning and operations.

Acceptable Growing Stock (AGS) and Unacceptable Growing Stock (UGS)

Another important factor needing consideration in the PTA is an assessment of whether trees are considered acceptable or unacceptable growing stock.

This assessment is necessary to determine whether a stand is suitable for specific treatments—such as Commercial Thinning or Selection, — where the objectives include improving the health and viability of stands for the future. To justify these types of treatments, adequate numbers of well-formed and healthy trees must be present. If insufficient numbers of well-formed, vigorous trees with long-term growth potential do not occur in a stand, it is a poor candidate for commercial thinning or selection. If this is the case, it is important to note that although a Selection system may not be appropriate due to the current forest condition, the same stand could be treated with these systems in the future, after their structure is improved with restoration treatments.

Acceptable growing stock (AGS)

Unacceptable growing stock (UGS)

Stands can be degraded in terms of long-term growth potential, if when carrying out a partial harvest, the best formed, most vigorous trees are removed, leaving the stand with a high proportion of unhealthy or poorly formed trees of limited potential. This is referred to as high-grading or selective harvesting. Comparing the AGS proportion before and after treatment can determine whether a stand has been subjected to high-grading. If a Commercial Thinning, Selection or Shelterwood is carried out successfully, the proportion of AGS trees in the stand is increased. If the proportion of AGS trees after treatment is lower, the stand is considered a high-grade. Treatment damage to tree boles, crowns, or roots can turn an AGS tree into a UGS tree. Trees will be left on site to enhance biodiversity (see previous section). Some of these biodiversity trees could be rated as UGS, if the proportion of AGS increases after treatment.

Definition of AGS

Trees are acceptable growing stock when they are healthy, with potential to produce high-value stems capable of meeting sawlog (hardwood and softwood) or studwood (softwood) specifications in the future, and the ability to thrive after thinning until the time of the next harvest.

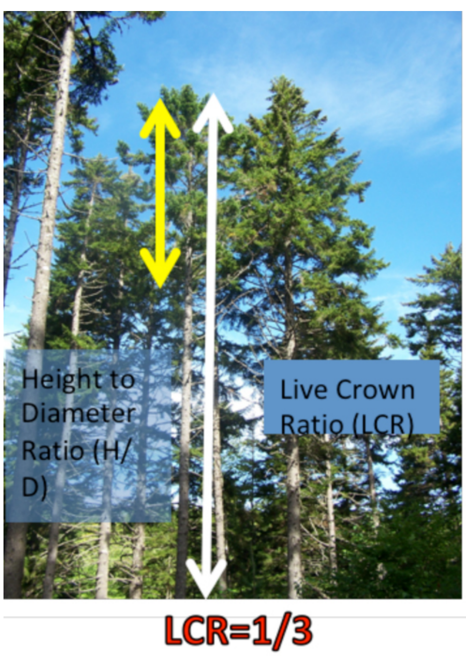
Characteristics of UGS trees

Some characteristics of trees that would classify them as UGS are indicated below:

Wind-damage risk

Trees that have crown structures that make them prone to wind damage, such as stem breakage or windthrow, are considered UGS.

- Trees with a height-to-diameter ratio (H/D, m/cm) greater than 0.80 are spindly trees that are tall compared to their stem diameter, with a higher potential for stem breakage and blowdown. This is measured as the height of a tree in metres divided by its diameter at breast height (Dbh) in centimetres.
- Trees with short live crowns or a low live-crown ratios (LCR) are more prone to wind damage. They are also slow to respond to a thinning. When LCR goes below 1/3, the tree is considered UGS and a poor candidate for release, except if growing in the understory. When trees are in the understory they may respond when their LCRs are shorter than 1/3. If a tree has more than 1/4 LCR, where the lower part of the live crown is less than ½ the height of the main canopy, it is considered as AGS if it meets the other criteria for AGS.

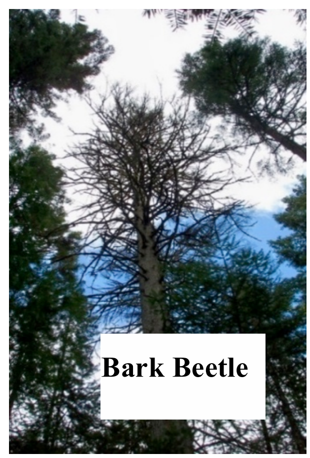


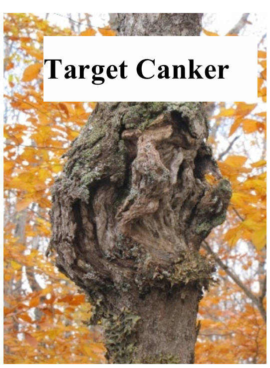
Insects/Disease

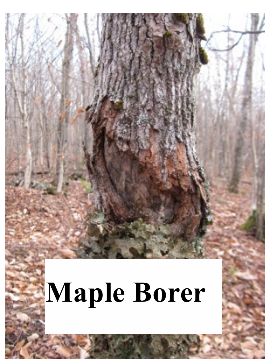
Trees that have been affected by insects or diseases are considered UGS. For example, balsam fir infested with balsam woolly adelgid (BWA) is at increased risk to mortality and therefore a poor candidate for release.

Other common infestations and diseases that would render individual trees UGS:

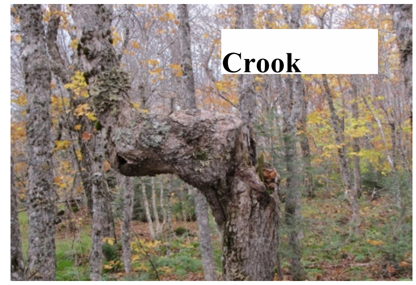
- Sirococcus shoot blight in red pine
- bark beetle in spruce
- beech bark disease
- hemlock adelgid https://forestinvasives.ca/Meet-the-Species/Insects/Hemlock-Wooly-Adelgid
- internal stem rot, evidenced by fungal fruiting bodies such as conks (frequently found on hardwoods)
- cinder conk, severe maple borer, and target canker (all hardwood defects)
- any defect with severe rot associated with it will render a tree UGS





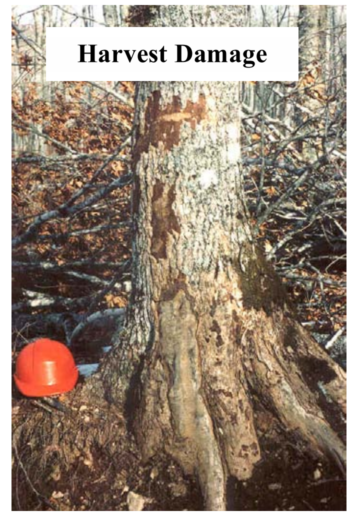


Poor form



Some trees have poor stem form, a category that includes, for example, severe crooks, sweeps, splits, and forked stems. These trees are considered UGS. They will never grow a stem straight enough to meet the specifications for higher value products such as sawlogs or studwood.

Tree Damage



Some trees are damaged by natural occurrences, others through harvesting. Several types of damage may cause a tree to be rated as UGS:

- stem or root damage that exposes the inner bark over an area exceeding 100 cm^2
- top damage that affects more than 1/3 of the live crown
- trees with dying tops

In hardwoods, numerous small epicormic branches originating from dormant adventitious buds along the stem indicate stress and may be a sign of a defect, causing a tree to be rated as UGS.

Species

All commercial species are eligible to be graded as AGS, but some non-commercial species are always considered UGS. These include:
(i) striped maple, (ii) pin cherry, (iii) grey birch, and (iv) mountain maple.

Some commercial species have characteristics that would make them more frequently graded as UGS. For example:

- Balsam fir is a short-lived species in Nova Scotia and is susceptible to many insects. Internal stem rot often develops at a relatively early age, compared to spruce. If internal rot is indicated through increment core samples, balsam fir should be considered UGS, even when external features indicate AGS. The grader should be able to recognize signs of balsam woolly adelgid (BWA), which would also cause balsam fir to be rated UGS.
- Red maple is relatively short-lived compared to sugar maple and is also more prone to internal rot. Sugar maple has a greater ability to compartmentalize rot so that it spreads slowly. This means that a defect on red maple would more frequently result in a UGS rating, compared to a similar defect in sugar maple.

Despite balsam fir and red maple being more prone to defects resulting in UGS ratings, not all balsam fir and red maple are UGS. If healthy and vigorous examples of these species exist in a stand in good form and are expected to maintain this state for 15 years, they are considered AGS.

For details on determining AGS, refer to the following FAQ section.

Frequently Asked Questions (FAQ)

Determining Acceptable and Unacceptable Growing Stock

1. There are two well-formed, vigorous trees next to each other. Should I call the one I will cut in the thinning a UGS?

   No. Both trees should be rated as AGS.

2 The tree I am grading has a sawlog in it now. Should I rate it AGS?

   Not necessarily. If you think that the tree is at risk over the next 15 years to degrade because of (for example) a broken top, rot, or another defect, then it should be rated UGS.

3. Are all balsam fir trees UGS?

   No. Each tree should be considered based on its condition. If a balsam fir tree is healthy, vigorous, without stem-rot, or insects, has the potential to produce a piece of studwood, and is forecasted to remain that way for 15 years, then it is considered AGS.

4. Are all striped maple, mountain maple, grey birch, and pin cherry UGS?

   Yes.

5. Are all undersized trees considered UGS, as they won't be sawlogs or studwood within 15 years?

   No. If you think that the undersized tree in question is healthy and vigorous with an LCR > 1/3 (see Item 16) and will at some time grow a stem of sawlog or studwood size and quality, it is considered AGS.

6. The crown of one tree is intertwined with the crown of another tree. Should I call this UGS?

   Not necessarily. If it is healthy, vigorous, and well-formed, and it can be released without damage, then it can be designated AGS.

7. Are all multiple stem trees considered UGS?

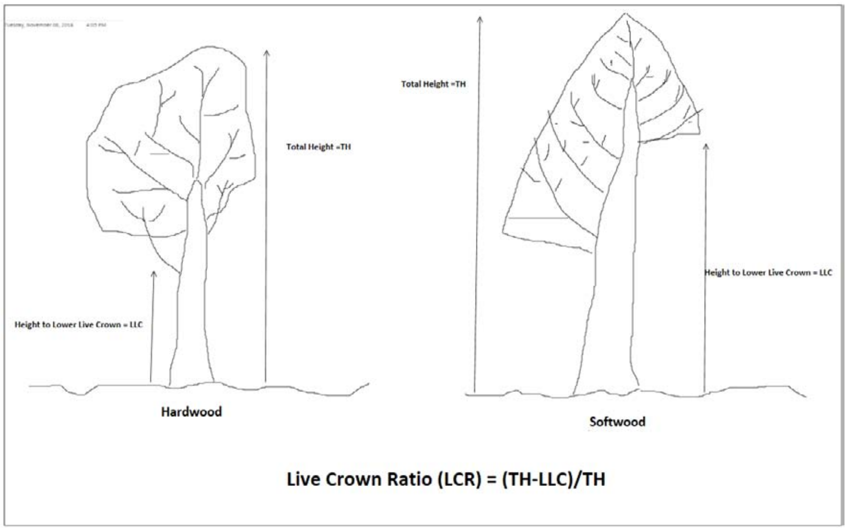
   Not necessarily. If some stems meet the criteria for AGS, they can be rated as such. Some of the stems can be rated AGS and others UGS, if one or more of the stems has poor form, vigour, or defects that would render them UGS, while the others may not (see Item 8).

8. If a multi-stem clump is within my plot with several stems of good form that meet all the specifications for AGS, should I tally them all as AGS?

   At most, tally 2 stems in a clump as AGS. If more than 2 stems in a clump meet AGS specifications, count the excess stems as UGS to avoid over-estimating the potential of the site for a commercial thinning or selection harvest.

9. A tree has a one-sided crown, should I call it UGS?

   In some cases, tree crowns are lopsided or one-sided because they have grown in dense stands not previously spaced. In these cases, the live crown length is measured on the portion of the crown that is greater than halfway around the circumference of the stem. If the live crown ratio (LCR) is 1/3 around more than half the stem, it is AGS.



10. Where does the live crown start for determining the live crown ratio?

    For softwoods, the live crown starts where live branches leave the stem at the point where the live crown encompasses more than halfway around the circumference of the stem (see Item 9.)
    For hardwoods, the live crown starts where the lowest branch that contains the part of the main live-canopy that encompasses greater than half the circumference of the stem leaves the stem.

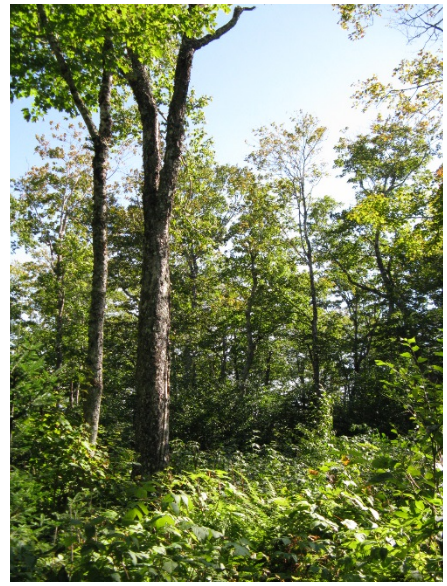
11. Why use a 15-year projection period?

    Fifteen years is used as the typical time when the next harvest is expected in Commercial Thinning or Selection harvests. In reality, the time of the next harvest should be scheduled for when the stand has grown back the amount of wood removed in the harvest (has "caught up"). This time varies with the number of trees removed (expressed as the percentage of Basal Area Removed, %BAR) and the fertility of the site as measured by Land Capability (LC). On the very best of sites, where a relatively small percentage of the basal area (e.g., 1/5) is removed, the catch-up time could be as short as 10 years. On the other hand, on poor sites where a high percentage of basal area (e.g., 1/2) is removed, the catch-up time could be as long as 30 years.

    Most softwood thinnings are recommended for stands growing on sites of at least LC 4, typically LC 5 or greater, with removal of 30 or 40 % of the basal area. If a typical LC 5 softwood stand is thinned by taking 30% of the basal area out of the area between extraction trails, approximately 15 years will be required for catch-up. Therefore a 15-year projection time is used for assessing acceptability (AGS/UGS).

12. How should I grade an older aspen?

    If you think a tree is senescent and will not maintain its sawlog quality 15 years into the future, it is considered UGS. The tree could be healthy and be alive in 15 years, but if it does not have a sawlog quality bole or will not maintain one, it is UGS.



13. A tree has a major fork—should I call it AGS or UGS?

    If (i) a tree has a fork that forms an angle of less than 45 degrees with the main stem above the fork; (ii) its diameter at the stem is greater than ½ the diameter of the main stem; (iii) affects more than 1/3 of the tree stem if it broke off at the fork; **and** (iv) it has rot associated with the fork, then it is UGS.

    Trees with forks that are less severe than described but have severe rot associated with them should also be called UGS.

14. A tree is leaning—should I call it UGS?

    If a tree has a lean with indications of root breakage or partial uprooting, then it should be called UGS. If a tree has a lean exceeding 15 degrees from vertical, it should be called UGS.

15. A tree has a crown with a partially dead or missing top—should it be called AGS?

    If a tree has a crown with a dead or missing top amounting to more than 1/4 of the crown, then it should be called UGS.

16. A healthy tree of LIT species is in the understory, but its live crown ratio is greater than 25% of the tree height. Is it AGS?

    Yes. If a healthy, well-formed tree of LIT species has only 25% LCR but the height of the bottom end of the live crown is less than ½ the total crown height, it can be considered AGS as it has potential to grow a longer LCR after release.

17. Are all UGS going to be harvested?

    No. Many trees classed as UGS are valuable for biodiversity or shade and will be left for this purpose. (See Biodiversity section.)