

FOREST RESEARCH REPORT

Nova Scotia Department of Natural Resources



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Report FOR 2015-4 No. 96

**August 12, 2015
(Updated February 23, 2017)**

Spruce – Pine Management Guide

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Introduction

Nova Scotia's Natural Resources Strategy (NSDNR, 2011) commits the province to fully implement an ecosystem based approach to forest management. In support of this initiative, ecosystem based management guides (McGrath, 2007; McGrath, 2011; McGrath *et al.*, 2015) have been developed for Tolerant Softwoods, Mixedwoods and Hardwoods. These guides provide silviculture prescriptions by interpreting the ecological, site and stand conditions required to make an ecosystem based management decision. The system designed to collect the site and stand information required for using these guides is referred to as the Pre-Treatment Assessment (PTA) and is described in McGrath (2013) and mandated by the Code of Forest Practices (NSDNR, 2012).

Forest management prescriptions should be designed to emulate ecological processes and incorporate structures that would occur under a natural disturbance regime. In the Spruce - Pine forest group, fire and windthrow can occur frequently as stand-level natural disturbances

resulting in the rapid mortality of an existing stand and the establishment of a new stand. Succession on these low fertility ecosites is less complex with stand level disturbances creating even-aged forests of similar species. The removal of fire in the ecosystem due to fire suppression will require forest managers to consider duff thickness management and ericaceous vegetation control in their management prescriptions. Forest managers should also incorporate the maintenance of large residual trees, particularly those with cavities, stick nests, or deadwood in their management prescriptions for wildlife habitat benefits.

The frequent reoccurrence of stand-level natural disturbances will maintain a cycle of even-aged forests and the early to mid-successional vegetation types such as those included in the Spruce-Pine forest group. Thus, evidence of gap dynamics and understory recruitment is usually less common in such stands.

Vegetation types in the Spruce-Pine forest group are found on a range of slope positions, and are often associated with shallow soils over bedrock and outcrops. Soils are mainly derived from coarse textured glacial till or glaciofluvial deposits. A wide range of soil moisture levels can be found, but fertility is generally poor throughout. Spruce-pine vegetation types cover a range of successional stages, but all typically lead to an edaphic^A climax dominated by black spruce, white pine or red oak. If stands are productive enough to support red spruce-hemlock, the Softwood/Mixedwood Management Guide (McGrath 2011) should be used. See guidance provided below in the hybrid spruce section.

Even-aged forest management can be planned using a sequence of treatments designed to maintain and regenerate a forest stand with one age class. These treatments can include clearcut harvesting, a seed tree cut, or a shelterwood cut. Stand tending and commercial thinning can also be prescribed to improve stand quality. This report uses keys to identify the stand and site conditions for ecosystem based forest management for the softwood and mixedwood vegetation types in the Spruce-Pine forest group of the Forest Ecosystem Classification (FEC) for Nova Scotia.

Use of the Keys

The Spruce-Pine Guide consists of several linked keys starting with the Main key. Users are directed to advance through the keys by answering questions (grey diamonds) and following the designated pathways (arrows). Eventually a management prescription (green rectangle) is reached or the user is referred to another sub-key (yellow rectangle) for further evaluation and prescription refinement. If a sub-key is indicated, it is followed until arriving at a prescription or a recommendation to wait and re-evaluate at a later time (“Let it grow”, red rectangle).

^A **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 due to local limitations in site condition.

Management Recommendations

The Spruce-Pine forest group occurs primarily on very poor to poor ecosites (AC1, 2, 3, 5, 6, 7 and MB 1, 2, 3) (Neily *et al.*, 2013). This limits the economic returns from intensive forest management applications such as pre-commercial thinning, commercial thinning and planting in this group. Stands that are pre-commercially and commercially thinned can increase production compared to untreated stands but gains are limited due to the lengthy response to such treatments. The establishment of plantations on any site is expensive and is usually reserved for the most productive sites. On the ecosites that support the Spruce-Pine forest group, natural regeneration should be considered the first choice for re-establishment of a forest stand.

Hybridized Spruce

Red spruce and black spruce will produce hybrid off-spring that have 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 and is most likely to occur within vegetation types SP5, SP6, SP7 and SP8 (Neily *et al.*, 2013). It is important to recognize hybrid spruce since the Spruce – Pine management interpretations use even-aged systems and not the uneven-aged systems of the Spruce – Hemlock Group. Hybrid spruce is commonly found in lowland ecodistricts including the Northumberland Lowlands, St. George’s Bay, Bras d’Or Lowlands and the Central Lowlands (NSDNR, 2006). Site features are often helpful in recognizing hybrid spruce. Sites of lower fertility are often associated with soils derived from coarse sandstones and granites, occur on soils shallow to bedrock, and have soils that are either rapidly and/or imperfectly drained. A significant coverage to ericaceous species^B and bracken fern can also be used to indicate less fertile sites. An abundance of pine may also indicate lower fertility. Advanced regeneration from seed is often absent under mature hybrid spruce, due to infertile seed common with hybridized species (Major *et al.*, 2005)

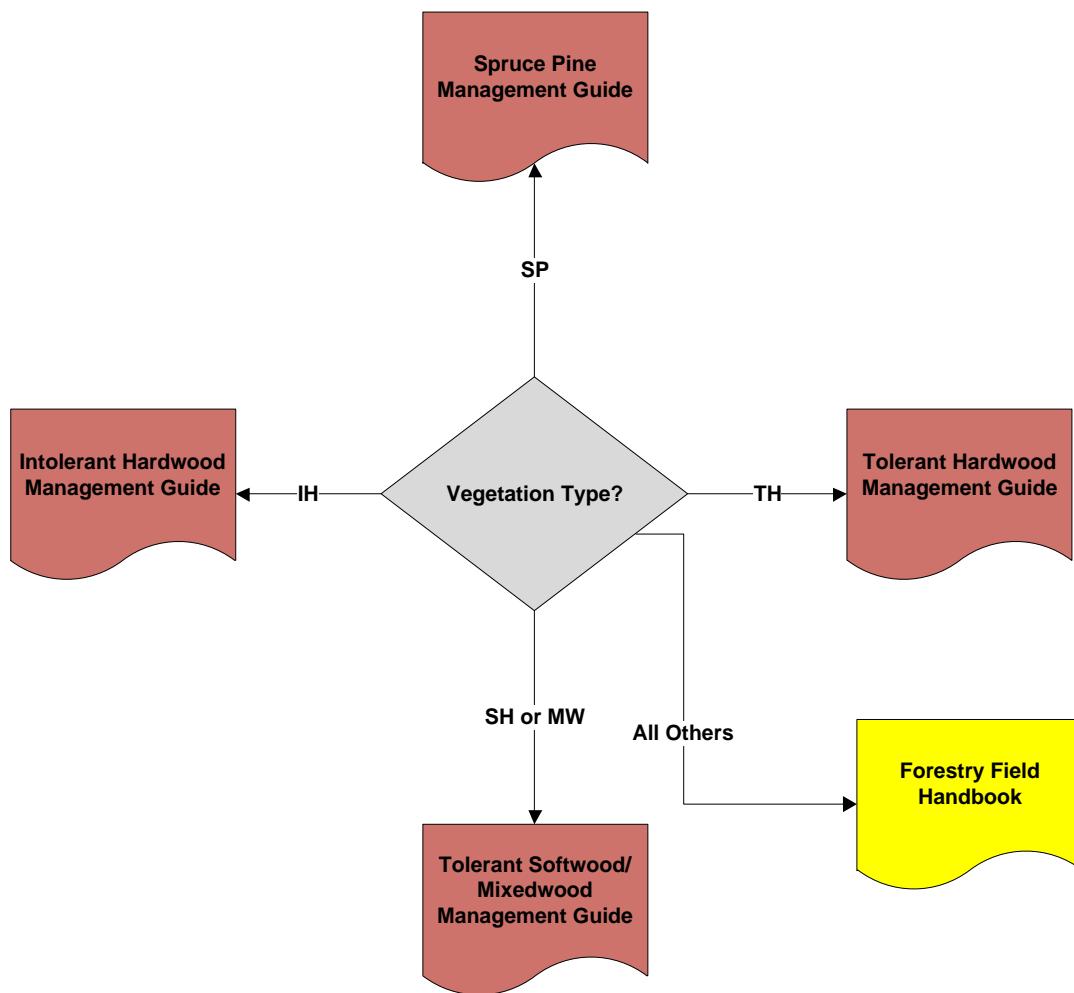
Windthrow Hazard

Windthrow Hazard is a function of site (wind) exposure as well as soil limitations (Neily *et al.*, 2013). Stand density, tree species rooting patterns, crown dimensions, and overall tree health are also important factors. The main soil factor influencing windthrow hazard is potential rooting depth which is related to soil moisture content, soil texture, stoniness and overall soil depth (Appendix I).

^B **Ericaceous species** – plants in or related to the heath family (*Ericaceae*) usually found on acidic (nutrient poor) soils including lambkill (*Kalmia angustifolium*), *Vaccinium* spp., e.g. blueberry, rhodora (*Rhododendron canadense*), and huckleberry (*Gaylussacia baccata*).

Management Guides by Vegetation Group

Key VT – Vegetation Types



KEY - VT - Vegetation Types

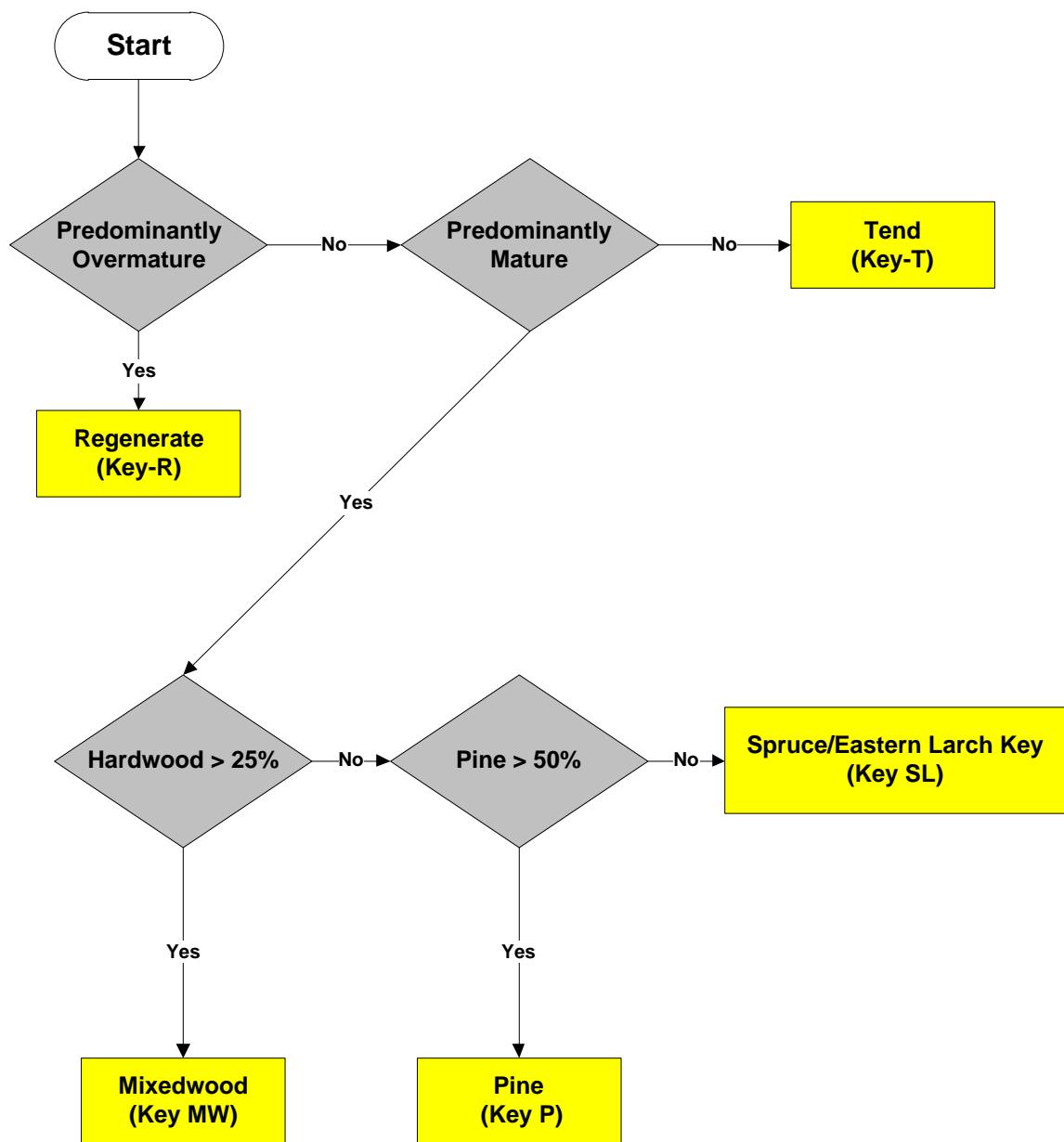
Instructions and Definitions for:

Decision Diamond

Vegetation Type – What vegetation type (Neily *et al.*, 2011) are you in? If in a Tolerant Hardwood (TH) vegetation type refer to McGrath (2007). If in a Spruce Hemlock (SH) or Mixedwood (MW) vegetation type refer to the Tolerant Softwood & Mixedwood Management Guide (McGrath, 2010). If in an Intolerant Hardwood (IH) vegetation type refer to this guide. If in a Spruce-Pine Vegetation Type (SP) refer to this guide.

Spruce Pine Management Guide

Key M - Main



KEY - M - Main

Instructions and Definitions for:

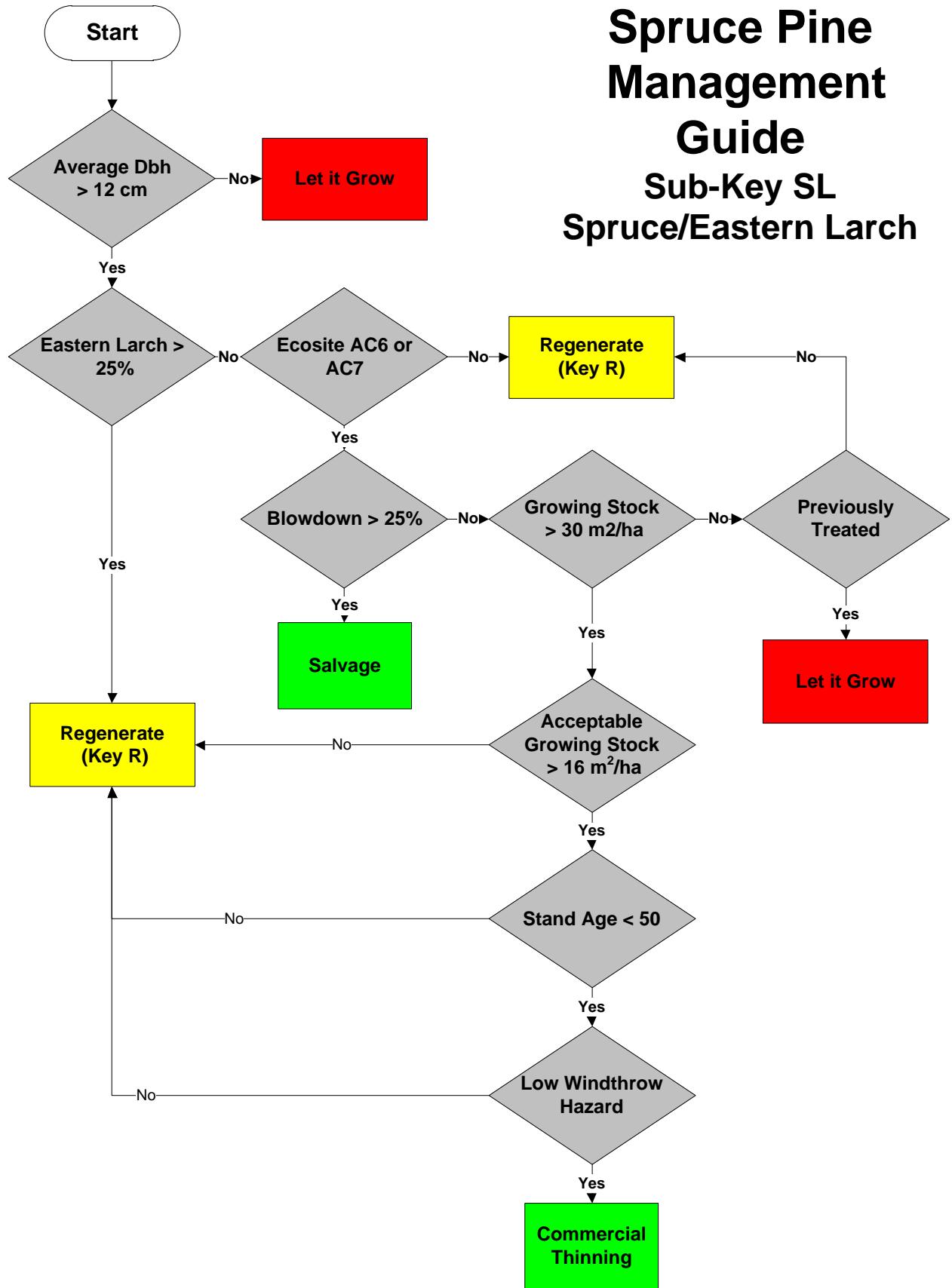
Decision Diamonds

- **Predominantly Over-Mature** – Is the overstory predominantly over-mature, meaning in a declining state, evidenced by very slow growth and mortality of larger trees (Appendix II)?
- **Predominantly Mature** – Is the overstory predominantly mature in terms of producing adequate seed for regeneration (Appendix II)?
- **Hardwood > 25%** - Is the stand made up of more than 25% hardwood species (as a % of stand basal area)?
- **Pine > 50%** - Is the stand made up of more than 50% pine (as a % of stand basal area)?

Spruce Pine Management Guide

Sub-Key SL

Spruce/Eastern Larch



SUB KEY – SL – Spruce/Eastern Larch

Instructions and Definitions for:

Decision Diamonds

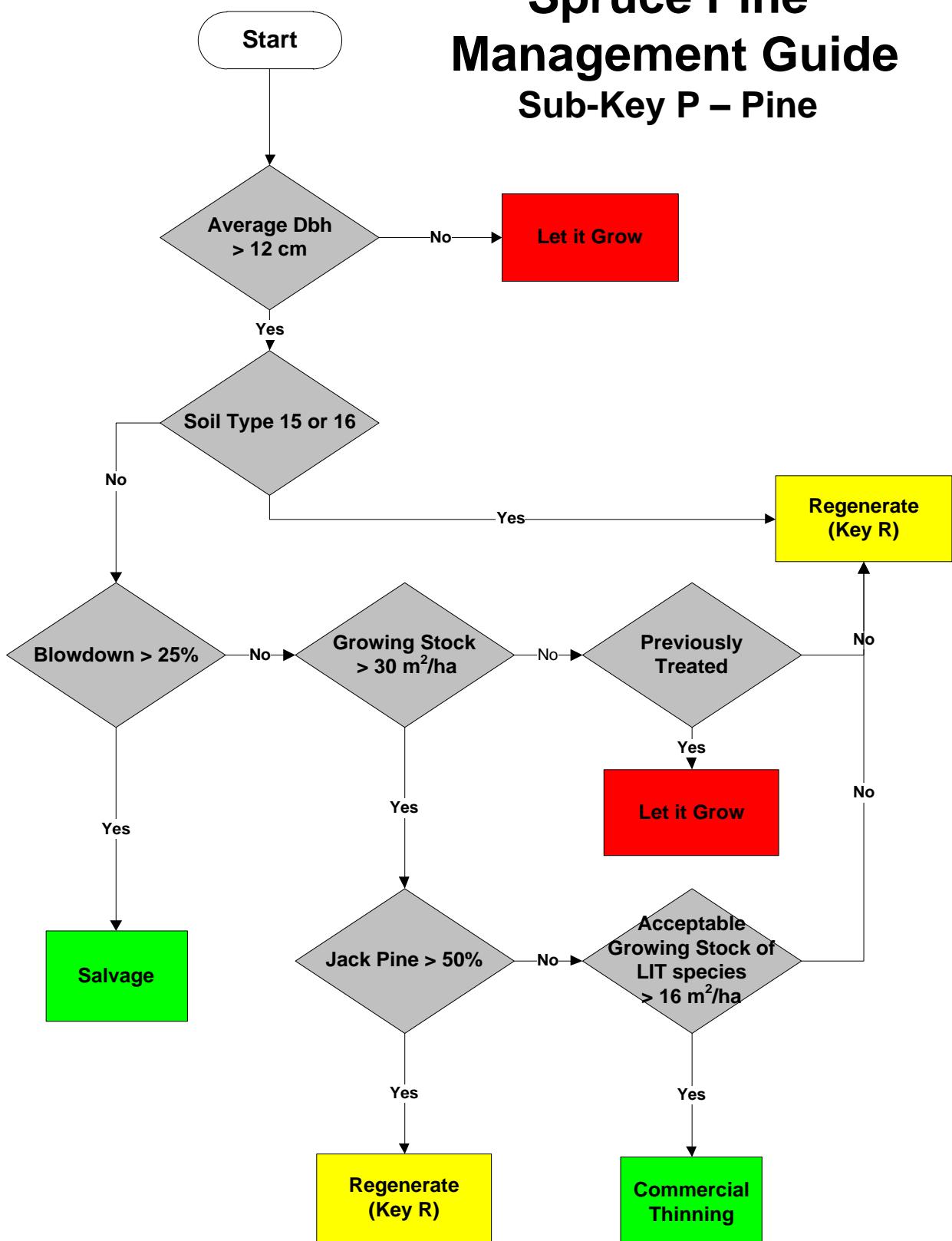
- **Average Dbh > 12 cm** - Is the quadratic mean diameter at breast height greater than 12cm (trees ≥ 10 cm Dbh class)?
- **Eastern Larch > 25%** - Is the stand made up of more than 25% eastern larch (as a % of stand basal area)?
- **Ecosite AC6 or AC7** – Is the Ecosite Acadian 6 or 7 (Neily et al., 2013)?
- **Blowdown > 25%** - Are more than 25% of the trees (measured in basal area) uprooted (blowdown still merchantable)?
- **Growing Stock > 30 m²/ha** – Is the basal area of trees greater than or equal to the 10 cm Dbh class greater than 30 m²/ha?
- **Previously Treated** – Was the stand previously pre-commercially thinned, planted or commercially thinned?
- **Acceptable Growing Stock > 16 m²/ha** – Is the basal area of Acceptable Growing Stock (AGS, Appendix III) greater than 16 m²/ha.
- **Stand Age < 50** - Is the stand age less than 50 years?
- **Low Windthrow Hazard** - Is the windthrow hazard low (Appendix I)?

Management Prescriptions

- **Let it grow** – Leave stand untreated to be re-evaluated at a later date.
- **Commercial Thinning (CT)** – Where high levels of AGS and adequate merchantable basal area exists, uniformly thin the stand insuring the leave trees are released. The objective of this treatment is to salvage lower quality merchantable trees and leave well-formed, healthy trees of preferred long lived species to accelerate their growth. The stand should be kept until it grows back the volume removed and becomes fully stocked. This will take on average 15-20 years when removing 30% of the basal area from the leave strips on average sites. Growth will be slower on poorer sites or if more basal area is removed. The objective of this treatment is not to regenerate the stand. The best opportunities for an economically viable commercial thinning occur on more productive ecosites capable of recapturing harvested volume from the thinning in a reasonable amount of time. Therefore, all Maritime Boreal (MB) ecosites and Acadian (AC) ecosites AC1, AC2, AC3, AC5 and AC8 may result in longer recovery times than what is considered economically viable, especially for black spruce. Age is also another factor that impacts the economic viability of commercial thinning and over mature stands may not recover the harvested volume. 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 due to the natural lower stocking levels and self-thinning characteristics of this species.
- **Salvage** - Remove overstory and salvage merchantable blowdown.

Spruce Pine Management Guide

Sub-Key P – Pine



SUB KEY – P – Pine

Instructions and Definitions for:

Decision Diamonds

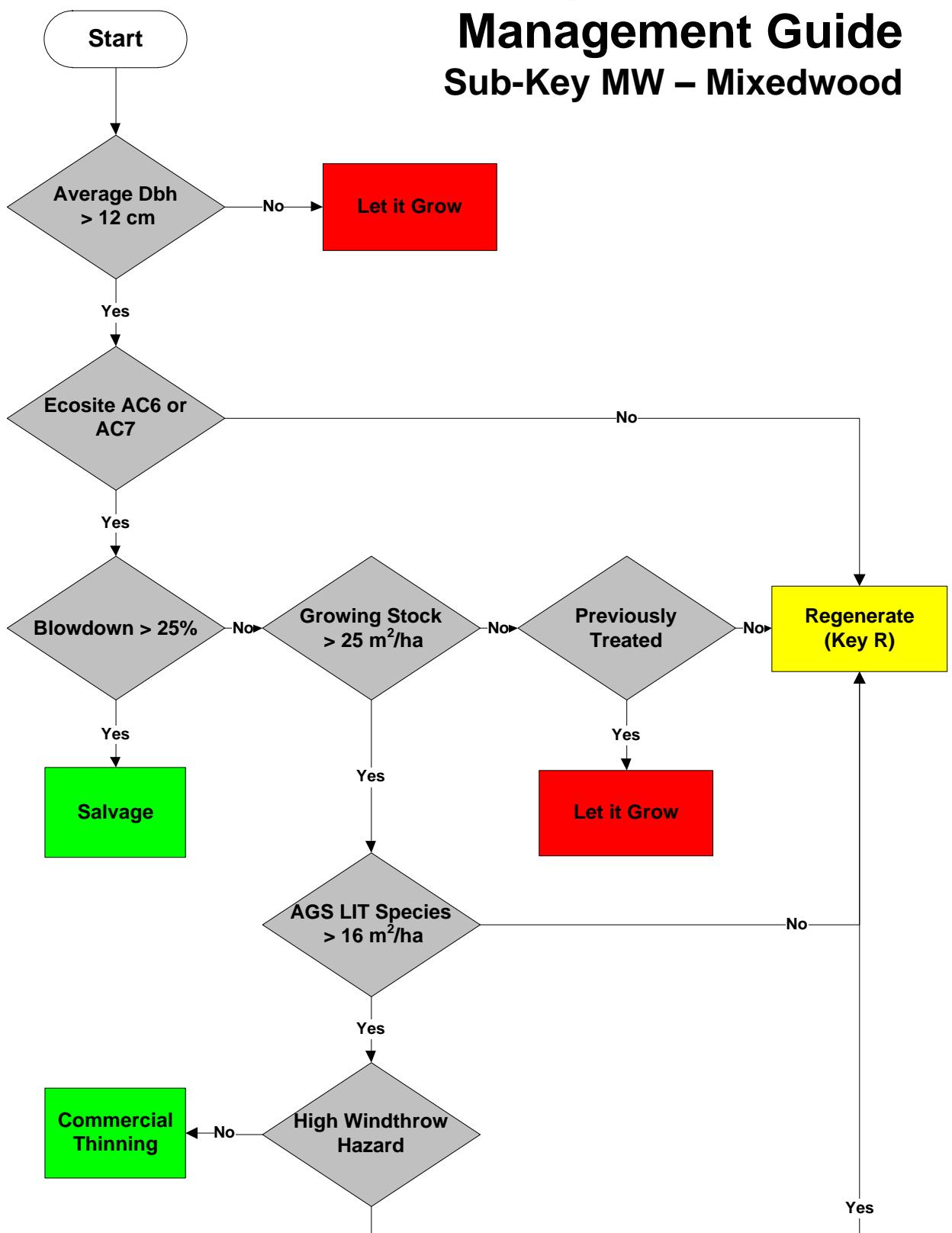
- **Average Dbh > 12 cm** - Is the quadratic mean diameter at breast height greater than 12 cm (trees ≥ 10 cm Dbh class)?
- **Soil Type 15 or 16** – Is the Soil Type 15 or 16 (shallow), including all phases (G, S or L)?
- **Blowdown > 25%** - Are more than 25% of the trees (measured in basal area) uprooted (blowdown still merchantable)?
- **Growing Stock > 30 m²/ha** – Is the basal area of trees greater than or equal to the 10 cm Dbh class greater than 30 m²/ha?
- **Previously Treated** – Was the stand previously pre-commercially thinned, planted or commercially thinned?
- **Jack Pine > 50%** - Is the stand made up of more than 50% jack pine (as a % of stand basal area)?
- **Acceptable Growing Stock of LIT species > 16m²/ha** – Is the Acceptable Growing Stock (AGS, Appendix III) of Long-Lived, Intermediate to Tolerant species (LIT, Appendix I) greater than 16 m²/ha?

Management Prescriptions

- **Let it grow** – Leave stand untreated to be re-evaluated at a later date.
- **Commercial Thinning (CT)** – Where high levels of AGS and adequate merchantable basal area exists, uniformly thin the stand insuring the leave trees are released. The objective of this treatment is to salvage lower quality merchantable trees and leave well-formed, healthy trees of preferred long lived species to accelerate their growth. The stand should be kept until it grows back the volume removed and becomes fully stocked. This will take on average 15-20 years when removing 30% of the basal area from the leave strips on average sites. Growth will be slower on poorer sites or if more basal area is removed. The objective of this treatment is not to regenerate the stand. The best opportunities for an economically viable commercial thinning occur on more productive ecosites capable of 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.
- **Salvage** - Remove overstory and salvage merchantable blowdown.

Spruce Pine Management Guide

Sub-Key MW – Mixedwood



SUB KEY – MW – Mixedwood

Instructions and Definitions for:

Decision Diamonds

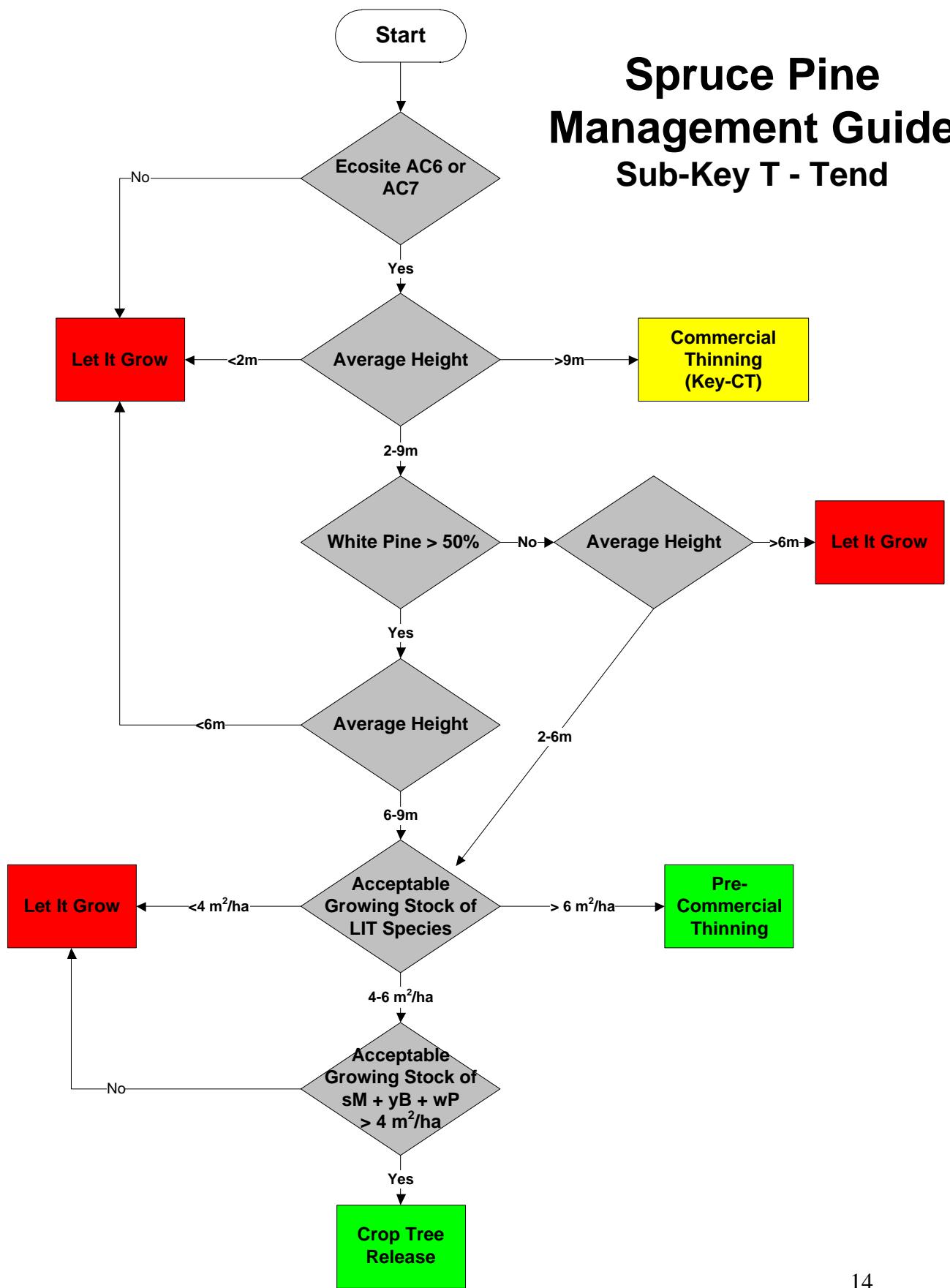
- **Average Dbh > 12 cm** - Is the quadratic mean diameter at breast height greater than 12cm (trees ≥ 10 cm Dbh class)?
- **Ecosite AC6 or AC7** – Is the Ecosite Acadian 6 or 7 (Neily et al., 2013)?
- **Blowdown > 25%** - Are more than 25% of the trees (measured in basal area) uprooted (blowdown still merchantable)?
- **Growing Stock > 25 m²/ha** – Is the basal area of trees greater than or equal to the 10 cm Dbh class greater than 25 m²/ha?
- **Previously Treated** – Was the stand previously pre-commercially thinned, planted or commercially thinned?
- **Acceptable Growing Stock (AGS) of LIT Species > 16 m²/ha** – Is the basal area of Acceptable Growing Stock (AGS, Appendix III) of Long-Lived, Intermediate to Tolerant species (LIT, Appendix II) greater than 16 m²/ha?
- **Acceptable Growing Stock (AGS) of sM + yB + wP > 2 m²/ha** – Is the basal area of Acceptable Growing Stock (AGS, Appendix III) of sugar maple, yellow birch and white pine greater than 4 m²/ha.
- **High Windthrow Hazard** - Is the windthrow hazard high (Appendix I)?

Management Prescriptions

- **Let it grow** – Leave stand untreated to be re-evaluated at a later date.
- **Commercial Thinning (CT)** – Where high levels of AGS and adequate merchantable basal area exists, uniformly thin the stand insuring the leave trees are released. The objective of this treatment is to salvage lower quality merchantable trees and leave well-formed, healthy trees of preferred long lived species to accelerate their growth. The stand should be kept until it grows back the volume removed and becomes fully stocked. This will take on average 15-20 years when removing 30% of the basal area from the leave strips on average sites. Growth will be slower on poorer sites or if more basal area is removed. The objective of this treatment is not to regenerate the stand. The best opportunities for an economically viable commercial thinning occur on more productive ecosites capable of recapturing harvested volume from the thinning in a reasonable amount of time. Therefore, all Maritime Boreal (MB) ecosites and Acadian (AC) ecosites AC1, AC2, AC3, AC5 and AC8 may result in longer recovery times than what is considered economically viable, especially for black spruce. 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 due to the natural lower stocking levels and self-thinning characteristics of this species.
- **Salvage** - Remove overstory and salvage merchantable blowdown.

Spruce Pine Management Guide

Sub-Key T - Tend



SUB KEY – T – Tend

Instructions and Definitions for:

Decision Diamonds

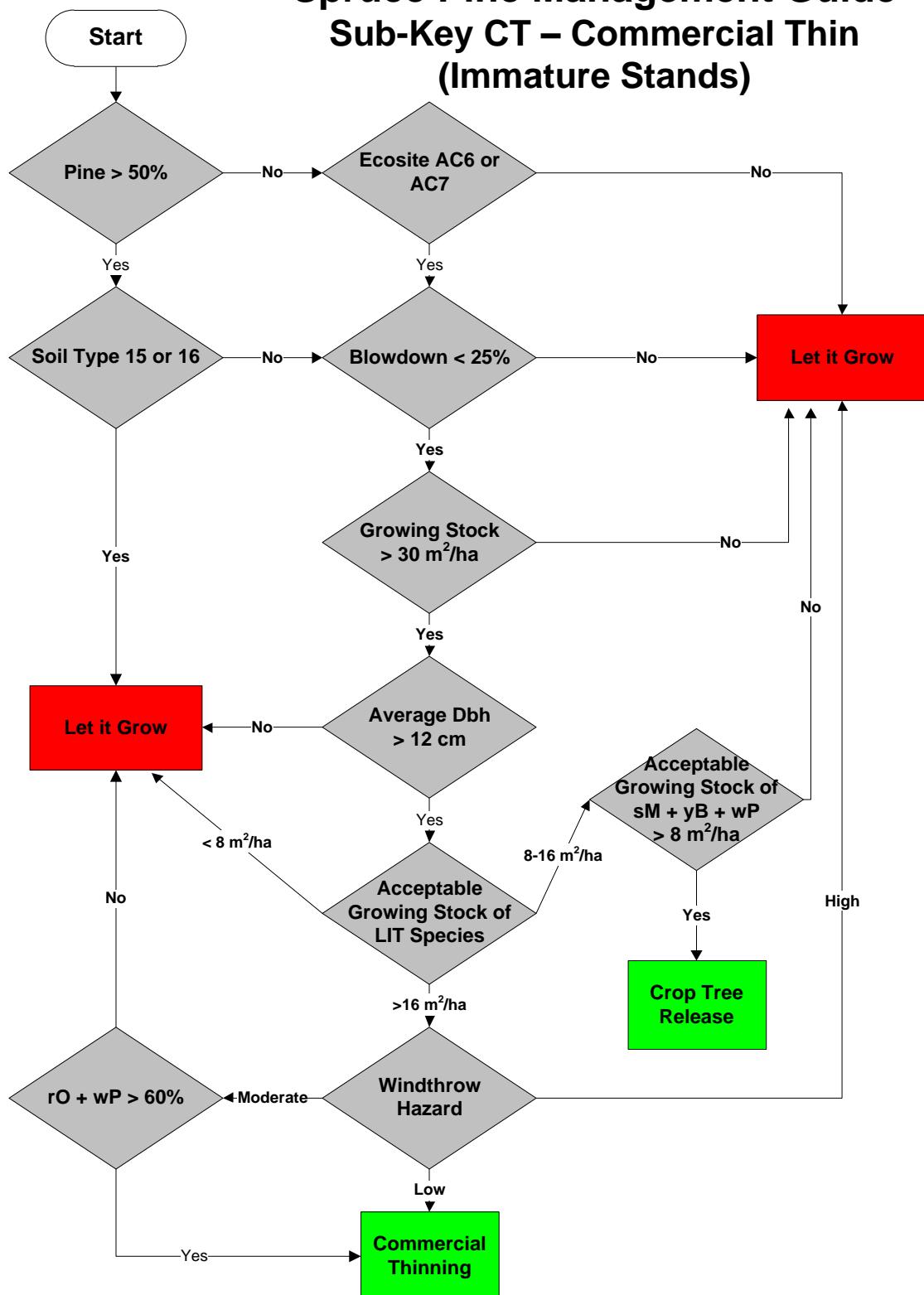
- **Ecosite AC6 or AC7** – Is the Ecosite Acadian 6 or 7 (Neily et al., 2013)?
- **Average Height** – What is the average height of the stand in metres?
- **White Pine > 50%** - Is the stand made up of more than 50% white pine (as a % of stand basal area)?
- **Acceptable Growing Stock of LIT Species** – What is the basal area of Acceptable Growing Stock (AGS, Appendix III) of Long-Lived, Intermediate to Tolerant species (LIT, Appendix II)? If greater than 6 m²/ha Pre-Commercial Thin. If less than 4 m²/ha Let It Grow. If at least 4 m²/ha and less than or equal to 6 m²/ha Crop Tree Release.
- **Acceptable Growing Stock (AGS) of sM + yB + wP > 4 m²/ha** – Is the basal area of Acceptable Growing Stock (AGS, Appendix III) of sugar maple, yellow birch and white pine greater than 4 m²/ha.

Management Prescriptions

- **Crop Tree Release** – Where intermediate levels of sugar maple, yellow birch and white pine AGS exist, 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. Only trees touching the crowns of crop trees are to be cut; remaining trees to be left standing.
- **Pre-commercial Thinning (PCT)** – Where high levels of AGS exist uniformly distributed throughout the stand (on average at least every 3 m), a uniform pre-commercial thinning is appropriate.
- **Let it grow** – Where low levels of AGS exist, let the stand grow and re-evaluate later.

Spruce Pine Management Guide

Sub-Key CT – Commercial Thin (Immature Stands)



SUB KEY – CT – Commercial Thinning

Instructions and Definitions for:

Decision Diamonds

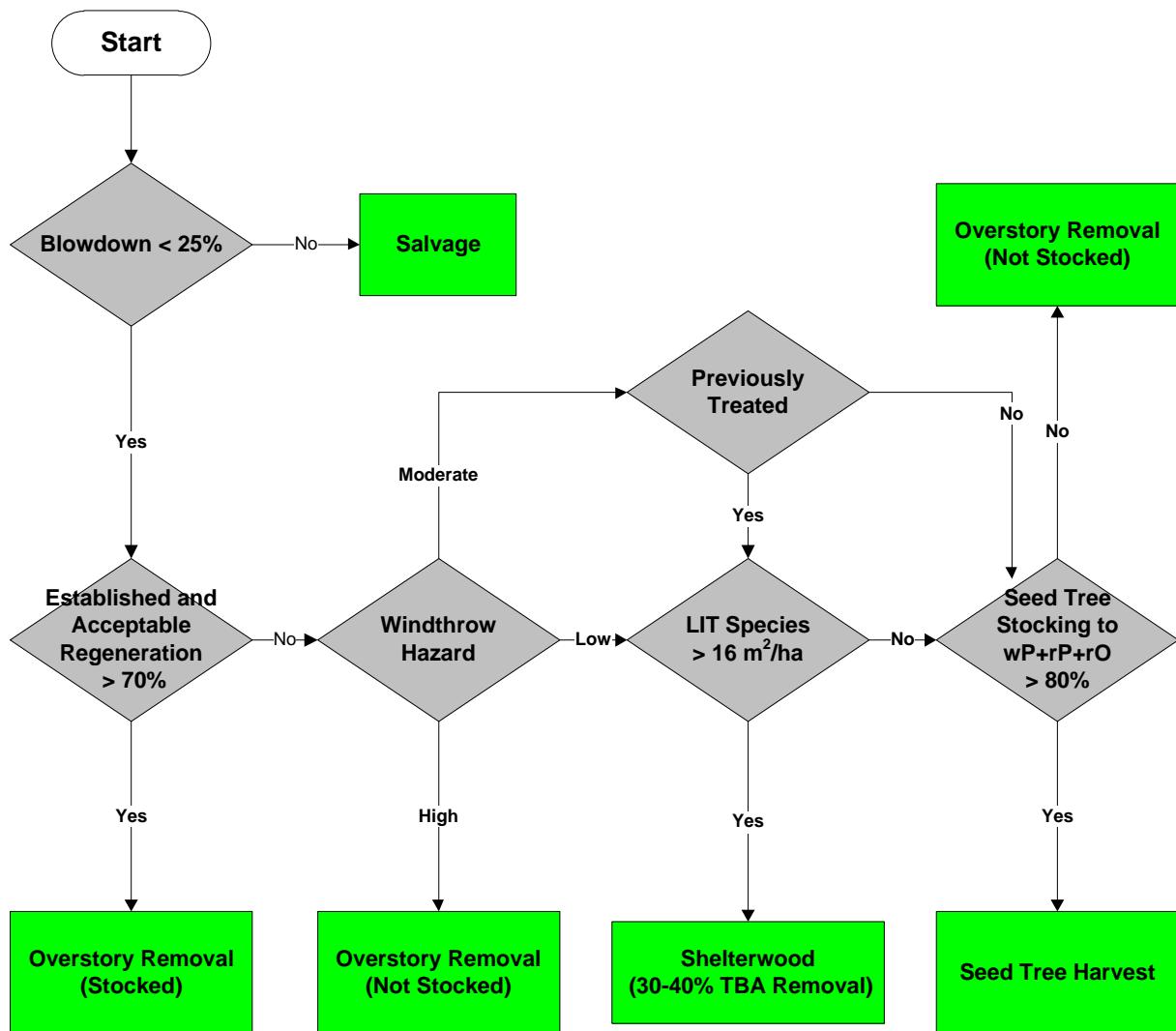
- **Pine > 50%** - Is the stand made up of more than 50% pine (as a % of stand basal area)?
- **Soil Type 15 or 16** – Is the Soil Type 15 or 16 (shallow, Neily et al., 2013)?
- **Ecosite AC6 or AC7** – Is the Ecosite Acadian 6 or 7 (Neily et al., 2013)?
- **Blowdown > 25%** - Are more than 25% of the trees (measured in basal area) uprooted (blowdown still merchantable)?
- **Growing Stock > 30 m²/ha** – Is the basal area of trees greater than or equal to the 10 cm Dbh class greater than 30 m²/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 m²/ha of Acceptable Growing Stock (AGS, Appendix III) of Long-Lived, Intermediate to Tolerant species (LIT, Appendix II)? If greater than 16 m²/ha Commercial Thin. If less than 8 m²/ha Let it Grow. If at least 8 m²/ha and less than or equal to 16 m²/ha Crop Tree Release.
- **Acceptable Growing Stock (AGS) of sM + yB + wP > 8 m²/ha** – Is the basal area of Acceptable Growing Stock (AGS, Appendix III) of sugar maple, yellow birch and white pine greater than 8 m²/ha.
- **Windthrow Hazard** - Is the windthrow hazard low, moderate or high (Appendix I)?
- **rO + wP > 60%** – Is the stand made up of more than 60% red oak and white pine combined by basal area?

Management Prescriptions

- **Let it grow** – Leave stand untreated to be re-evaluated later.
- **Crop Tree Release** – Where intermediate levels of sugar maple, yellow birch and white pine AGS exist, 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. Only trees touching the crowns of crop trees are to be cut; remaining trees to be left standing.
- **Commercial Thinning (CT)** – Where high levels of AGS and adequate merchantable basal area exists, uniformly thin the stand insuring the leave trees are released. The objective of this treatment is to salvage lower quality merchantable trees and leave well-formed, healthy trees of preferred long lived species to accelerate their growth. The stand should be kept until it grows back the volume removed and becomes fully stocked. This will take on average 15-20 years when removing 30% of the basal area from the leave strips on average sites. Growth will be slower on poorer sites or if more basal area is removed. The objective of this treatment is not to regenerate the stand. The best opportunities for an economically viable commercial thinning occur on more productive ecosites capable of recapturing harvested volume from the thinning in a reasonable amount of time. Therefore, all Maritime Boreal (MB) ecosites and Acadian (AC) ecosites AC1, AC2, AC3, AC5 and AC8 may result in longer recovery times than what is considered economically viable, especially for black spruce. 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 due to the natural lower stocking levels and self-thinning characteristics of this species.

Spruce Pine Management Guide

Sub Key R - Regenerate



SUB-KEY R – Regenerate

Instructions and definitions for:

Decision Diamonds

- **Blowdown > 25%** - Are more than 25% of the trees (measured in basal area) uprooted (blowdown still merchantable)?
- **Established and Acceptable Regeneration > 70%** — Is the stocking to acceptable established regeneration of commercial species (Appendix II) greater than 70% (at 2.4 m spacing)? Regeneration is considered established when 30 cm in height and rooted in mineral soil and capable of withstanding increased light and heat due to loss of overstory. Poorly formed and umbrella type regeneration should not be included. Black spruce regeneration from layering is acceptable. Only include trees less than 10 cm Dbh.
- **Windthrow Hazard?** Is the Windthrow Hazard (Appendix I) low moderate or high?
- **LIT Species > 16 m²/ha.** Does the stand have more than 16 m²/ha of Long-Lived, Intermediate to Tolerant species (LIT, Appendix II)?
- **Seed Tree stocking to wP+rP+rO > 80%** - Is the stocking (to 20 m spacing, 15-35 trees per hectare) of wP, rP and rO combined greater than 80%? Red pine, white pine and red oak trees must be mature and have at least one third live crown ratio (capable of producing large viable seed crops). Trees should be wind firm.
- **Previously Treated** – Has the stand been pre-commercially thinned, commercially thinned or had a previous partial harvest?

Management Prescriptions

- **Salvage** - Remove overstory and salvage merchantable blowdown.
- **Overstory Removal (stocked)** – Release regeneration by removing overstory. Protect regeneration during harvesting operation. Where high stocking to dense white pine regeneration occurs, an additional shelterwood may be required to prevent white pine weevil from damaging the log potential of the stand.
- **Overstory Removal (not stocked)** – Protect any regeneration during harvesting operation. Plant or fill plant if adequate regeneration not present after two growing seasons.
- **Shelterwood (30-40% TBA removal)** – Uniformly thin overstory to produce light conditions suited for desired species. The remaining overstory must be harvested when suitable regeneration is established to sufficient stocking. Thirty percent of the basal area is to be removed from leave strips, when regenerating shade tolerant species (Appendix II). If intermediate shade tolerant species are being regenerated take 40% basal area from the leave strips. Shelterwood harvesting systems may be applied in a uniform manner over the stand or arranged in strips or patches. Thirty percent of the basal area from leave strips is to be removed for stands dominated by black spruce. On moist soil types, such as ST3, ST6 and ST16, windthrow of black spruce can be significant and shelterwood harvesting is not recommended. For deeper rooted species, such as white pine and red oak 40% of the basal area should be removed in the leave strips. In all cases windthrow hazard must be low (Appendix I). When using patches, openings should be .04-.10 ha in size for black spruce and .10-.15 ha for white pine and red oak. Using a strip shelterwood, requires at least 2 unharvested strips to each cut strip. The strip width should be 1 tree height for regenerating black spruce and 2 tree heights for white pine and red oak. Since there is a high potential for competition from ericaceous species, seedbed preparation through scarification may be considered during or following these treatments.
- **Seed Tree Harvest** - During a harvest operation 15-35 seed trees per hectare (NSDNR, 1993) of uniformly-distributed wind-firm white pine, red pine or red oak trees of seed-bearing age are required to be left on-site. Black spruce and jack pine are not recommended due to their shallow rooting and windthrow risk, but cone-bearing slash of these species should be considered in the overall regeneration potential for the site. If these species are to be used as seed trees, they should be left in clumps of at least 50 trees and 3-5 clumps for every three hectares of clearcut. Wildlife Habitat and Watercourse Protection regulations must be followed (NSDNR, 2001). All pine species regenerate best on exposed mineral soil. The preparation of mineral soil seedbeds can be achieved with scarification during or after harvesting.

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Appendix I. Windthrow Hazard Key and Wind Exposure Definitions.

Windthrow Hazard Rating ^A Categories Based on Exposure and Soils.					
Soil Type (Keys <i>et al.</i> , 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					
^A Windthrow Hazard Rating	Low	Moderate	High		
Exposure^A Definitions Adopted from Keys <i>et al.</i> (2011).					
Class	Description				Code
<i>Sheltered</i>	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
<i>Moderately Sheltered</i>	Intermediate between Moderate and Sheltered. Includes middle slopes between high ridges and broad basins which are afforded some wind protection from one or more directions				MS
<i>Moderate</i>	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
<i>Moderately Exposed</i>	Intermediate between Exposed and Moderate. Includes upper slopes of inland ridges or hills, except where sheltered by a larger hill.				ME
<i>Exposed</i>	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.					

Appendix II. Silvics of Common Nova Scotia Trees

Knowledge of the characteristics (Silvics) of common native trees in Nova Scotia is critical in understanding how forest management activities affect regeneration, growth and succession. The Forest Management Guides (FMG) use stand maturity, longevity and shade tolerance characteristics to prescribe appropriate prescriptions. Harvests are optimally timed after they become mature and before over-maturity. Harvesting after maturity increases opportunities for natural regeneration. Timber losses are avoided if harvesting takes place before over-maturity as slow growth and increased mortality occur at this age. 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 harvests, while intolerant species are not. Shade tolerance can vary according to site and development stage. For example, white spruce growing on old field sites are known to generally have a shorter life span than when growing on forest sites. White ash is known to be more tolerant early in its development and become less tolerant with age.

Silvics of Common Commercial Nova Scotia Trees						
Species	Maturity	Over-Maturity	Longevity	Shade Tolerance	LIT	LT
<i>Softwoods</i>						
Red Spruce	45	100	L	T	Yes	Yes
Eastern Hemlock	50	100	L	T	Yes	Yes
White Pine	50	100	L	IM	Yes	No
White Spruce (Forest)	60	80	L	IM	Yes	No
White Spruce (OF)	40	60	M	IM	No	No
Black Spruce	30	70	M	IM-T	No	No
Balsam Fir	30	50	M	T	No	No
Red Pine	50	70	M	I	No	No
Jack Pine	40	60	M	I	No	No
Eastern Larch	40	60	M	I	No	No
<i>Hardwoods</i>						
Sugar Maple	80	100	L	T	Yes	Yes
Yellow Birch	70	90	L	IM	Yes	No
White Ash	50	80	L	IM-T	Yes	No
Red Oak	50	80	L	IM	Yes	No
Red Maple	40	60	M	IM-T	No	No
White Birch	50	50	M	I	No	No
Trembling Aspen	30	50	M	I	No	No
Large-tooth Aspen	30	50	M	I	No	No

Modified from: **Harrison**, MFRS. Silvics of Common Maritime Softwoods and Hardwoods; **Burns and Honkala** (ed.). 1990. USDA. Silvics of North America, and **Farrar**, 1995. Fitzhenry & Whiteside Ltd. Trees of Canada.

Maturity: Age when trees generally reach full seed production

Over-Maturity: Age when trees generally begin to reach senescence as evidenced by slow growth and mortality.

Longevity: M – Moderate 50-70 years, L – Long Lived >70 years

Shade Tolerance: I – Intolerant, IM – Intermediate, IM-T – Intermediate to Tolerant T – Tolerant

LIT: Long-Lived, Intermediate to Tolerant Species, **LT:** Long-Lived, Tolerant Species

White Spruce (OF):White Spruce regenerating in Old Fields; **White Spruce (Forest):**White Spruce regenerating in Forest sites.

Appendix III. Identification of Acceptable Growing Stock (AGS) and Unacceptable Growing Stock (UGS)

Background

To determine appropriate treatment prescriptions, the level of Acceptable Growing Stock (AGS) must be determined. This information is necessary as a means to determine whether a stand is suitable for partial cutting treatments whose objectives are to improve the health and viability of stands for future harvest such as Commercial Thinning and Selection Management. Adequate numbers of well-formed, healthy and vigorous trees that have potential for higher value crops, for at least fifteen years into the future, must be present to justify these types of harvests. Leaving poor formed trees prone to wind damage or decline due to defects, rot and insect infestations are poor investments. If insufficient amounts of well-formed vigorous trees with long term potential do not occur in a stand, it is a poor candidate for Pre-commercial Thinning, Commercial Thinning or Selection management harvests.

Stands can be degraded in the process of carrying out a Pre-commercial Thinning, Commercial Thinning or Selection Management Harvest by harvesting the best trees and leaving poor formed trees with limited potential. This is referred to as high-grading or selective harvesting.

Comparing the AGS proportion before and after treatment can be used as a means of assessing high-grading. If a Commercial Thinning or Selection Management Harvest is carried out successfully, the proportion of AGS trees in the stand is increased. If the proportion of AGS trees after treatment is lower, it can be considered a high-grade. It should be pointed out that treatment damage to tree boles, crowns or roots can turn an AGS to an UGS.

Definition of AGS

Trees are Acceptable Growing Stock (AGS) when they are healthy with potential to produce high value stems suitable to meet sawlog or studwood specifications in the future and the ability to thrive after thinning until the time of the next harvest.

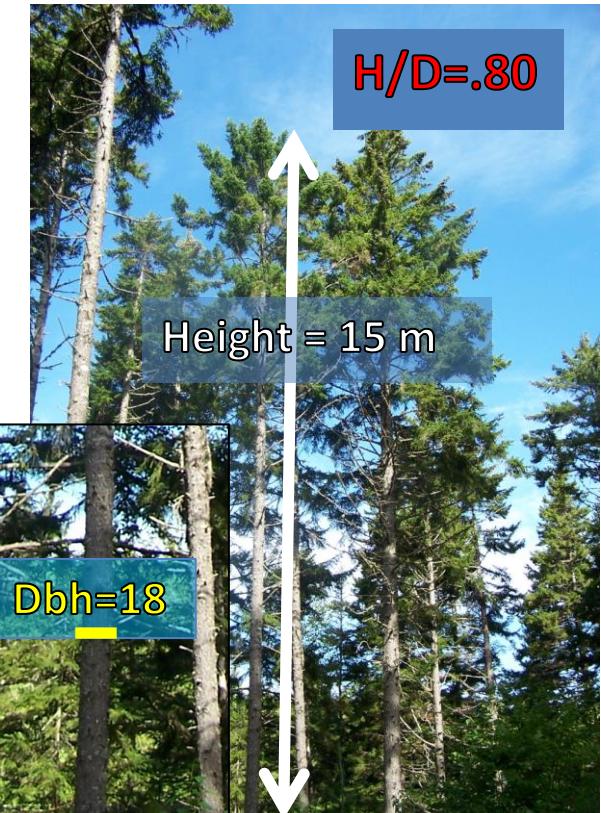
Characteristics of UGS trees

Some characteristics of trees that would render them 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 .80 are spindly trees that are tall compared to their stem girth 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 in centimetres.
- Trees with short live crowns or a low live crown ratio (LCR) are more prone to wind damage. They are also slow to respond to a thinning. When LCR goes below 1/3, it is considered UGS and a poor candidate for release.



Insects/Disease

Trees affected by insects and/or diseases are considered UGS. For example, balsam fir infested with balsam wooly adelgid (BWA) is at risk to die and therefore a poor candidate for release.

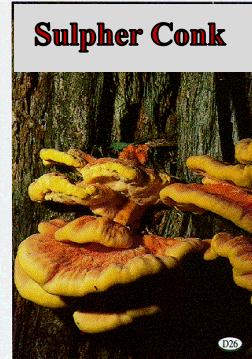
Some other common diseases and insects that would render trees UGS are:

- Sirococcus shoot blight in Red Pine
- Bark beetle in Spruce.



- Internal stem rot evidenced by fungi fruiting bodies such as conks (frequently found on hardwoods).

Some defects that would indicate UGS are cinder conk, severe maple borer and target canker. Any defect with severe rot associated with it will render a tree UGS



from: Anderson and Rice. 1993.

Poor form

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



Tree Damage

Some trees are damaged either through natural occurrences or through harvesting. These defects may cause a tree to be rated as UGS. For example:



- Stem or root damage that exposes the inner bark over an area exceeding 100cm²
- 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 cause a tree to be rated as UGS.

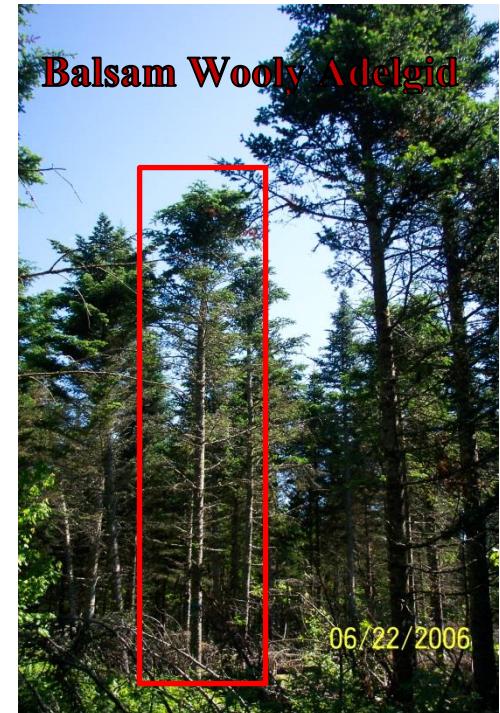
Species

All commercial species are eligible to be graded as AGS but some non-commercial species are always considered UGS, such as striped maple, pin cherry or mountain maple. Some commercial species have characteristics that would make them

more frequently graded as UGS.

For example:

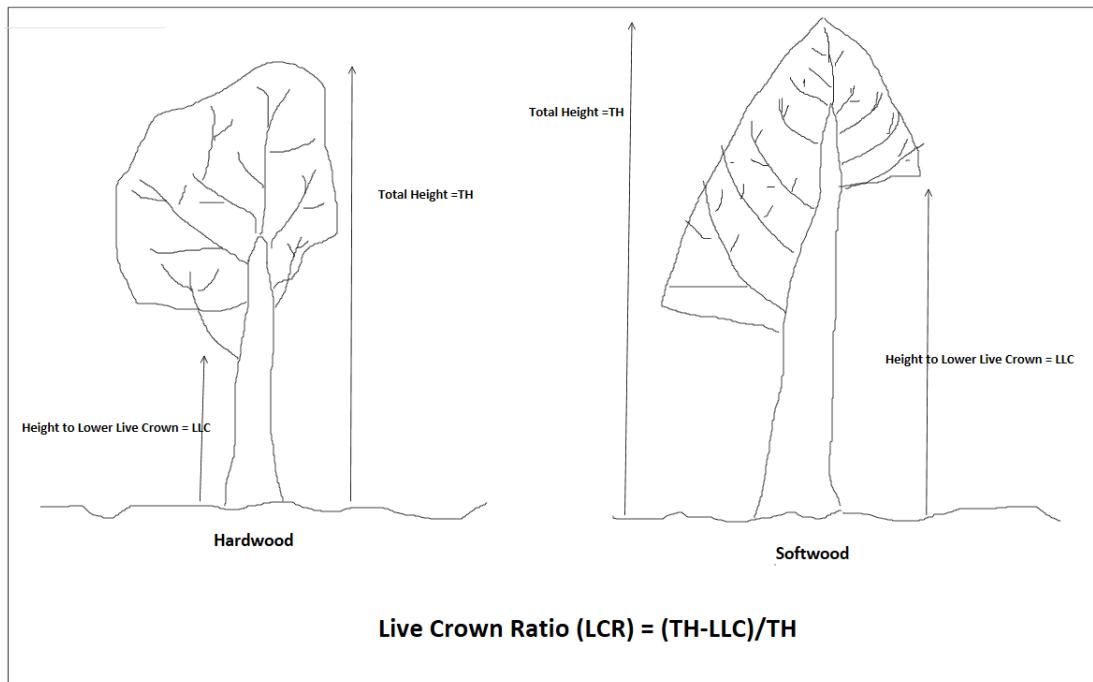
- Balsam fir is a short lived species in Nova Scotia and is susceptible to many insects. Internal stem rot develops at an early age compared to spruce. If internal rot is indicated through increment core samples, balsam fir could be considered UGS, even when external features indicate AGS. The grader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



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

Frequently Asked Questions (FAQ)

1. There are two well-formed vigorous trees next to each other. Should I call the one I will cut in the thinning an UGS? No both trees should be rated as AGS
2. The tree I am grading has a sawlog in it now. Should I call it a 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 other defect then it should be rated UGS.
3. 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 a LCR > 1/3 and will at some time grow a stem of sawlog or studwood size and quality it is considered AGS.
4. 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 1/2 way around the circumference of the stem. If Live Crown Ration (LCR) is 1/3 around more than 1/2 the stem it is AGS.
5. Where does the live crown start for determining live crown ratio? For softwoods, the live crown starts where live branches enter the stem at the point where the live crown encompasses more than 1/2 way around the circumference of the stem (see 9.) For hardwoods, the live crown starts where the lowest branch that contains part of the main live-canopy that encompasses greater than 1/2 the circumference of the stem.



6. Are all multiple stem trees considered UGS? *Not necessarily. If both stems meet the criteria for AGS they can be rated as such. One of the stems can be rated AGS and the other UGS if one of the stems has poor form, vigour or defects that would render it UGS while the other does not.*
7. 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.*
8. 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 and has the potential to produce a piece of studwood and is forecasted to remain that way for 15 years it is considered AGS*
9. Are all striped maple, mountain maple and pin cherry UGS? *Yes*
10. 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 wood that is removed in the harvest (or “caught-up”). This time varies with the number of trees removed (expressed as the % 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. 20%) 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. 50%) 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, and removing 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 leave strips, approximately 15 years will be required for catch-up. This is why a 15 year projection time is used for assessing acceptability (AGS/UGS).*
11. How should I grade an overmature Aspen? *If you think a tree is overmature 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.*
12. A tree has a major fork, should I call the tree an AGS or UGS? *If a tree has a fork that forms an angle of less than 45 degrees with the main stem above the fork and its diameter at the stem is greater than ½ the diameter of the main stem and is located more than 1/3 of the way from the top of the tree and the ground and it has rot associated with the fork it is UGS. Trees with forks that are less severe than described but have severe rot associated with it should also be called UGS.*

13. A tree is leaning, should I call it an UGS? If a tree has a lean with indications of root breakage or partial uprooting it should be called UGS. If a tree has a lean exceeding 15 degrees from vertical it should be called an UGS.
14. A tree has a crown with a partially dead or missing top should it be called an AGS. If a tree has a crown with a dead or missing top amounting to more than 1/4 of the crown it should be called UGS
15. 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 it can be called an AGS.

Appendix IV. Management Prescriptions (SP)

Tending

Commercial Thinning - Where a stand contains predominately merchantable trees of Acceptable Growing Stock (AGS) uniformly distributed, potential for commercial thinning exists. The objective of this treatment is to increase growth of the stand and/or improve species composition or quality. The best opportunities for an economically viable commercial thinning occur on more productive ecosites capable of recapturing harvested volume from the thinning in a reasonable amount of time. All Maritime Boreal (MB) ecosites and Acadian (AC) ecosites AC1, AC2, AC3, AC5 and AC8 may result in longer recovery times than what is considered economically viable, especially for black spruce. Age is also another factor that impacts the economic viability of commercial thinning and over mature stands may not recover the harvested volume. For black spruce the best results occur when trees are less than 50 years old at breast height.

When evaluating a stand for commercial thinning the live crown ratio should also be considered. Trees with less than a 1/3 live crown ratio will not respond well to thinning.

Windthrow is a concern in all partially harvested stands especially where soils are imperfectly to poorly drained or shallow to bedrock. Stands that have been previously treated (pre-commercially thinned or commercially thinned) may be more wind firm. Pine and oak are deeper rooted than black spruce and less susceptible to windthrow. However, jack pine is susceptible to windthrow due to the limited rooting density of the species. Commercial thinning is not recommended in eastern larch due to the natural lower stocking levels and self-thinning characteristics of this species.

Crop Tree Release – When considering a crop tree release, moderate levels of sugar maple, yellow birch and white pine AGS need to be present on site. 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. Only trees touching the crowns of crop trees are to be cut, remaining trees to be left standing.

Pre-Commercial Thinning (PCT) – This treatment is used to reduce the number of trees in young stands before the stems are large enough for commercial use. A second benefit of the treatment is that it allows managers to influence the composition of the future stand by favoring one or more species over another, while at the same time maintaining tree species diversity. The intent is to concentrate growth on fewer stems thus increasing stand diameter, improving conditions for a later commercial thinning, and reducing time to reach operability. As with commercial thinning, the richer ecosites respond better to treatment. Softwood crop trees should have a live crown ratio of at least 1/3 to ensure growth response. Recommended PCT spacings range from 1.8-2.4m for softwoods and 2.4m for hardwoods.

Natural Regeneration

Natural regeneration is an ecologically acceptable and economically viable way to reforest a Spruce-Pine harvested stand. If there is not enough advanced natural regeneration established at the time of harvest, seed trees can be left or a shelterwood can be prescribed.

Seed tree harvest - During a harvest operation 15-35 seed trees per hectare (NSDNR, 1993) of uniformly-distributed wind-firm white or red pine trees of seed-bearing age are required to be left on-site. Black spruce and jack pine are not recommended due to their shallow rooting and windthrow risk, but cone-bearing slash of these species should be considered in the overall regeneration potential for the site. If these species are to be used as seed trees, they should be left in clumps of at least 50 trees and 3-5 clumps for every three hectares of clearcut. Wildlife Habitat and Watercourse Protection regulations must be followed (NSDNR, 2001).

All pine species regenerate best on exposed mineral soil. The preparation of mineral soil seedbeds can be achieved with scarification during or after harvesting.

Shelterwood harvest – This system can be used to thin the overstory to produce light conditions suited for desired species. Shelterwood harvesting systems may be applied in a uniform manner over the stand or arranged in strips or patches. On moist soil types such as ST3, ST6 and ST16, windthrow of black spruce can be significant and shelterwood harvesting is not recommended. The remaining overstory is harvested when suitable regeneration is established to sufficient stocking. Thirty percent of the basal area is to be removed for stands dominated by black spruce. For deeper rooted intermediate shade tolerant species such as white pine or red oak, 40% of the basal area should be removed from the leave strips. Windthrow hazard must be low (Appendix I) for black spruce and low to moderate for red oak and white pine. When using patches, openings should be .04-.10 ha in size for black spruce and .10-.15 ha for white pine and red oak. Using a strip shelterwood, requires at least 2 unharvested strips to each cut strip. The strip width should be 1 tree height for regenerating black spruce and 2 tree heights for white pine and red oak. Since there is a high potential for competition from ericaceous species, seedbed preparation through scarification may be considered during or following these treatments.

Artificial Regeneration (Planting)

Planting is recommended if after two growing seasons adequate regeneration has not established after a clearcut. If seed trees are being used, the establishment period can be extended as long as suitable seedbeds are available. On drier ecosites, planting of black spruce or pine is recommended instead of relying on natural regeneration. On moist sites natural regeneration from seed, if present, is preferred. Competition is often a concern after harvest. Some Spruce-Pine sites have moderate to high levels of herbs (e.g. bracken fern) and ericaceous species which can impede regeneration. Site preparation can be used to increase planting opportunity and success.

Vegetation types in this forest group can also have thick forest floors which dry out after clear-cut harvesting and cause seedling mortality if the roots of the seedling are not penetrating into

the moister mineral soil. The use of site preparation equipment can be required to reduce the forest floor and create plantable microsites.

Planting of red spruce and white spruce should be limited to only the very best of soil types in ecosites AC6 and AC7 and only be considered if follow-up treatments for competition control are available.

Partial Harvesting

Partial harvesting opportunities for the Spruce – Pine (SP) forest group are limited as this group is primarily even-aged forest comprised of shorter lived species with low to intermediate shade tolerance. Ecologically the Vegetation Types in this group mainly re-establish following stand level disturbances and grow until re-disturbed or they reach their maximum longevity. Therefore, partial harvesting opportunities in the Spruce - Pine group are focused on stand renewal treatments such as shelterwoods and seed tree and early commercial thinnings.

Pruning Pine and Red Oak

Pruning is best applied to those species that have a high economic return through the production of knot free lumber and veneer. The pruning of white pine is a viable management option where high value white pine can be grown. Damage by white pine weevil can often be corrected through leader pruning, correcting stem form and reducing the risk of disease. Stem pruning can be justified to improve the value of select crop trees. Pruning red and jack pine for poles and posts, other than to reduce large branches, provides little economic advantage. Pruning red oak for timber quality has not been developed and most indications are that forest grown red oak readily self-prunes. The pruning of oak should be limited to improving overall tree form when trees are young. For further information on pruning refer to:

<http://novascotia.ca/natr/woodlot/pdf/treepruning.pdf>

Prescribed Burning

Prescribed burning as a pre-treatment to prepare seedbeds for red pine and red oak regeneration has not been developed to the point where it is recommended for use in Nova Scotia at this time. Some of the benefits of prescribed burning include maintaining soil structure, reducing competition, improve access for planting, improve seedling survival, and increase nutrient availability and surface soil temperature. Further research may identify site and stand conditions where this treatment would be appropriate.

Overstory Removal

Overstory Removals are prescribed in mature stands under two conditions (1) where adequate regeneration of established preferred regeneration exists and needs to be released or (2) where adequate regeneration does not exist and suitable species or sites do not exist to enable a successful shelterwood or seed tree treatment. Soils may be shallow or sites exposed to high winds making leaving residual trees for seed or shade impractical.