FOREST RESEARCH REPORT
Nova Scotia Department of Natural Resources

Contents

Introduction …… 1
Use of the Keys …… 2
Key VT – Vegetation Types…… 6
Key M – Main ……. 8
Sub-Key T – Tend …..……. 10
Sub-Key CT – Commercial Thin…12
Sub-Key R – Regeneration ……. 14
References …… 16
Appendix I – Silvics of Common Nova Scotia Trees …… 17
Appendix II – Management Prescriptions ..……. 18
Appendix III – Identification of Acceptable Growing Stock ……. 22

NOVA SCOTIA

Report FOR 2015-3 No. 95
October 26, 2015
(updated February 23, 2017)

Intolerant Hardwood Management Guide

Tim McGrath
Peter Neily
Eugene Quigley

Forestry Division
Truro, Nova Scotia

Introduction

The 2011 Natural Resources Strategy commits Nova Scotia to implementing an ecosystem based approach to forest management (NSDNR, 2011). In support of this initiative, ecosystem based management guides are being developed. Tolerant Hardwood and Tolerant Softwood/Mixed Management Guides have been previously published (McGrath, 2007, McGrath 2010). This guide covers the Intolerant Hardwood Vegetation Group (Neily *et al*. 2011). These guides will help the province move towards prescribing silviculture and harvests based on ecological and stand conditions. The system to collect the information required for using these guides is referred to as the Pre-treatment Assessment [PTA], (McGrath, 2013). PTAs are required on crown land and encouraged on private land. Refer to McGrath (2013) for information regarding this system.

Use of the Keys

These keys were developed for the Intolerant Hardwood (IH) vegetation group and are also used for Tolerant Hardwood (TH), Spruce Hemlock (SH) and Mixedwood (MW) vegetation types not dominated by Tolerant Long-Lived species (Appendix I) as defined in Nova Scotia's Forest Ecosystems Classification (Neily *et al*., 2011). Refer to Key VT to determine the Management Guide relevant to the stand under consideration.

The Intolerant Hardwood Guide consists of four separate keys. Users start at the Main key (Key M) working their way through a series of questions concerning current stand conditions to arrive at a prescription. To reach a recommendation, the user may be referred to one of three sub-keys. The sub-keys include Tending (Sub-Key T), Commercial Thinning (Sub-Key CT) and Regeneration (Sub-Key R).

In the keys, any text outlined by a diamond and shaded in grey is a question that must be answered. Depending on the answers to these questions the designated path is followed until a rectangle is encountered. These rectangles refer to, either a sub-key (shaded in yellow), a management prescription (shaded in green), a recommendation to wait and re-evaluate later (shaded in red), or referral to another Management Guide (shaded in brown). If a sub-key is indicated, it is followed until arriving at a prescription. Short prescription descriptions are imbedded in the keys. They are discussed in more detail in Appendix II.

Windthrow Hazard

When prescribing partial harvesting systems in Nova Scotia, the potential for blowdown of residual trees is of concern. As a result, this guide incorporates an assessment of windthrow hazard as an important consideration when prescribing treatments. This windthrow hazard rating (Low, Medium or High) depends on site exposure and soil characteristics. The soil characteristic component of windthrow hazard can be directly determined from soil type, according to Keys *et al*. (2011b). Windthrow hazard also depends on exposure of the stand to winds due to topography, slope position, proximity to the coast and to cut edges (Stathers *et al*., 1994). An evaluation of the wind exposure rating (Table 2) must be completed to combine with soils characteristics to estimate overall windthrow hazard as shown in Table 1. In this guide, partial harvests are not recommended in high windthrow hazard situations, but are recommended in low hazard conditions. The decision to proceed in medium hazard situations comes with increased risk of elevated harvesting cost and revenue loss due to windthrow.

Table 1. Windthrow Hazard Rating[A] Categories Based on Exposure and Soils.					
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					
[A]Windthrow Hazard Rating	**Low**	**Moderate**	**High**		

Table 2. Exposure[A] Definitions Adopted from Keys *et al*. (2011).		
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 which 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.		

Restoration to Later Successional Vegetation Types

Intolerant vegetation types (IH1-IH6: Neily *et al.* 2011) are mainly early successional stands. Many of the forest stands classified as Intolerant have the potential to be moved towards their naturally occurring later successional version by using appropriate harvesting methods. Table 3 (from Neily *et al*. 2011) shows the possible successional links for Intolerant Hardwood vegetation types in the province. For example, a stand classified as IH3 Large-tooth aspen/Christmas fern-New York fern has the potential to move towards TH3 Sugar maple-White ash/Christmas fern. The ability to move from IH3 to TH3 through partial harvesting, depends on a number of stand characteristics such as the presence of seed source trees or advanced regeneration of later successional species found in TH3 stands (e.g. sugar maple). The IH forest management guide defines stand conditions that indicate whether a forest manager could be successful in restoring these later successional species using harvesting methods such as shelterwoods. The choice of whether to move a stand along its natural development path when possible, depends on an evaluation of the landscape within which the stand is located, its condition and stand management objectives. The Ecological Land Classification (ELC; NSDNR, 2006) forms the basis for classifying these landscapes in Nova Scotia.

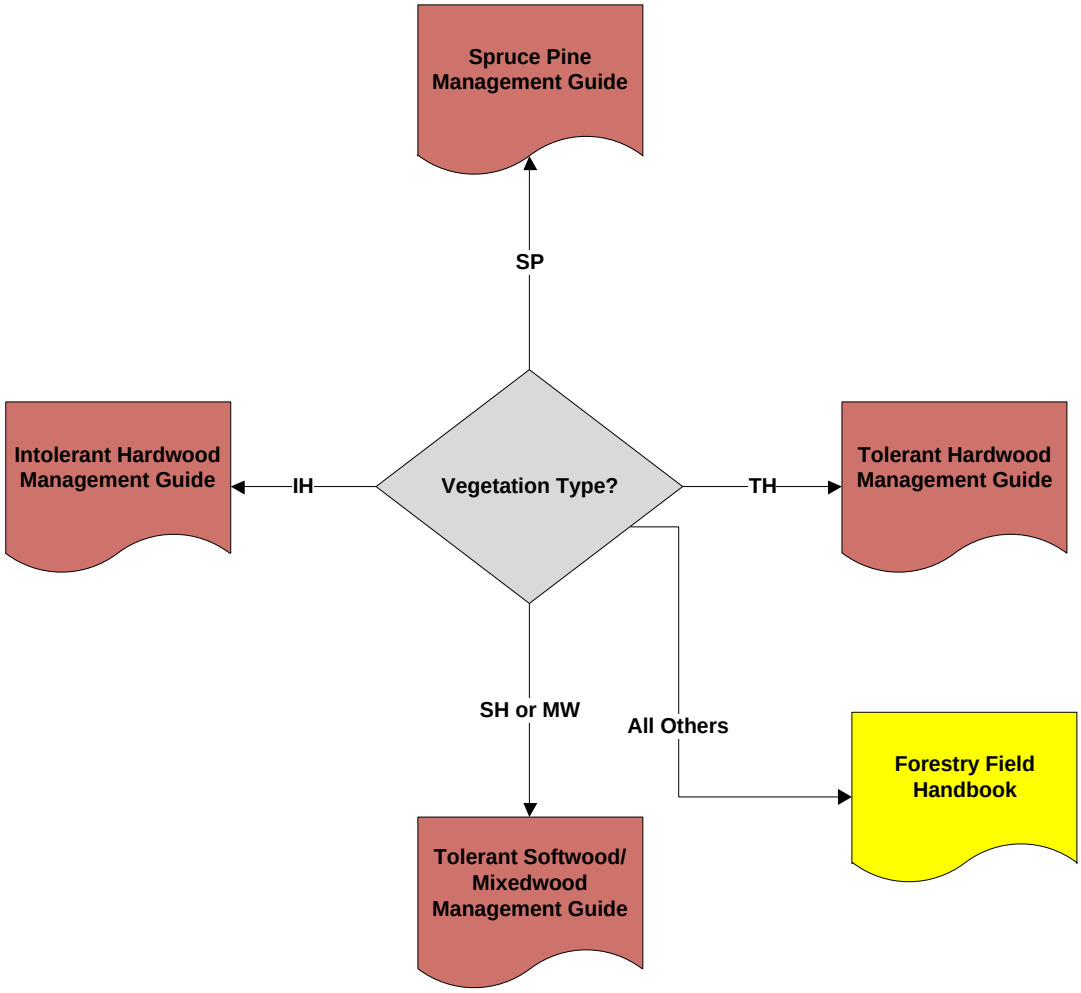
In some cases, it may be more appropriate to maintain an Intolerant Hardwood stand's early successional stage even when restoration is possible. The choice of whether to restore or not should impact the harvesting methods chosen. In our IH3 example, early successional Large-tooth aspen trees would be maintained after clearcutting due to the species' ability to regenerate by suckering in open conditions. If restoration was preferred in this IH3 stand and existing adequate amounts of later-successional seed-source trees or regeneration exists, a shelterwod treatment may be effective in moving the stand towards its later successional stage. It should be noted that other methods could be used to restore later successional species. For example, an IH3 stand could be restored to a mid-successional SH-5 Red spruce-Balsam fir /Schreber's moss by clearcutting, planting red spruce and weeding the suckering Large-tooth aspen where herbicides are available for use.

The IH management keys explicitly ask whether restoration of Long-Lived species is the management objective. Depending on the user's response to this question, differing harvest methods are recommended (Key R).

Table 3. Successional Links for the Intolerant Hardwood (IH) Forest Group (Neily *et al.*, 2011)

	Early	Middle	Late
IH1	**IH1**, IH2	SP6	SH4, SP9
IH2	IH1, **IH2**	SP4	SH4, SP9
IH3	**IH3**, IH4, IH5, IH6	IH7, MW2, SH5, SH6, SH7, SH8	MW1, MW3, SH1, SH3, TH1, TH2, TH3, TH4, TH6, TH8
IH4	**IH4**	IH7, MW2, MW4, SH5, SH6, SH7, SH8, SH9, SH10	MW1, MW3, SH1, SH2, SH3, SH4, TH6, TH8
IH5	**IH5**, MW5	IH7, MW4, SH5, SH6, SH7, SH8	MW1, MW3, SH3, TH1, TH2, TH3, TH4, TH8
IH6	**IH6**	IH7, MW2, SH5, SH6, SH7, SH8, SH9, SH10	MW1, MW3, SH1, SH2, SH3, SH4, TH1, TH2, TH6, TH8
IH7	IH3, IH4, IH5, IH6	**IH7**, TH7	MW1, TH1, TH2, TH3, TH6, TH8

Management Guides by Vegetation Group
Key VT – Vegetation Types



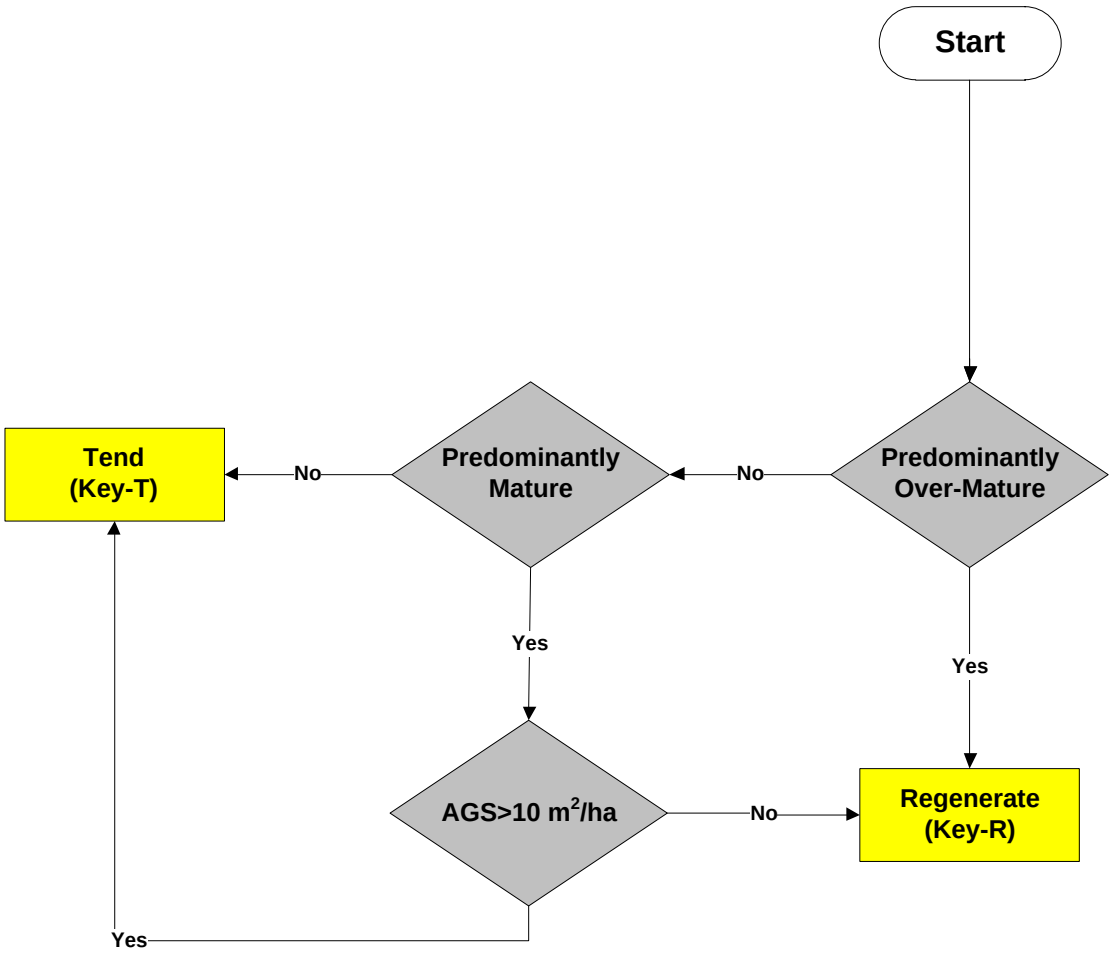
KEY - VT - Vegetation Types

Instructions and Definitions for:

Decision Diamond

Vegetation Type – What vegetation type (Neily *et al*., 2011) are you in ? If in a Tolerant Hardwood **v**egetation 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 Neily, Quigley and McGrath (2014). If in any other vegetation type refer to the Forestry Field Handbook (NSDNR, 1993).

Intolerant Hardwood Management Key
Key M - Main



KEY - M - Main

Instructions and Definitions for:

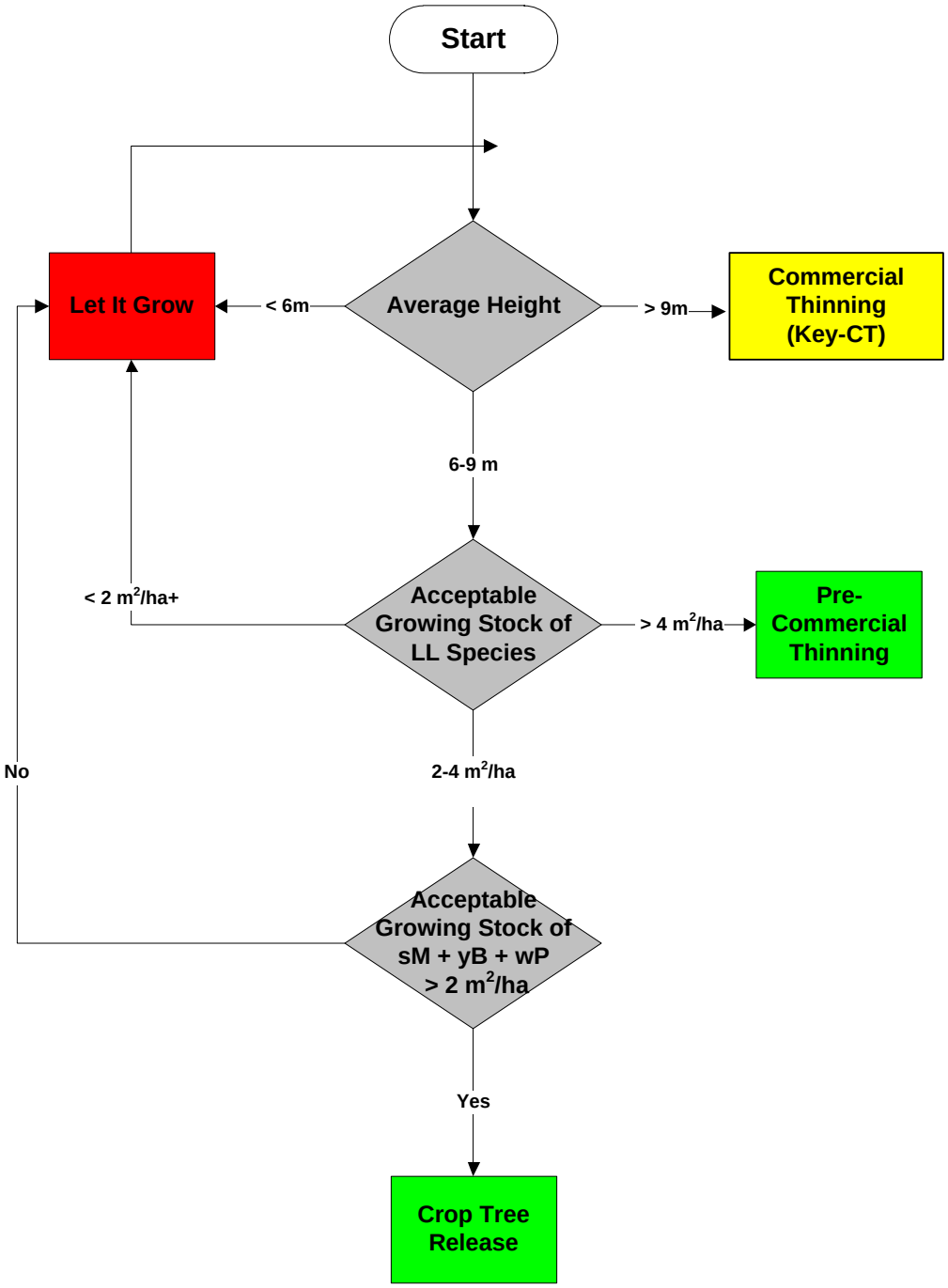
Decision Diamonds

- **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 I)
- **Predominantly Mature** – Is the overstory predominantly mature in terms of producing adequate seed for regeneration (Appendix I).
- **AGS > 10 m^2/ha** – Is the basal area of Acceptable Growing Stock (AGS^A, Appendix III) greater than 10 m^2/ha.

[A] 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 (Appendix III).

Intolerant Hardwood Management Key

Sub-Key T - Tend



SUB-KEY 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 (AGS[B]) of LL species[C]** – What is the Acceptable Growing Stock basal area of Long-Lived (LL) species. For stands averaging between 6 and 9 m tall, is it less than 2 m^2/ha, between 2 and 4 m^2/ha or greater than 4 m^2/ha.
- **Acceptable Growing Stock (AGS[F]) of sM + yB + wP > 2 m^2/ha** – Is the basal area of Acceptable Growing Stock of sugar maple, yellow birch and white pine greater than 2 m^2/ha.

Management Prescriptions

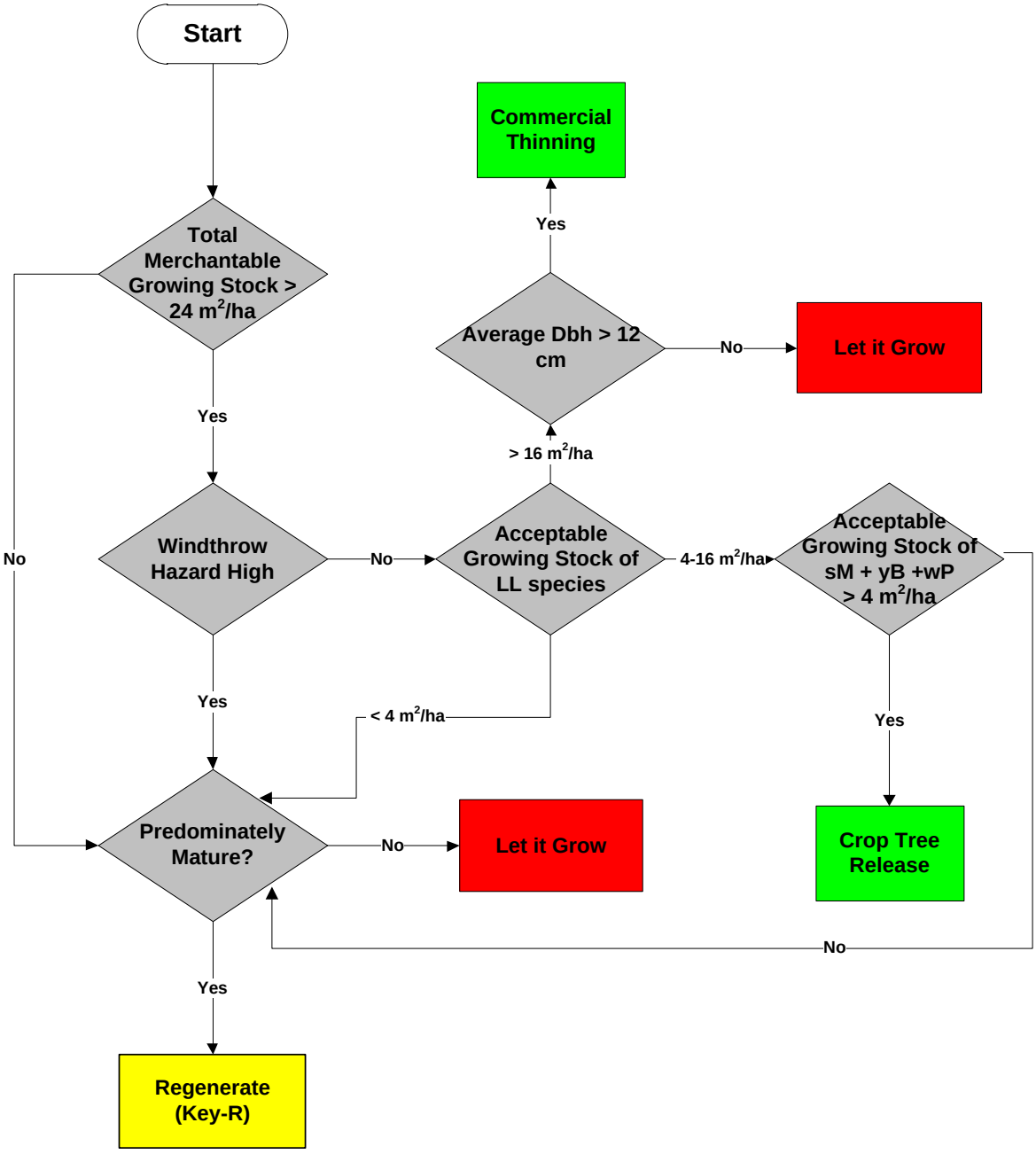
- **Crop Tree Release –** Where moderate levels of sugar maple, yellow birch or white pine AGS exist, release only the best quality trees on at least three sides so that no trees are touching or overtopping the crowns of the released trees. The released trees must be vigorous, of good form and have high 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 at a later date.

[B] 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 (Appendix III).

[C] **LL species** - Long lived species, including red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak and white ash.

Intolerant Hardwood Management Key

Sub-Key CT – Commercial Thin



SUB-KEY CT – Commercial Thinning

Instructions and Definitions for:

Decision Diamonds

- **Total Merchantable Growing Stock > 24 m^2/ha –** Is the basal area of merchantable trees greater than 24 m^2/ha?
- **Windthrow Hazard (refer to Table 1 on page 3)**
  - **High** – Exposed ***or*** rooting depth < 30 cm ***or*** Imperfect to Very Poor Drainage[D]
  - **Moderate –** Moderately Exposed ***and*** rooting depth ≥ 30 cm ***and*** Moderately Well to Rapid Drainage
  - **Low –** Moderate to Sheltered ***and*** rooting depth ≥ 30 cm ***and*** Moderately Well to Rapid Drainage
- **Acceptable Growing Stock (AGS[E]) of LL species[F]** – What is the Acceptable Growing Stock basal area of Long-Lived (LL) species. For stands averaging between 6 and 9 m tall, is it less than 4 m^2/ha, between 4 and 16 m^2/ha or greater than 16 m^2/ha.
- **Acceptable Growing Stock (AGS[F]) of sM + yB + wP > 4 m^2/ha** – Is the basal area of Acceptable Growing Stock of sugar maple, yellow birch and white pine greater than 4 m^2/ha.
- **Average Dbh > 12 cm** – Is the Quadratic mean diameter (at breast height) more than 12cm (trees ≥10 cm Dbh class)?
- **Predominantly Mature** – Is the overstory predominantly mature in terms of producing good seed crops, necessary for natural regeneration (Appendix I).

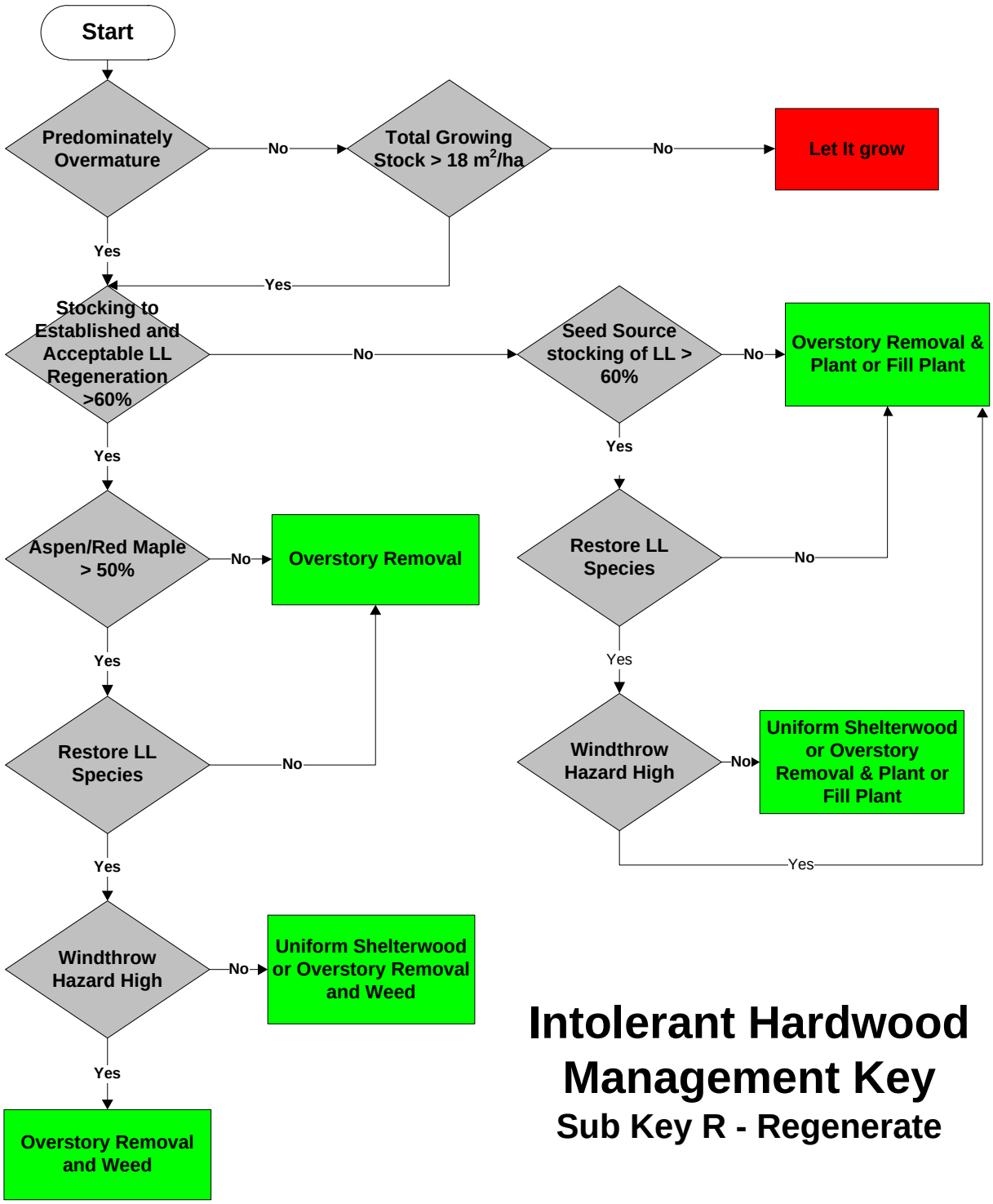
Management Prescriptions

- **Crop Tree Release –** Where moderate 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. 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 30-40% of the basal area from the leave strips. The objective of this treatment is <u>not</u> to regenerate the stand.
- **Let it grow** – Let the stand grow and re-evaluate the stand later.

[D] As an alternative to rooting depth and soil drainage, soil type (Keys *et al*., 2011b) can be used to determine windthrow hazard due to soils (see Table 1 on page 3).

[E] 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 (Appendix III).

[F] **LL species** - Long lived species, including red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak and white ash.



Intolerant Hardwood Management Key

Sub Key R - Regenerate

SUB-KEY R – Regenerate
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 I)
- **Total Growing Stock > 18 m^2/ha** – Is the total basal area of trees at least 10 cm in diameter at breast height greater than 18 m^2/ha?
- **Stocking to Established Acceptable LL**[G] **Regeneration > 60%** – Is the stocking to acceptable established[H] Long Lived species regeneration greater than 60% (at 2.4 m spacing)?
- **Windthrow Hazard High? (refer to Table 1 on page 3)**
  - **High** – Exposed ***or*** rooting depth < 30 cm ***or*** Imperfect to Very Poor Drainage[I]
- **Seed source stocking of LL**[K] **species > 60% -** Is the stocking (to 20 m spacing) of seed source trees of LL species greater than 60%?
- **Aspen/Red Maple > 50%-** Is the % of Aspen[J] and Red Maple basal area combined more than 50% of the total basal area of the stand.
- **Restore LL**[J] **Species –** Is one of the objectives of this harvest to restore Long Lived species?

Management Prescriptions

- **Overstory Removal** – Release regeneration by removing overstory. Protect advanced regeneration in harvesting operation.
- **Overstory Removal & Plant or Fill Plant** – Remove overstory and plant or fill plant if adequate regeneration not present after two growing seasons. Weeding of competition must be completed where necessary to insure successful plantation establishment.
- **Overstory Removal & Weed** – Remove overstory and weed competing species to insure establishment of LL regeneration. Protect advanced regeneration in harvesting operation.
- **Uniform Shelterwood** – 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 (sugar maple, red spruce or eastern hemlock). If species such as yellow birch, white ash, red oak or white pine predominates up to 50% Basal Area can be removed from the leave strips.
- **Let it grow** – Let the stand grow and re-evaluate the stand later.

[G] LL species-Long lived species, including red spruce, eastern hemlock, white pine, sugar maple, yellow birch, red oak, and white ash
[H] Established regeneration can survive after the entire canopy is removed at one time. As a rule this occurs when the seedlings are rooted in mineral soil and they are 0.3m (1 foot) in height. Only include trees < 10 cm Dbh.
[I] As an alternative to rooting depth and soil drainage, soil type (Keys *et al*., 2011) can be used to determine windthrow hazard due to soils (see Table 1 on page 3).
[J] Aspen – Includes Trembling Aspen, Large tooth Aspen and Balsam Poplar.

References

Anderson, H.W. and J.H. Rice. 1993. A Tree Marking Guide for the Tolerant Hardwood Group in Ontario. Science and Technology Series, Volume 8. Forest Resources Branch, Ontario Ministry of Natural Resources. 225 pp**.**

Burns, R.M. and B.H Honkala (cord.). 1990. Silvics of North America, Volume 1, Conifers and Volume 2, Hardwoods. United States Dept of Agriculture, Forest Service, Washington DC, Agriculture Handbook 654. Volume 1(675 pp.) Volume 2 (877 pp.)
http://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm

Harrison, G. Silvics of Common Maritime Softwoods and Hardwoods. Maritime Forest Ranger School. 67 pp.

Keys, K., P. Neily, E. Quigley and B. Stewrart. 2011a. Forest Ecosystem Classification for Nova Scotia. Part III: Ecosites (2010). Nova Scotia Dept. of Natural Resources, Renewable Resources Branch. Report FOR 2011-2. 92 pp.
http://www.gov.ns.ca/natr/library/forestry/reports/Ecosites.pdf

Keys, K., P. Neily and E. Quigley. 2011b. Forest Ecosystem Classification for Nova Scotia. Part II: Soil Types (2010). Nova Scotia Dept. of Natural Resources, Renewable Resources Branch. Report FOR 2011-3. 119 pp.
http://www.gov.ns.ca/natr/library/forestry/reports/Soil-Types.pdf

McGrath, T. 2007. Tolerant Hardwood Management Guide. Timber Management Group, Forest Management Planning Section, Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia. Report FOR 2007-8, Forest Research Report no. 84. 23 pp.
http://www.gov.ns.ca/natr/library/forestry/reports/REPORT84.pdf

McGrath, T. 2010. Tolerant Softwood / Mixedwood Management Guide. Timber Management Group, Forest Management Planning Section, Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia. Report FOR 2010-2, Forest Research Report no. 91. 23 pp.
http://www.gov.ns.ca/natr/library/forestry/reports/REPORT91.pdf

McGrath, T. 2013. Pre-Treatment Assessment (PTA) Requirements Under the Nova Scotia Code of Forest Practices. Timber Management Group, Forest Management Planning Section, Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia. Draft Report. 17 pp.
http://novascotia.ca/natr/forestry/programs/timberman/pta.pdf

McGrath, T. and J. Ellingsen. 2009. The Effects of Hurricane Juan on Managed Stands Commercially Thinned in Central Nova Scotia. Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia, Report FOR 2009-2, Forest Research Report no. 89. 9 pp.
http://www.gov.ns.ca/natr/library/forestry/reports/Report89.pdf

Neily, P., S. Basquill, E. Quigley and B. Stewart and K. Keys. 2011. Forest Ecosystem Classification for Nova Scotia. Part I: Vegetation Types (2010). Nova Scotia Dept. of Natural Resources, Renewable Resources Branch. Report FOR 2011-1. 264 pp.
http://novascotia.ca/natr/forestry/veg-types/

NSDNR. 1993. Forestry Field Handbook. Forest Research Section, Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia. 43 pp. http://www.gov.ns.ca/natr/forestry/handbook/

NSDNR. 2001. Wildlife Habitat and Watercourse Protection Regulations.
http://www.gov.ns.ca/just/regulations/regs/fowhwp.htm

NSDNR. 2006. Ecological Land Classification Map of Nova Scotia Version 2,
Updated March 22, 2006. Ecosystem Management Group, Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia.
http://gis4.natr.gov.ns.ca/website/nselcmap/viewer.htm

NSDNR. 2008. Nova Scotia's Code of Forest Practice, A Framework for the Implementation of Sustainable Forest Management, Interim Guidelines for Crown Land. Nova Scotia Dept. of Natural Resources, Truro, Nova Scotia. 32 pp.
http://www.gov.ns.ca/natr/forestry/reports/Code-of-Forest-Practice-2008.pdf

NSDNR. 2011. The path we share, a natural resources strategy for Nova Scotia 2011-2020. Report Number DNR 2011-1, ISBN: 978-1-55457-431-5. 79 pp. http://novascotia.ca/natr/strategy/pdf/Strategy_Strategy.pdf

Stathers, R.J., T.P. Rollerson and S.J. Mitchell. 1994. Windthrow Handbook for British Columbia Forests. B.C. Min. For., Victoria, B.C. Working Paper 9401. 31 pp.

Appendix I - 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. This IH Forest Management Guide (FMG) uses stand maturity, longevity and shade tolerance characteristics (Table 4) to prescribe appropriate prescriptions. Harvest are optimally timed between when they become mature and over-mature. Harvesting after maturity increases opportunities for natural regeneration as it is the point when trees generally reach full seed production. Timber losses are avoided if harvesting takes place before over-maturity as tree senescence, slow growth and increased mortality occur at this age. A specie's "Shade Tolerance" defines the ability of a species to regenerate from seed in shaded conditions. Tolerant species (e.g. sugar maple) are successful in regenerating in partial shade, produced with shelterwood harvests, while intolerant species (e.g. trembling aspen) are not.

Table 4. Silvics of Common Maritime Trees

Species	Maturity (full seed production, yrs)	Over-Maturity (average mature tree, yrs)	Longevity	Shade Tolerance
Softwoods				
Red Pine	50	70	M	I
White Pine	50	100	L	IM
Jack Pine	40	60	M	I
Black Spruce	30	70	M	T
White Spruce	60	60	M	IM
Red Spruce	45	100	L	T
Balsam Fir	30	50	M	T
Eastern Larch	40	60	M	I
Eastern Hemlock	50	100	L	T
Hardwoods				
Trembling Aspen	30	50	M	I
Large-tooth Aspen	30	50	M	I
Yellow Birch	70	90	L	IM
White Birch	50	50	M	I
Red Oak	50	80	L	IM
Sugar Maple	80	100	L	T
Red Maple	40	60	M	T
White Ash	50	80	L	IM

Adapted from: Girvan Harrison, MFRS. Silvics of Common Maritime Softwoods and Hardwoods and Burns and Honkala (ed.). 1996. USDA. Silvics of North America.
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 40-70 years, L – Long >70 years
Shade Tolerance: I – Intolerant, IM – Intermediate, T – Tolerant

Appendix II - Management Prescriptions

Several management prescriptions are made in these guides. The keys include glossaries with short descriptions of these prescriptions. This section provides more details concerning these prescriptions.

- **Crop Tree Release –** A crop tree release is mainly a tending operation, where a relative few high-quality sugar maple, yellow birch or white pine trees (AGS) with potential for high-value are released while the rest of the stand is left un-tended.

  It is especially effective where there are a few high-value potential trees in a stand that is dominated by stems without high value potential. Investment in this pre-commercial treatment is concentrated on only releasing stems with the best potential return on investment. This treatment is relevant where there is a high value market for large trees of good stem quality. 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 vigor and crown structure, will give high return by investing in its release. It is important to limit the number of trees released to only the best quality trees at a minimum spacing (10 m) between released trees. Since the objective is to produce large trees of high quality and value, they need space to grow to the size necessary to meet specifications. If too many trees are released, they will have to be cut to release other higher quality trees to make growing room, wasting the initial investment in their release. The trees to be released should be released on at least 3 sides to maximize diameter growth. To avoid exposure damage, trees left on the south facing side of the crop tree can be left. The release should only cut trees that are overtopping the crop tree or have their crowns touching the crowns of crop trees. If a tree is below the canopy or not have its crown touching the crop tree it should be left standing. In some cases, two high quality 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 3 sided release.

  This treatment will result in areas with small holes in the canopy formed by releasing crop trees, interspersed with un-thinned areas. Some lower quality merchantable sized trees of relative 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 for this treatment is to release the trees with the very best potential. The crop trees must be vigorous, of good form and have high value potential. Crop trees should be self-pruned for at least the length of one sawlog or be manually pruned. Do not prune in the same year as the release treatment to avoid epicormic branching.

- **Pre-commercial Thinning (PCT) –** A pre-commercial thinning is a treatment where the better quality trees of preferred species are spaced by cutting lower quality stems to accelerate diameter growth and improve stand composition. This treatment is performed when the stand is un-merchantable

  Cut stems are left on site to leave nutrients for the leave trees. If carried out effectively the stands treated with PCT can become merchantable at an earlier age, thereby increasing the Mean Annual Increment of merchantable volume (GNY model: http://novascotia.ca/natr/forestry/programs/timberman/growthyield.asp). Stand succession can be influenced by favoring tolerant species and later successional Vegetation Types (Neily *et al*. 2011). It is prescribed where high levels of AGS exist uniformly distributed throughout the stand (on average at least every 3 m). The spacing of the trees left as future crop trees should be at least 1.8 metres but not more than 2.4 metres apart. The selection of the appropriate spacing and timing of the PCT treatment depends on the species and the anticipated future management scenario for the stand.

  If softwood stands are spaced to less than 1.8 metre spacing, natural mortality due to crowding of released trees will occur before the stems become merchantable size. If softwoods are spaced wider than 2.4 m apart, excessive branching will occur and wood quality will be degraded. When Commercial Thinning (CT) is anticipated as a follow-up treatment to the PCT, the wider spacings are preferred to improve the piece size and economic feasibility of the CT treatment. If it is anticipated that the stand will be clearcut and not CT the narrow spacing may be preferred to minimize rotation age. In terms of PCT timing, to maximize the growth returns from softwoods, early PCT's are most effective. In general softwood PCT's should be performed when the crop trees are between 2 and 6 metres tall. If done earlier, crop tree selection is difficult, but when done too late, growth response and thinning productivity is lower. Care must be taken when releasing softwoods, to favor 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 and value 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 at the later part of the timing window (6 m) as the red maple clumps will re-sprout unless controlled. It is also prudent to leave a couple of weak stems in the clumps to reduce re-sprouting. The crop trees left should be high quality trees of preferred species. Care should be taken to maintain species diversity when carrying out this treatment.

  For hardwoods, spacing should be 2.4 metres, as released trees require a growing space of 2.4 metres to reach an average diameter of 15 cm before self-thinning occurs. It is especially important to limit PCT spacing to 2.4 metres in hardwoods when the goal is to produce sawlogs as a future product. Wider spacings produce increased branching and more defects. Pre-commercial thinning hardwoods should occur later than for softwoods, as branching has a larger potential impact on future value, due to the stimulation of branching. Hardwoods should be thinned when between 6 and 9 metres tall.

- **Commercial Thinning (CT) –** This is a treatment whose aim is to harvest commercial trees, while improving the growth, quality and species content of the leave trees for harvesting at a future date.

  It is recommended where high levels of uniformly distributed AGS and adequate merchantable basal area exists. 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 objective of this treatment is not to regenerate the stand but to improve the growth and species mix of leave trees. It can result in higher yields of quality products, with an increased piece size and harvesting efficiency. It also can be used as a tool to influence stand succession to favor high quality later successional species and later successional vegetation types. The leave trees should be kept until the stand grows back the volume removed and becomes fully stocked. This will take on average 15-20 years when removing 30-40% of the basal area from the leave strips. Care should be taken to release trees throughout the stand. Limited release is achieved from the extraction trails, therefore trees left in the leave strips should be thinned as well to maximize the benefit of the treatment. Care must be taken to limit stem, root and crown damage when harvesting and extracting trees; and to minimize trail 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 leave strips to achieve sufficient release of future crop trees.

- **Overstory Removal** – This is a regeneration treatment that removes the mature overstory to release existing regeneration where sufficient established acceptable regeneration exists. Harvesting activities must protect the preferred advanced regeneration.

- **Overstory Removal & Plant or Fill Plant** – This is a regeneration prescription where sufficient regeneration of acceptable and established regeneration is not present and a shelterwood treatment is not possible due to windthrow hazard. The overstory is removed and the site planted or fill planted if adequate regeneration is not present after two growing seasons. Weeding of competition must be completed, where necessary, to insure successful plantation establishment.

- **Overstory Removal & Weed** – This is a regeneration treatment, prescribed where sufficient regeneration of acceptable and established regeneration is present and high levels of red maple sprout and/or aspen suckering competition is anticipated. Harvesting activities must protect the preferred advanced regeneration.
  The overstory is removed and the site weeded to remove competing species to insure successful establishment of preferred regeneration.

- **Uniform Shelterwood** – Uniformly thin overstory to produce light conditions suited for regeneration of 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 the leave strips when regenerating shade tolerant species (sugar maple, red spruce or eastern hemlock). If regenerating

intermediate shade tolerant species such as yellow birch, white ash, red oak or white pine, 40-50% of the basal area should be removed from the leave strips. 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 5-10 years after the shelterwood. If sufficient established regeneration exists an overstory removal is recommended. If adequate regeneration has not been realized after 10 years, another shelterwood treatment should be considered.

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.

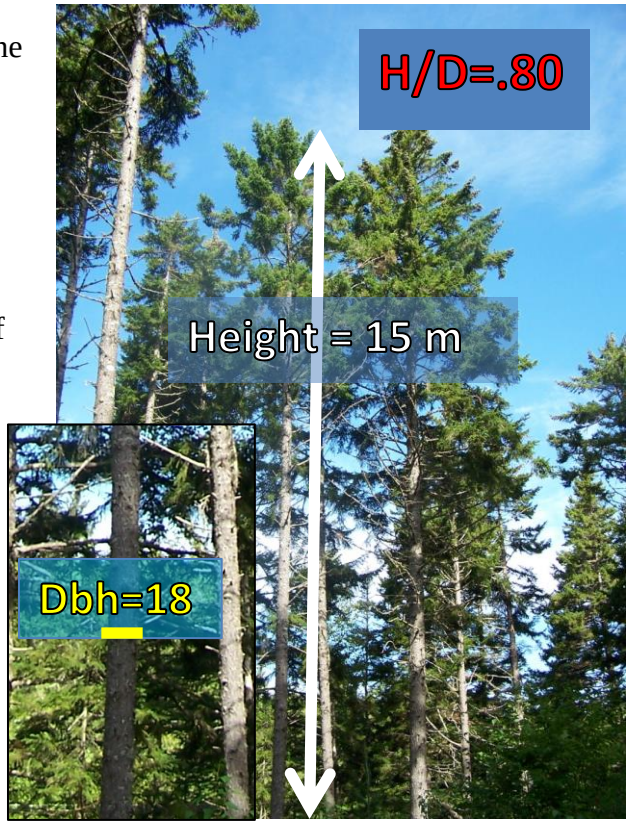
Characteristics of UGS trees

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

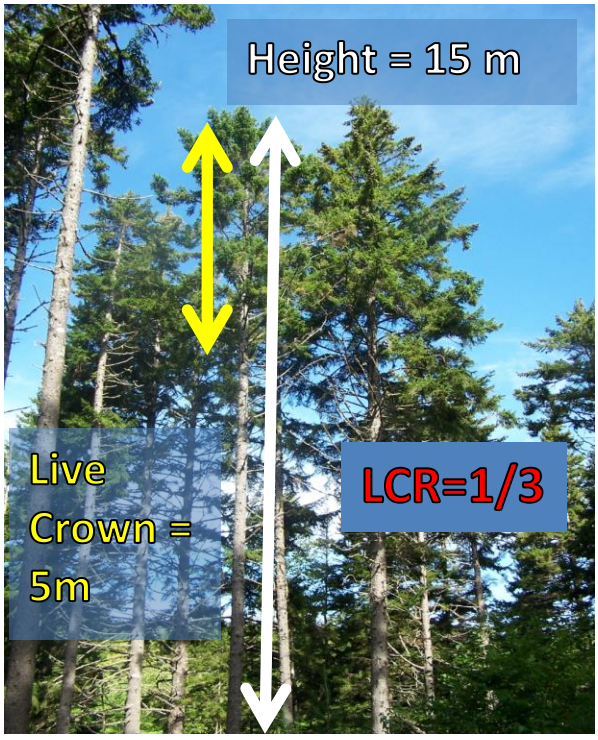
Wind damage risk

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

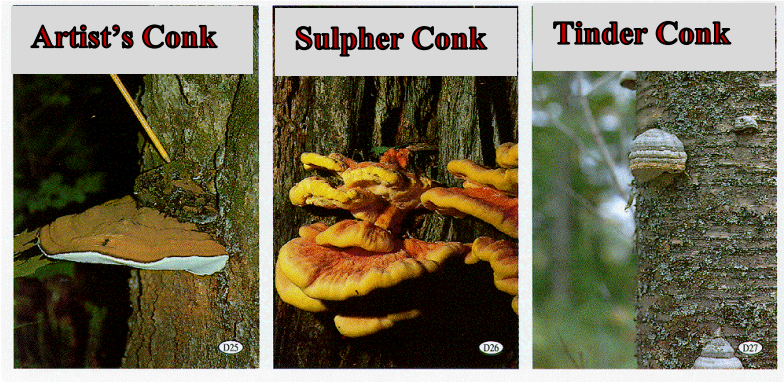
Trees affected by insects and/or diseases are considered UGS. For example, balsam fir infested with balsam wooly adelgid (BWA) is at risk to die and therefore a poor candidate for release.

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 100cm^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 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.

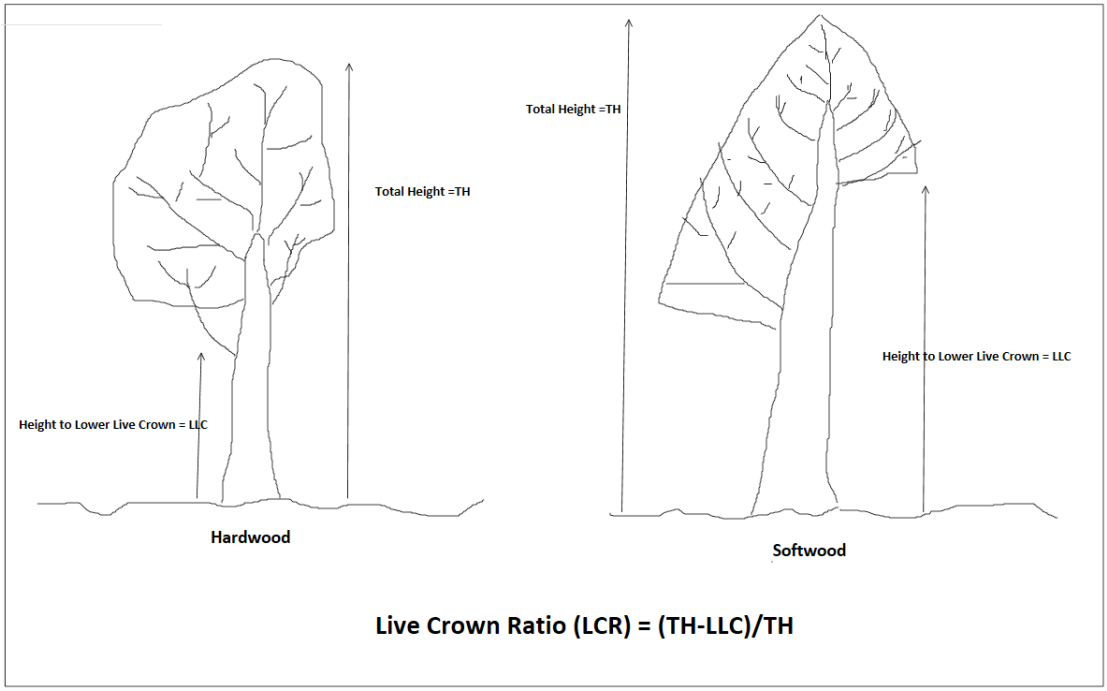
For example:

- 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 ½ way around the circumference of the stem. If Live Crown Ration (LCR) is 1/3 around more than ½ 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 ½ 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 ½ 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.*