# NHRI SPS 2.0: Quick Start Guide

## NHRI Silviculture Prescription System

*Version 2.0 - January 2020*

# TABLE OF CONTENTS

# INTRODUCING NHRI's SPS 2.0

***A simple and quick way to get the optimal prescription for your stand***

The NHRI's Silviculture Prescription System is a 5-step process that starts with the description of a stand and ultimately recommends very specific treatments in forests that are dominated by hardwoods.

The NHRI Silviculture Prescription System was introduced in 2015 and its implementation was gradually undertaken in various stands of all tenure types in New Brunswick. From these trials, several improvements were recommended and led to the re-design of the SPS. Version 2.0 of the SPS was completed in January 2020. Improvements brought to our original SPS include:

- Simplified framework;
- New nomenclature of silviculture systems to minimize confusion on two-aged/extensive systems (formerly called "Irregular Shelterwoods");
- More robust logic for treatment determination;
- Better instructions for implementation.

This document is meant as a *Quick Start Guide* for experienced practitioners and users with limited silviculture experience and basic knowledge of forestry principles. The *Quick Start Guide* serves much like an instruction manual aimed at getting started in applying the NHRI SPS as a silviculture tool.

If you are looking for more detailed information, or simply looking to learn more, about the NHRI's SPS 2.0 please don't hesitate to visit our website (www.hardwoodsnb.ca) where you will find detailed guides, videos and presentations on our silviculture prescription system and various other topics related to northern hardwoods and mixed forests silviculture.

# INTRODUCING NHRI's SPS 2.0

***A simple and quick way to get the optimal prescription for your stand***

The first thing anyone, whether a forestry expert or novice, should do before getting started with SPS 2.0 is to download the smart phone application. This is especially true if you have limited knowledge of forestry principles and silviculture techniques and/or have limited time at your disposal—but still very interested in obtaining a prescription for a given stand.

An updated mobile phone application is available for both I-Phone and Android devices. The App was designed with an easy to use interface through which you can rapidly obtain a prescription for a given hardwood stand. The user simply answers a sequence of questions about the characteristics of the stand which ultimately leads to the recommendation of a specific prescription. All that is left to do is to consult the silviculture framework and prescription tearsheets to ensure stand eligibility, management objectives and operational conditions are respected.

***Downloading the App is easy!***

- Click one one of the photos below
- Scan the QR code
- Search *"NHRI SPS"* in Apple App Store
- Search *"NHRI TOOLS"* in Google Play
- Visit our website @ www.hardwoodsnb.ca


# NHRI's Silviculture Prescription System

## *SPS 2.0 - IMPLEMENTATION STEPS AND REQUIRED TOOLS*

### STEP #1
**Define Stand Type**

*Use the master key to determine species composition and age class structre.*

### STEP #2
**Determine Treatment**

*Run the treatment determination keys to get to a recommended prescription.*

### STEP #3
**Review Silviculture Framework**

*Consult silviculture framework and prescription tearsheets to ensure stand eligibility, management objectives & operational conditions are respected.*

### STEP #4
***Provide Work Instructions***

*Communicate work instructions to operators and supervisors.*

### STEP #5
***Monitor Performance***

*Communicate performance expectations by providing implementation checklists to field crews.*

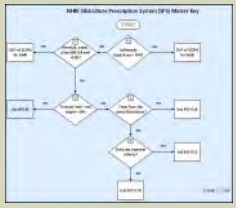

### TOOL #1
**Master Key**

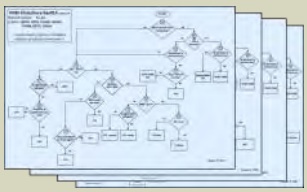
### TOOL #2
**Treatment Keys**

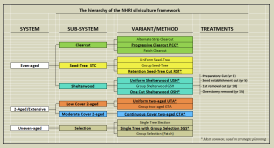
### TOOL #3
**Framework & Tearsheats**

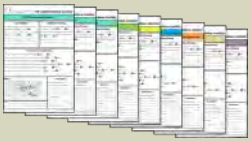
### TOOL #4
**Work Insructions**

### TOOL #5
**Implementation Checklists**





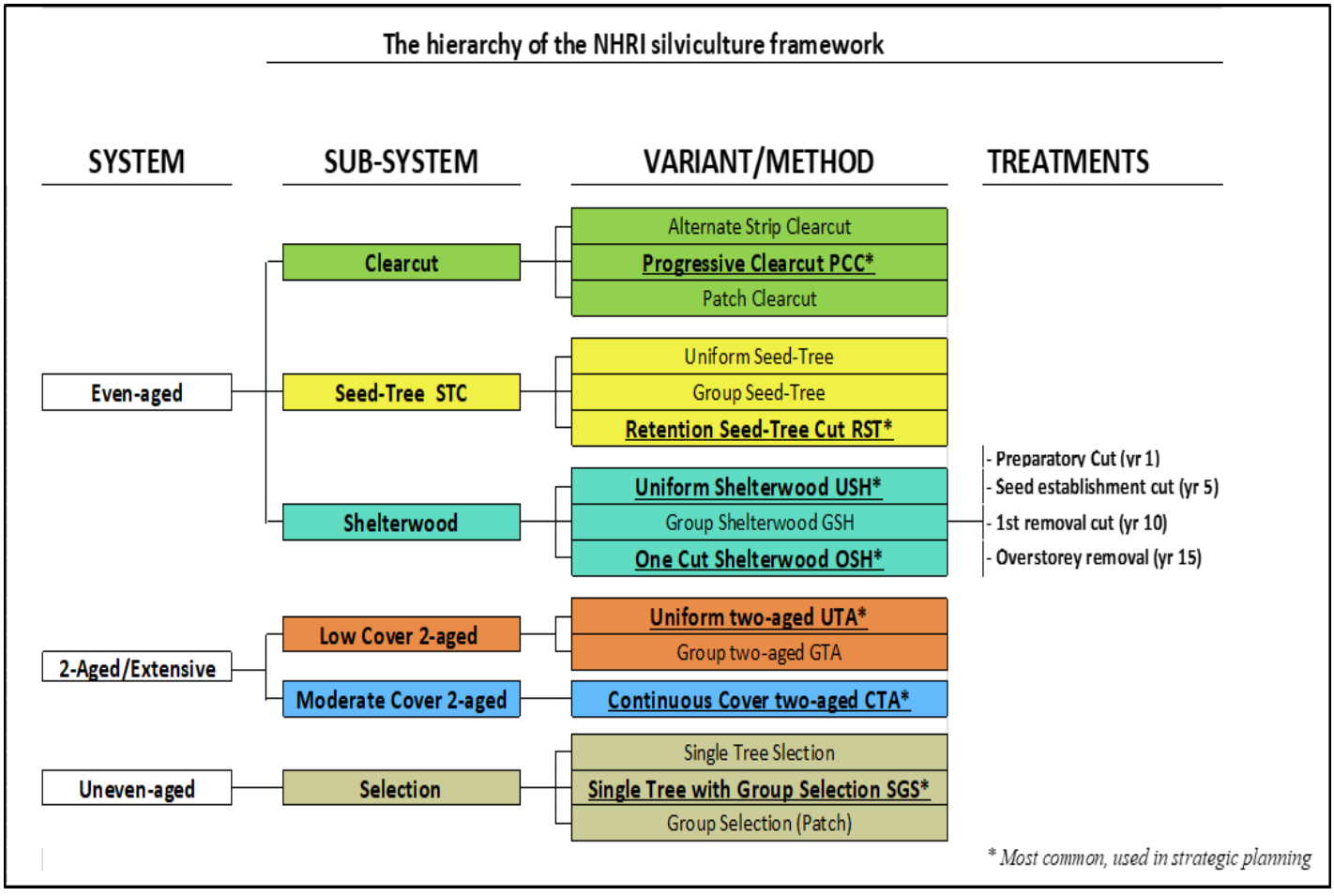




# BEFORE GETTING STARTED

***Get familiar with NHRI silviculture regimes and key silviculture concepts!***

In this guide, we provide useful information to help forest practitioners and managers implement NHRI's SPS 2.0; a silvicultural system designed to meet desired management objectives. Before you start implementing the system it is crucial to understand which silvicultural systems, sub-systems and their variants should be considered for a given stand. Below are the highlights of the six sub-systems stemming from the three primary forest systems, with a summary of their characteristics.



# BEFORE GETTING STARTED

***Get familiar with NHRI silviculture regimes and key silviculture concepts!***

## Even-aged systems

- Purpose is to create a new stand at once with all tree ages within 1/5 of a rotation (20 years);
- Relies on prompt establishment and survival of species of interests;
- For hardwoods, does not rely on artificial regeneration;
- Used where the characteristics of the existing stand and trees are not meeting expectations (species, quality, stocking, health) and, no small crop trees are present.

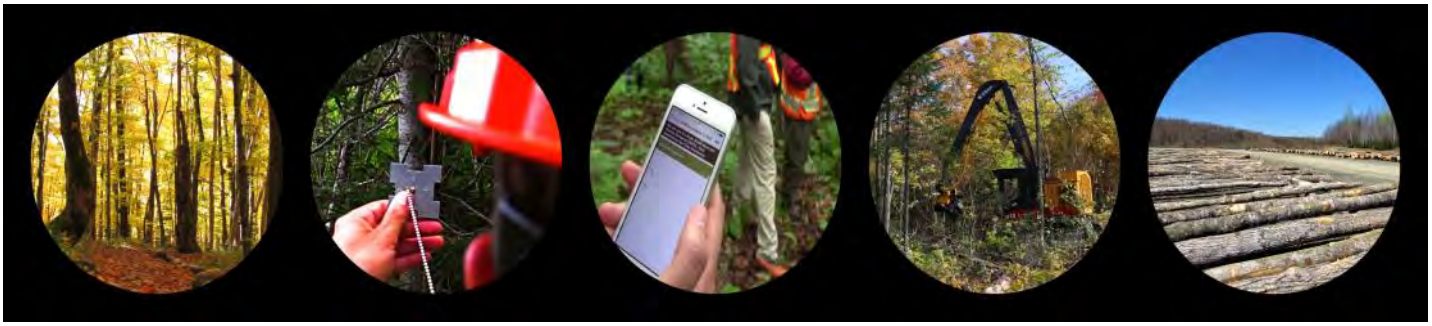
## Uneven-aged systems

- Purpose is to maintain at least 3 age classes and continuous cover for a long-time horizon;
- Re-entries are aimed at fulfilling the 3 main silviculture objectives: regeneration, release and harvest;
- Relies on the cycling of one stratum into the next one where younger age classes require exponentially more trees than older ones;
- Used where the characteristics of the existing stand and trees are already adequate;
- Suited mostly for species of relatively high tolerance to shade.

## Two-aged/extensive

- Purpose is to start with a 2-cohort structure but with options to change trajectory in the future;
- Treatments aim at establishing regeneration, tending smaller size trees and harvest large ones;
- Re-entries tend to be scheduled at longer intervals;
- In northeastern forests, could very well become the dominant silviculture system.

Popular treatments within this silviculture hierarchy are summarized in **APPENDIX 3—FRAMEWORK & PRESCRIPTION TEARSHEETS.**



# STEP 1: DETERMINE STAND TYPE

## *Determine species composition and age class structure*

When using the SPS, we start by determining broad species composition and age class structure using the Master Key. Our system applies to stands that comprise at least 30% hardwoods and is aligned with NB NRED's FUNA classification. Generally, a stand is characterized as a pure or mixed stand based on species composition. In pure stands, 70% or more of the main canopy is made up of a single tree species or group on a basal area basis; whereas, in mixed stands, none of the species occupy 70% or more of the main canopy.

According to natural stand dynamics theory, a stand develops in different phases ranging from stand initiation to an old growth stage. However, disturbances can move stand development backward or forward in the process, depending on type, severity and timing of the disturbances. A stand structure at a given time provides only a static picture of the dynamic stand development process. After a stand replacement disturbance, a new stand is initiated by shade intolerant or pioneer species. As the stand develops, mid-tolerant (or mid-successional) species will dominate the stand during stem exclusion and understory re-initiation stage. Tolerant (late-successional) species dominate the stand in old growth stage. Therefore, species composition and age class distribution are two important components of a stand structure.

Step one is conducted by navigating through the Master Key found in **APPENDIX 1—MASTER KEY**.

For more info on stand dynamics and disturbance, watch the following video on the NHRI YouTube Channel:

**VIDEO:** NHRI SPS: Trees from the same disturbance

The following table lists the **6 classes** used by the NHRI.

| | # cohorts | # strata | # species |
|---|---|---|---|
| E1-regular (1-2 species) | 1 | <=2 | 1-2 |
| E2- stratified mixture | 1 | >2 | >=2 |
| D1-regular and D2- irregular | 2 | 2 | >=2 |
| M1-balanced | 3 | 3 | >=2 |
| M2- irregular | 3 | 3 | >=2 |

# STEP 1: DETERMINE STAND TYPE

***Run the Master Key to determine species composition and age class structure***

The purpose of the Master Key is to generally determine the species composition and age class structure of a given stand through a series of questions. Once users answer the questions they are referred to one of the four specific Treatment Determination Keys. Below is an explanation of the questions found in the Master Key (See **APPENDIX 1—MASTER KEY**).

## Questions from the Master Key

*Purpose of the Master Key questions s to refer to one of the four specific decision trees*

***#1: Is the proportion of Basal Area (BA) for softwoods > 70%?***

Used to screen out (put out-of-scope) stands and FUNAs that belong to the softwood category in order to limit the SPS only to mixed wood and hardwood stand types.

***#2: Is the proportion (BA) of hemlock+ cedar+ pine>30% OR softwoods >50%?***

Its purpose is to tease out mixed stands that contain species having very specific silvicultural requirements. They are out of the scope of the SPS.

***#3: Is the proportion of tolerant hardwoods + red maple > 70%***

Used to assign silviculture treatments that are specific to tolerant hardwood stands and manage for high value. Silviculture prescriptions are different for those stands depending on the current age class structure.

***#4: Are the merchantable-size trees originating from the same disturbance?***

Used to determine if the trees that form the current stand are of the same cohort (+-20 years apart) and have an even-aged structure that is characterized by a bell-shaped distribution of diameters. Clues for determination include evidence from stumps, diameter distribution and historical records. Specific silviculture regimes apply to those stand structures.

***#5: Are there only two separate cohorts/strata present?***

Its purpose is to determine if the stand originated from two distinct disturbances. The diameter distribution is often bi-modal, and these age class structures have specific silviculture regimes. By default, stands that did not meet criteria for questions #4 and #5 are classified as multi-cohort or uneven-aged with at least 3 distinct cohorts. These stands are called uneven-aged and when of acceptable species composition and quality tend to be managed to maintain permanent cover.

# STEP 2: DETERMINE TREATMENT

***Run the Treatment Determination Keys to get to a recommended prescription***

The next step is crucial to the formulation of prescriptions and necessitates the most work. A total of four determination keys were developed to diagnose the stand, or micro-stand, by looking at fine tree and stand inventory metrics. The keys were designed to mitigate where inventory information could not be absolute and to compensate for minor user errors and omissions in the process. Following is a brief explanation/background/rationale for the questions asked in the SPS keys introduced in **APPENDIX 2—TREATMENT DETERMINATION KEYS**.

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## Questions from Treatment Determination Keys

**#6: Determination of beech stand archetypes**

Stands that contain beech must be assigned very specific treatments to prevent encroachment of beech in the understory that will materialize in a stand dominated by the species in the future.

It is generally considered an unacceptable growing stock due to its low timber quality caused by beech-bark disease rendering its products to be of very low quality and never attaining large size. Stands that contain 20% beech in the merchantable diameter class may contain beech in the mid- and understory. Therefore, there is the risk of beech dominating future stands if the right silvicultural prescriptions are not applied in current stands.

***#6a: Is beech present in any of the canopy layer?***

The presence of beech in the stand triggers a careful evaluation of if and where challenges may exist using traditional silviculture treatments.

***#6b: Is the merchantable Basal Area of beech in the upper canopy > 10%?***

Numerous studies have demonstrated that even low amounts of beech will lead to dominance in the long term when small gap harvesting is used. In cases when beech is present, bigger openings are to be prescribed.

**#6c: Is beech dominant (visual assessment, more than a third) in middle and/or lower canopy layers?**

From past activities, it may be that while beech was nearly eliminated in the upper canopy layers, the cut trees, from vegetative propagation (stump/root sprouts) generated a new cohort of beech. Perpetuating small gap cuts will accentuate the problem.

**#6d: Is acceptable growing stock (AGS) > unacceptable growing stock (UGS) and at least 8 m2/ha of AGS? (concept is explained in more detail under question #8)**

# STEP 2: DETERMINE TREATMENT

***Run the treatment determination keys to get to a recommended prescription***

## Questions from Treatment Determination Keys

**#7: Basal Area thresholds for merchantable-size trees (>10 cm class)**

Basal area (BA), a key forest stand descriptor, is estimated either using tree measurement data obtained from fixed area plots or using variable plot sampling (prisms, angle gauge, Relascope). It refers to the sum of cross-sectional area of trees (diameter at breast height ≥ 10 cm) per hectare that are alive at the time of measurement and, expressed in m2 ha-1 (or ft2 acre-1). It is an important measure of a forest stand because it takes into account both tree size and density and therefore, it is often the basis for forest management decision making.

BA serves as a measure of competition for individual trees because in closed stands, other things being equal, the greater the basal area, the greater the competition, and the slower the growth of individuals (see figure here below). Therefore, BA is linked with individual tree as well as stand growth.

Stocking is also better expressed in terms of BA than density because BA considers both tree size and density. It is, therefore, an efficient estimate of the standing stock (volume) of timber available in a forest stand. This helps implementing silvicultural treatments that are sustainable as well as feasible.

As an indicator of competition: BA serves as a measure of competition for individual trees because in closed stands, other things being equal, the greater the basal area, the greater the competition, and the slower the growth of individuals. Therefore, BA is linked with individual tree as well as stand growth. The stocking level expressed in basal area is useful to determine relative density (a measure of competition) that regulates growth but also, operability limits for feasible operations (since B.A. is closely correlated to volume and easier to determine rapidly).

For more info on basal area, watch the following video on the NHRI YouTube Channel:

**VIDEO:** NHRI SPS: Basal Area

# STEP 2: DETERMINE TREATMENT

***Run the Treatment Determination Keys to get to a recommended prescription***

## Questions from Treatment Determination Keys

**#7: Basal Area thresholds for merchantable-size trees (>10 cm class)**

**#7a: Is Basal Area >18 m2/ha?**

The purpose of this threshold in multi-cohort (uneven-aged) stands is to separate low basal area stands because they were recently treated and on the right path vs. that are losing value and require remedial silviculture.

**#7b: Is Basal Area>20 m2/ha?**

Stands that have not attained that threshold but are dominated by AGS should continue to increase (ingrowth + growth). When the proportion of UGS is greater but there is adequate regeneration, treatments to protect and release are prescribed. When UGS are dominant and regeneration is not adequate, starting over with even-aged treatments is recommended.

**#7c: Is Basal Area>24 m2/ha**

For stand improvement treatments with high residual basal area, there is a relatively high starting basal area requirement. If a third of the stand must be removed and the minimum residual basal area should be 16 m2/ha, the pre-treatment level must be higher than 24 m2/ha. Furthermore, treatments such as single/group selection are also expensive to execute, and a reasonable amount of volume must be available.

**#8: Proportions (for merchantable Basal Area) of acceptable growing stock (AGS) and unacceptable growing stock (UGS)**

The most common method to designate quality of standing trees is the AGS/UGS system. Acceptable growing stock consists of vigorous trees of desired species and of good quality that can continue to grow (or at least not stagnate) and will not lose value and health in the near future or at least until the next entry. Unacceptable growing stock possess one or several of the opposite characteristics. High proportion of AGS will help maximize the growth of residual trees and improve the quality of the residual and future stands. The determination of AGS/UGS is done using species, form and risk with tables and determination keys from the Tree Classification System for New Brunswick (Pelletier et al. 2016). Because of a general lack of objective criteria to determine AGS or UGS and that most tree grading systems look at current product content or only health, the NHRI decided to create a tree classification system that uses species, tree form and risk of losing vigor to assign AGS/UGS. A summary is presented in **APPENDIX 6—TREE CLASSIFICATION SYSTEM & AGS/UGS MATRIX**.

**VIDEO:** NHRI SPS: Tree Classification System

# STEP 2: DETERMINE TREATMENT

***Run the Treatment Determination Keys to get to a recommended prescription***

## Questions from Treatment Determination Keys

**#8: Proportions (for merchantable Basal Area) of acceptable growing stock (AGS) and unacceptable growing stock (UGS)**

In the Silviculture Prescription System, the following questions allude to ratios of AGS/UGS:

**#8a: Is the proportion of AGS ≥ proportion of UGS?**

A simple ratio to determine if most merchantable trees are in AGS or UGS categories from basal area summaries. It is a quick way to rapidly determine the overall quality potential of the stands. When at least half of the stand contains acceptable growing stock, there are more silviculture options.

**#8b: Is the proportion of AGS > UGS in pole size, small and medium trees (10-38 cm)**

Often, large trees of poorer quality will skew ratios based on basal area. This ratio looks specifically at the tree classes that would be retained after some treatments

**#8c: Are there AGS in pole-size trees?**

The presence of quality trees of the desired species in the 10cm – 20cm range will discourage the use of even-aged treatments where all trees will be harvested within 20 years and small trees with potential for sawtimber will not develop. Arbitrarily the minimum number of pole-size AGS should be around 100/ha.

**#8d: Is the proportion of AGS ≥ 60%?**

Sophisticated treatments of the uneven-aged system such as single-tree/group selection require stands with a high proportion of quality trees at the beginning because of the high residual density after treatment. Those stands must already meet a high basal area level at the outset (24m2/ha).

**#8e: Is the proportion of AGS ≥ 40%?**

As in question #8d, treatments that aim at perpetuating and maintaining cover require a moderate amount of quality trees to allow flexibility during implementation.

**#8f: Are there at least 10 m2/ha of AGS in tolerant hardwoods?**

This threshold is to determine if there is enough quality in order to consider more elaborate treatments like continuous cover two-aged and commercial thinning in mixed hardwood stands where composition and stocking does not allow to consider a selection system.

**#8g: Presence of AGS in tolerant hardwood poles and saplings**

This question is meant to avoid use of even-aged treatments where all trees will be harvested within 20 years and small trees with potential for sawtimber will not develop. Arbitrarily the minimum number of pole-size AGS should be around 100/ha.

# STEP 2: DETERMINE TREATMENT

***Run the Treatment Determination Keys to get to a recommended prescription***

## Questions from Treatment Determination Keys

**#9: Is regeneration adequate?**

This is a very important element of silviculture diagnostic where the presence of acceptable regeneration will lead to treatments that release and/or protect what is establish. Criteria foe determination include species composition (species of interest), stocking (>1500 well distributed saplings/ha) and health (vigorous, low competition and not browed).

**#10: Are quality pole-sized trees present?**

This question is to decide if there are enough quality pole-sized trees (AGS) to opt for a low residual extended regime that will maintain the over a long horizon (UTA) vs. one that will remove them within 20years before they produce sawtimber.

**#11: Is there presence of over-mature or of low vigor trees?**

The presence of old and unhealthy trees will lead to the recommendation of a treatment with high removal intensity such as a uniform shelterwood cut.

**#12: Is the quadratic mean diameter ≤ 20 cm?**

In quality stands with an even-aged structure, the potential for commercial thinning should be investigated. However, when trees are too large, commercial thinning treatments are not recommended.

**#13: Is base to live crown on crop trees > 4 m?**

When a commercial thinning is prescribed in quality tolerant hardwoods, we must be careful where live limbs are low on the stem to release to a point where it will encourage the production of epicormic branches and the maintenance of live branches for a long period.

For more info on this subject, watch the following video on the NHRI YouTube Channel:

**VIDEO:** NHRI TOOLS: STAND DENSITY MANAGEMENT

# STEP 2: DETERMINE TREATMENT

***Run the Treatment Determination Keys to get to a recommended prescription***

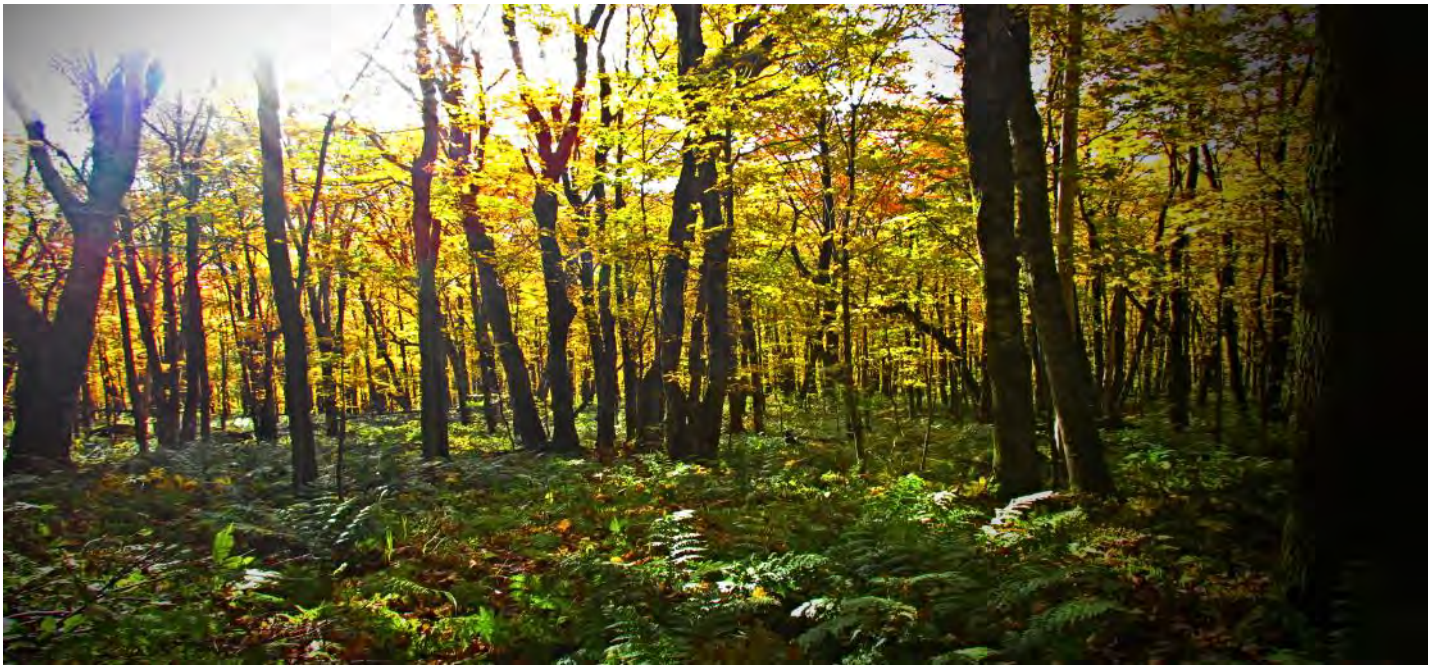
## Questions from Treatment Determination Keys

**#14: Are poplars and intolerant hardwoods ≥ 30% of the basal area?**

In those instances, partial harvest will likely exacerbate the vegetative propagation of poplars and dramatically increase the proportion in the stand. To learn more on the subjects of tolerance to shade and the presence on intolerant hardwoods in the upper canopy please refer to the following videos on the NHRI YouTube Channel:

**VIDEO:** NHRI SPS: Tolerance to shade

**VIDEO:** NHRI SPS: Overmature strata and patches of IH and Fir



# STEP 3: REVIEW PRESCRIPTIONS

***Ensure eligibility, objectives and operational conditions are respected***

## Review: Silviculture Framework & Prescription Tearsheets

Once a treatment/regime is identified in Step 2 the user should use diligence and verify the validity of findings during Step 3.

At this stage it becomes very important to do a sensitivity analysis for the answers provided for the questions raised in the keys. For example, it is possible that in cases where the stand conditions were around the arbitrary thresholds, answering another way may lead to a recommendation for treatment/ regime that is better suited.

It is also imperative that users revise the selected treatment/regime for eligibility, objectives, operational considerations etc. by reviewing the **NHRI'S Silviculture Framework** and the **Prescription Tearsheet** for the treatment in question (see, **APPENDIX 3—FRAMEWORK & PRESCRIPTION TEARSHEETS**). The Prescription Tearsheets are simple and concise but contain a wealth of very useful information meant to ensure that you apply the right silviculture treatment to your stand:

- System
- Sub-system
- Stand Eligibility
- FUNA Structure
- Treatment Objectives
- Treatment Description
- Desired Outcomes
- Key Success Factors
- Operatial Coonsiderations (Harvest System, Season, Trail Network, etc.)
- Implementation Instructions
- Additional Considerations
- Getting Started
- Etc.

# STEP 4: PROVIDE INSTRUCTIONS/CUTTING ORDERS

***Communicate work instructions to operators, supervisors and contractors***

The 4th step consists of communicating instructions to operators, supervisory personnel and contractors. Within the NHRI SPS 2.0 each treatment has matching **Work Instructions** (see, **APPENDIX 4—WORK INSTRUCTIONS**) which include: the selection of a trail network, recommended harvesting system, residual BA or cover targets and cut priorities/pecking orders by species, quality and size groups. We also highly recommend that key success measures and targets be formulated on a block-specific work order. It is very important to communicate the order of implementation of the treatment correctly:

**A. When possible use the recommended harvesting system and season of operation;**

**B. Implement the recommended trail network—varies by treatment;**

**C. Reduce stand density as per the treatment target.** ***Aim for the high end of the range but allow for variation within the stand;***

**D. Use the cut priorities and cutting instructions to attain the target basal area;**

- Acceptable Growing Stock (AGS)
  - Low risk and good form sugar maple, yellow birch, red oak <48cm
  - Other trees of good health and form
  - Quality pole and medium sized trees of interest
  - Saplings of desired species in good health
- Unacceptable Growing Stock (UGS)
  - Deteriorating health
  - High risk of losing health and value
  - Poor form
  - Low value species (beech, fir, poplar, white birch)
  - Multiple stems from sprouts
  - Fir > 15cm
- Optional UGS
  - Ash (because of Emerald Ash Borer)
  - Butternut (Because of butternut canker)
  - Spruce > 40cm

**E. Other considerations;**

- When releasing crop trees, leave some non-competing 'trainer trees 'to prevent the production of epicormic branches.
- Leave a few large and very large trees of desired species but in deteriorating health, and without high grade potential that do not compete with crop trees for the production of seedlings. IMPORTANT: modify BA threshold upwards accordingly to prevent high grading of the stand.

# STEP 5: PERFOMANCE MONITORING

## *Communicate performance expectations to implementation crew*

The final step consists of communicating performance expectations to the implementation crew. Checklists have been developed to that effect and can be found in **APPENDIX 5—IMPLEMENTATION CHECKLISTS**. The checklists developed by NHRI can be customized to fit your management objectives and operational reality. NHRI's SPS **Implementation Checklists** are divided into the following performance monitoring items:

- General Information
- Stand Eligibility
- Trail Pattern/Planning
- Desired Short-Term Outcomes

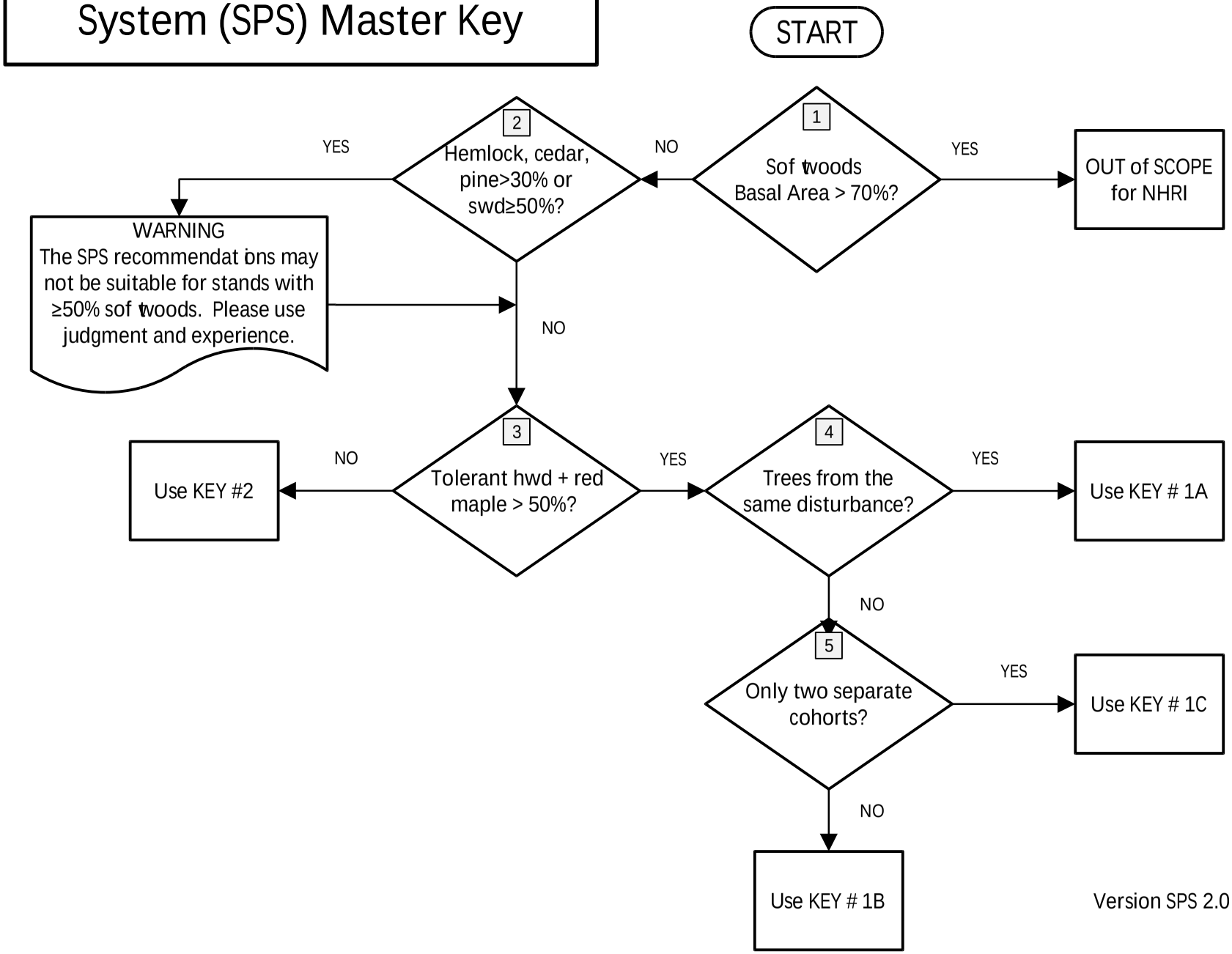



# Appendix I

# SPS Implementation Tools

## Master Key

# NHRI Silviculture Prescription System (SPS) Master Key




Version SPS 2.0 (Jan. 2020)

# Appendix II

# SPS Implementation Tools

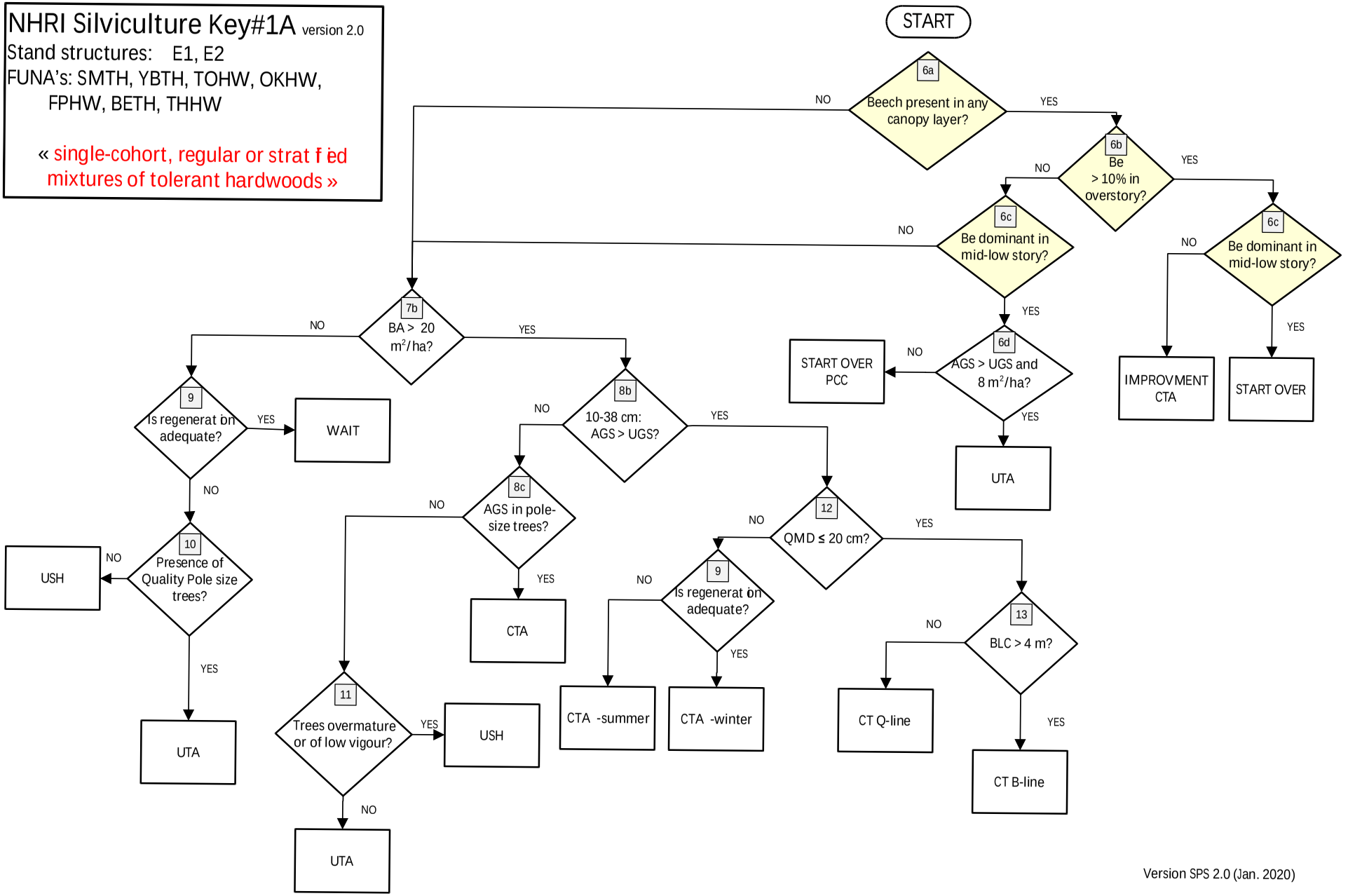
## Treatment Keys

# NHRI Silviculture Key#1A version 2.0

Stand structures: E1, E2

FUNA's: SMTH, YBTH, TOHW, OKHW, FPHW, BETH, THHW

« single-cohort, regular or strat f ied mixtures of tolerant hardwoods »



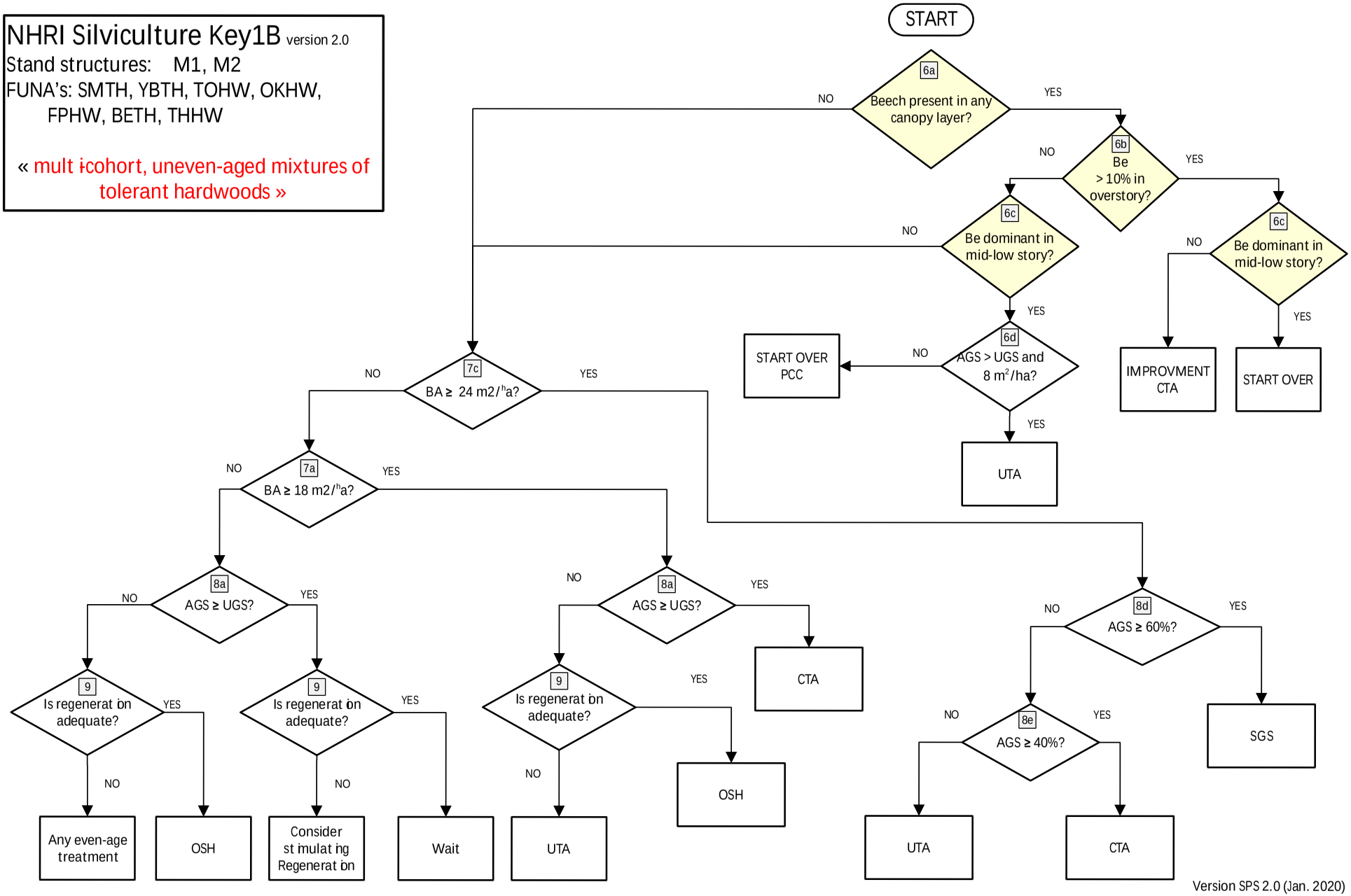

Version SPS 2.0 (Jan. 2020)

# NHRI Silviculture Key1B version 2.0

Stand structures: M1, M2

FUNA's: SMTH, YBTH, TOHW, OKHW, FPHW, BETH, THHW

« multi-cohort, uneven-aged mixtures of tolerant hardwoods »



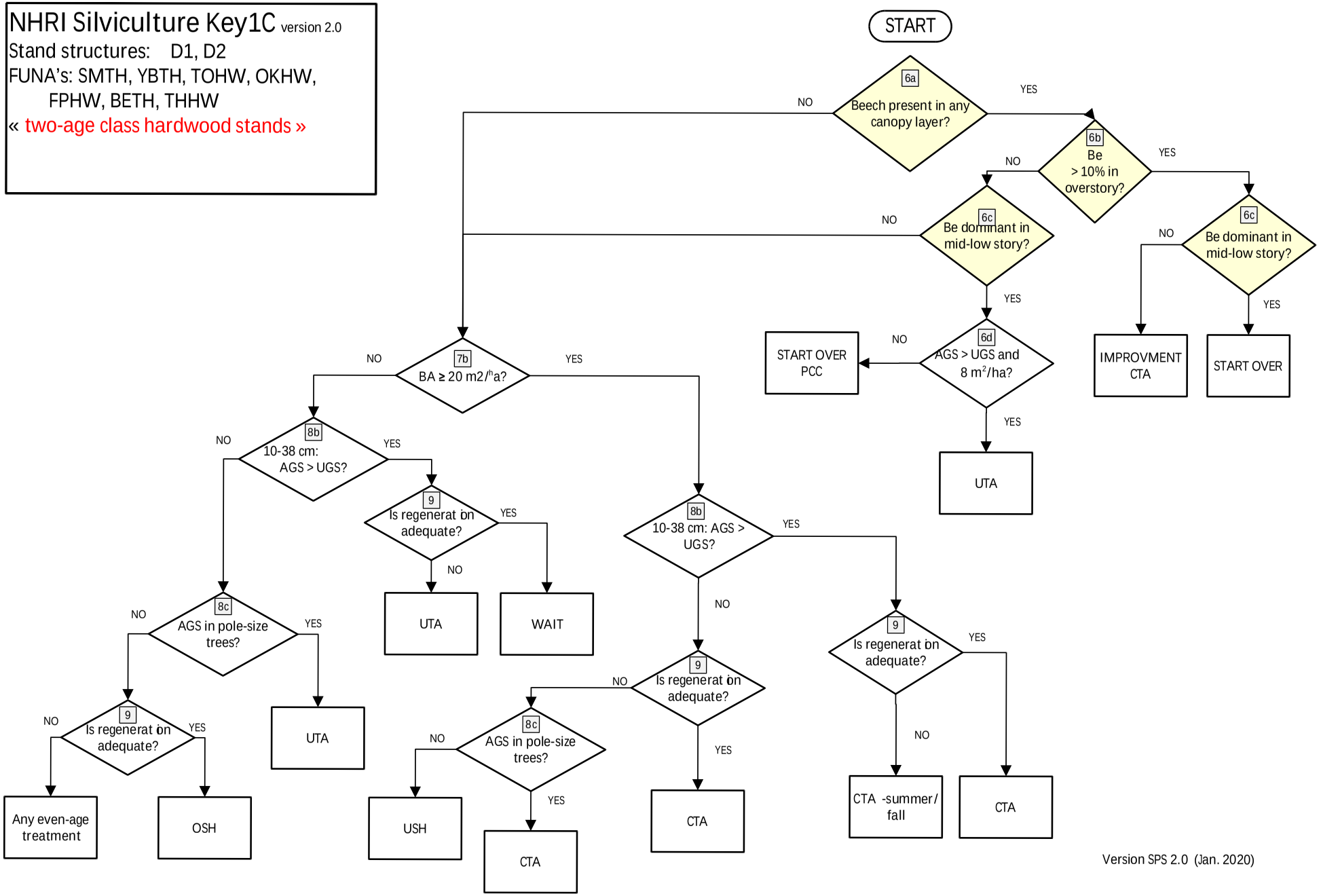

Version SPS 2.0 (Jan. 2020)

# NHRI Silviculture Key1C version 2.0

Stand structures: D1, D2

FUNA's: SMTH, YBTH, TOHW, OKHW, FPHW, BETH, THHW

« two-age class hardwood stands »



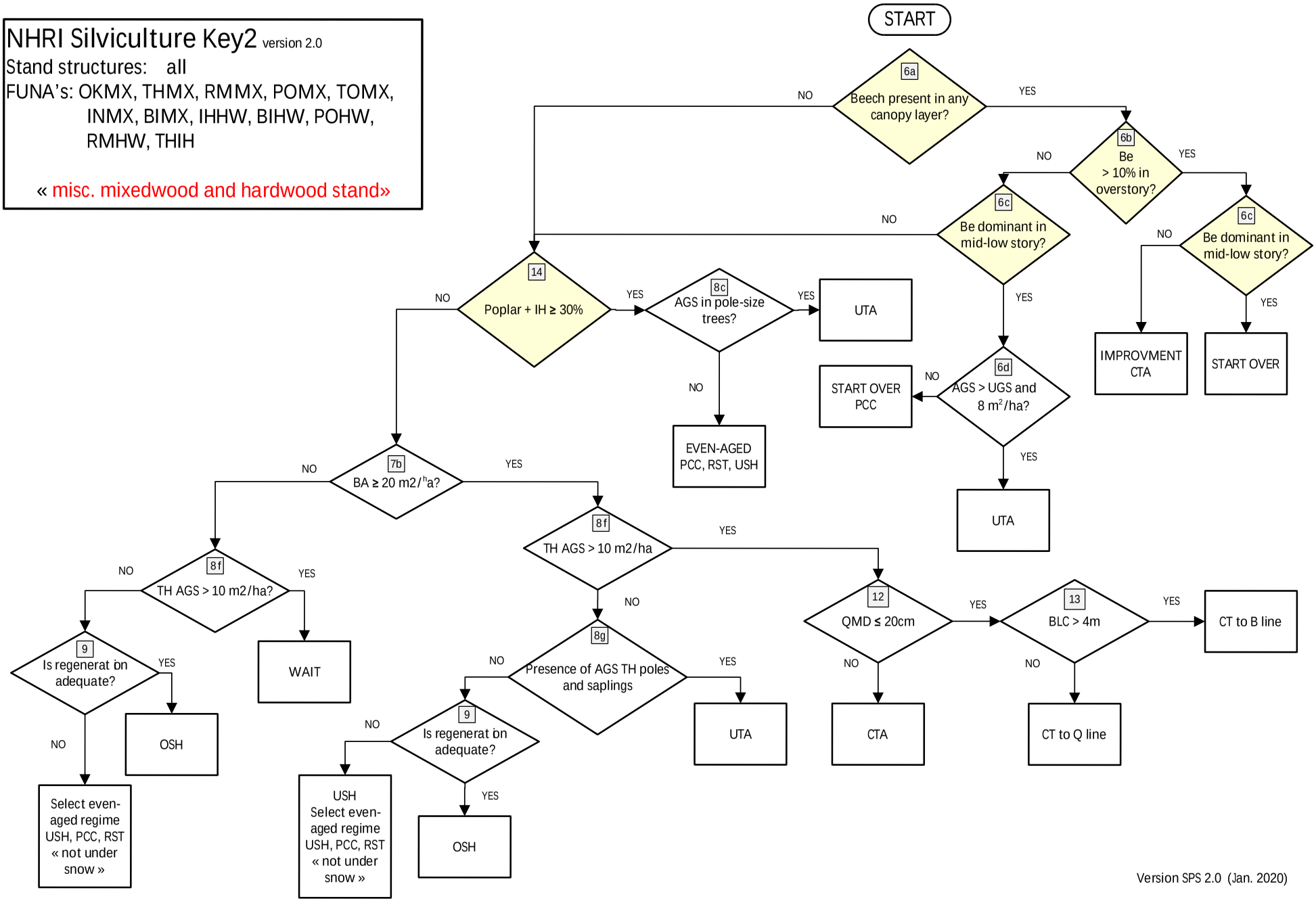

Version SPS 2.0 (Jan. 2020)

# NHRI Silviculture Key2 version 2.0

Stand structures: all

FUNA's: OKMX, THMX, RMMX, POMX, TOMX, INMX, BIMX, IHHW, BIHW, POHW, RMHW, THIH

« misc. mixedwood and hardwood stand»



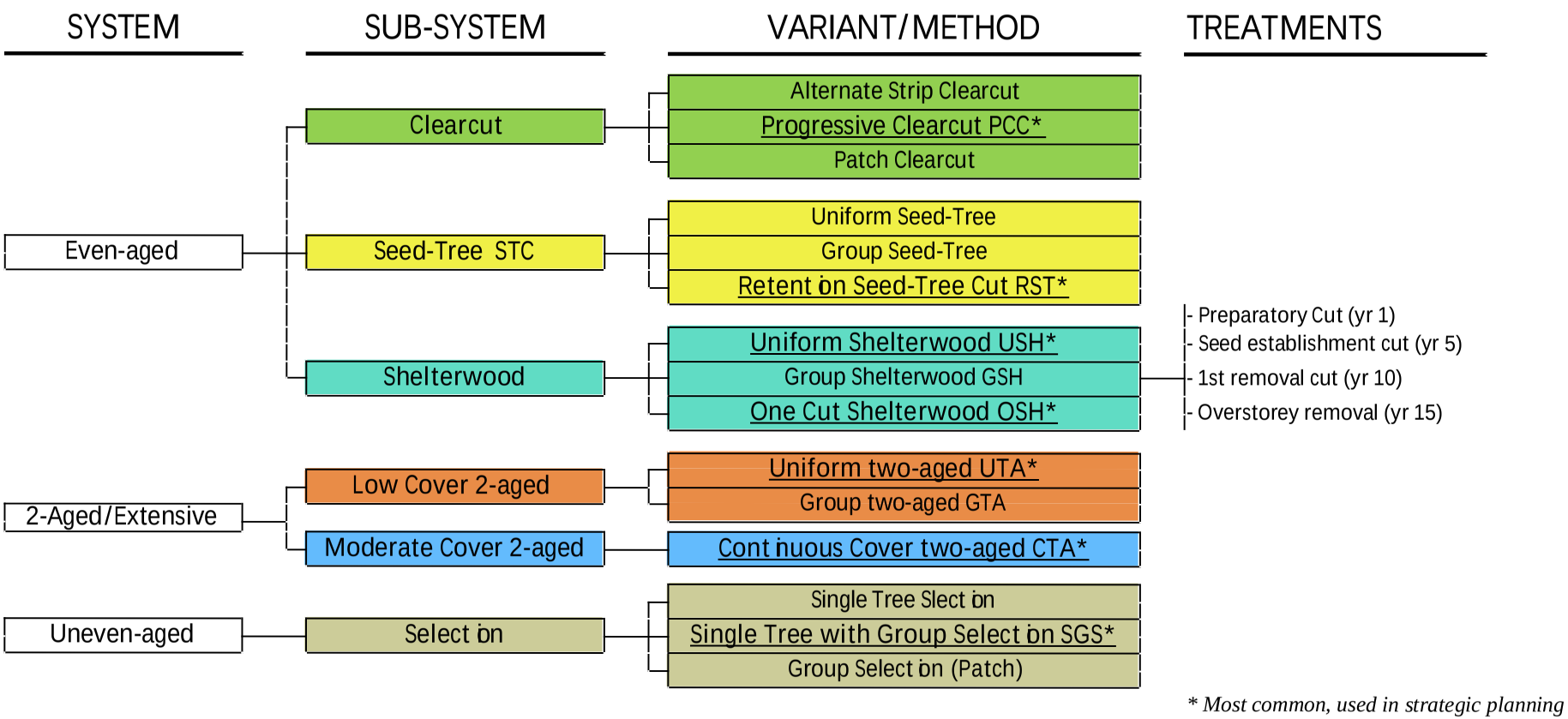

Version SPS 2.0 (Jan. 2020)

# Appendix III

# SPS Implementation Tools

## Framework and Tearsheets

## The hierarchy of the NHRI silviculture framework




** Most common, used in strategic planning*

NHRI SPS Prescription Tearsheet

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*Variant/Treatment:*

# PROGRESSIVE STRIP CLEARCUT

System: **EVEN-AGED**

Sub-system: **Clearcut**

**PCC**

## Stand Eligibility

- **FUNA:** BETH, THIH, THMX, INHW
- **Structure:** all but M1 & M2 (except for BETH)
- Presence of trees of desired species and quality to provide seeds
- Species that require some protection from exposure to regenerate successfully
- Mature to overmature development stage
- Poor quality stand and/or low stocking
- Even distribution of trees within stand
- Lack of pre-established regeneration
- Low probability of competition by aggressive interfering plants

## Treatment Objectives

This process of regeneration brings together cuts that include harvesting all or almost all merchantable stems in a stand (90 to 100% of the merchantable volume) within 20 years. This sub-system removes most or all merchantable trees from the stand in three or more operations and subsequently regenerates an even-aged stand. The regeneration is obtained from natural seeding from adjacent stands, harvested trees, advance regeneration or artificial sources (planting or direct seeding). It is important to adjust the size of the areas cut based on the distance over which the seeds are disseminated.

The general factors to consider before implementing clearcut are:

- High percentage of mature and unhealthy trees
- Presence of seed trees of desired species
- Seedling characteristics of desired species (i.e. need some shelter for establishment and survival)
- Suitable seedbed and growing conditions
- Site preparation if required
- Existing and potential competition from undesired vegetation

## Description

The stand is removed using series of strips harvested over three or more entries, usually covering an equal area on each occasion. This method may be chosen to reduce water fluctuations, windthrow, erosion and to offer some shelter.

Depending on the width of the strips and the orientation and protective effect of the adjacent trees, this pattern can favor regeneration of intermediate shade-tolerant species like yellow birch, American elm and basswood (American linden) and better control of invasion by competition. The alternate uncut strips are removed within a period of time not exceeding 20% of intended rotation (<20 years).

- If possible, orient the strips northwest to southeast so that residual trees can protect regeneration from high light intensity while allowing seed dispersion by wind.
- Cut strips should be perpendicular to the prevailing winds to promote even seed distribution.
- Understand shade tolerance of the desired species (wider strips for less shade-tolerant species and vice versa).

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Creation of progressive strips in the stand.<br>• Creation of germination beds<br>• Abundance of seeds for germination<br>• Adequate soil exposure<br>• No site damage<br>• No valuable trees at risk left standing | • Recruitement of new cohort of desired species<br>• Low competition by interfering plants<br>• Good seedling survival<br>• Low tree mortality | • Full stocking of seedlings and saplings<br>• Low competition and High relative stand density to allow for quality development<br>• Stand ready for intermediate silviculture |

## Key Success Factors

- Strip pattern adjusted to the species of interest
- Planned on good seed years
- Strips oriented to maximize seed dispersion

# IMPLEMENTATION
## *PROGRESSIVE STRIP CLEARCUT*

**PCC**

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | X | | |
| **CTL System** | | X | |
| **Leaves Off** | X | X | |
| **Frozen Ground** | | X | |

## Getting Started

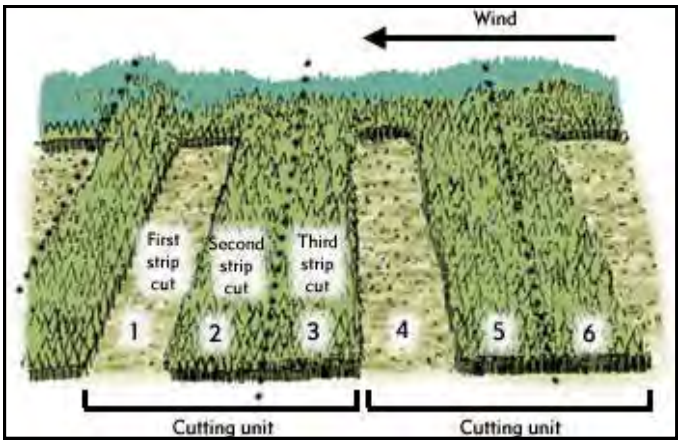
- Select the # of strips required (function of # entries desired)
- Plan treatments in a good seed year and in the proper season
- Determine the right strip width according to species (see table below)
- When possible, orient strips so that they are mostly perpendicular to dominant winds but avoid prolonged direct light (NW or SE)
- Schedule the next re-entries so that the entire area is covered in less than 20 years (i.e. years 1, 10, 20)

## Implementation Instructions

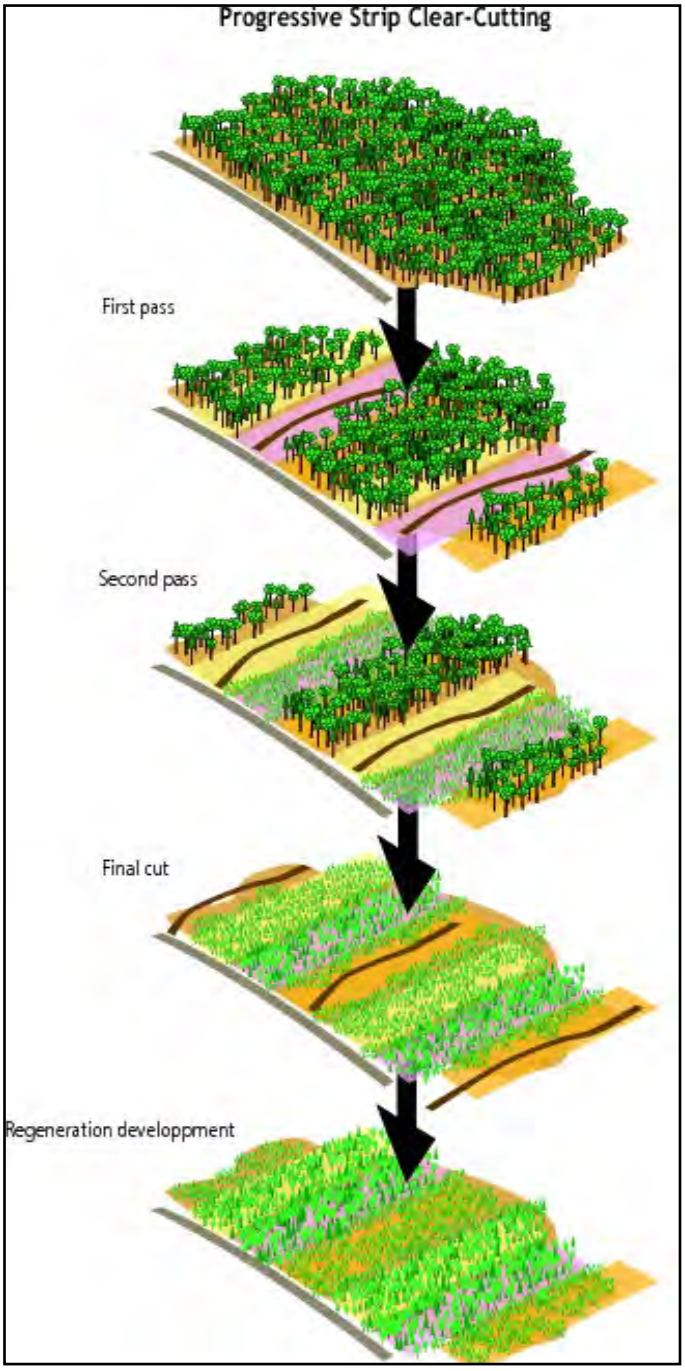
| | |
|---|---|
| **Residual Density in Selection Strip:** | 5 m2/ha |
| **Cut Priority:** | Cut all merchantable trees >22cm and maintain/release AGS in pole size trees and saplings when present |
| **Cutting Instructions:** | Year 1: : establish first strip<br>Year 10:: cut 2nd strip<br>Year 20: cut final strips<br>Width: 1.5 x tree height<br>(20-30 m average width depending on tree height) |

## Additional Considerations

- Put emphasis on the creation of seed germination beds.




https://www.for.gov.bc.ca/hfp/training/00014/varclear.htm#clear




Source: CERFO

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*Method/Treatment:*

# RETENTION SEED-TREE CUT

System: **EVEN-AGED**

Sub-system: **Clearcut/seed tree**

**RST**

## Stand Eligibility

- **FUNA:** BETH, THIH, TOHW, THMX
- **Structure:** all but M1 (except for BETH)
- Presence of trees of desired species and quality to provide seeds
- Species that do not require some protection from exposure to regenerate successfully
- Mature to overmature development stage
- Poor quality stand or low stocking
- Even distribution of trees within stand
- Lack of pre-established regeneration
- Low probability of competition by aggressive interfering plants

## Treatment Objectives

In this process, a few well-distributed seed-trees establish regeneration when all the other trees have been cut. This process is used to optimize the distribution of seeds spread by the wind.

Spacing between seed-trees left on the cut-over area varies based on the species and size of the trees (Table 2). If seed-trees are dispersed, the quantity of seed-trees to be preserved is determined by calculating the area that each tree can seed, adding a risk factor to cover any losses of seed-trees and converting the resulting area into density of trees by hectare.

Seed-trees can either be harvested a few years after the original cut when regeneration is established or be left for longer (reserve cutting or reserve seed-tree; réserve de semenciers) to produce timber of larger size. They can be harvested during the first thinnings of the regenerated stand or even during final cutting depending on the risk of causing damage to seedlings and saplings.

## Description

This system leaves individual seed-trees or clusters of seed-producing trees in a clearcut mainly to provide regeneration . The trees excluded from harvesting to supply seeds for the next crop should be of good quality and vigorous. They are generally too far apart to affect the microclimate or shelter the new regeneration. Seed-tree cutting involves up to two steps: a seed cut and a removal cut and has the following variants:

**Uniform Seed-tree**: Individual trees are excluded from harvesting and are generally distributed evenly throughout the harvested area. Seed trees are harvested in the future.

**Group seed-tree**: Clusters of seed trees are left in groups or strips throughout the harvested area. The distribution of the groups of trees excluded from harvesting could be uniform or irregular to maximize seed dispersal of the desired species. The seedf dessimination distance is an essential consideration for determining distances between patches or groups of seed trees. Clumps are later removed.

**Seed-tree with reserve**: Individual and patches of trees that are left to meet long-term objectives such as visual landscape management and special wildlife habitats rather than to regenerate the stand.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Acceptable amount of quality seed trees throughout the block<br>• Creation of germination beds<br>• Abundance of seeds for germination<br>• Adequate Soil exposure<br>• No site damage | • Recruitement of new cohort of desired species<br>• Low competition by interfering plants<br>• Good seedling survival | • Full stocking of seedlings and saplings<br>• Low competition<br>• High density to allow for quality development<br>• Stand ready for intermediate silviculture |

## Key Success Factors

- Number and distribution of seed trees planned according to requirements of species of interest.
- Planned on good seed years
- Soil exposed to generate seed germination beds

# IMPLEMENTATION
## *RETENTION SEED-TREE CUT* — RST

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| Full Tree System | X | | |
| CTL System | | X | |
| Leaves Off | X | X | |
| Frozen Ground | | X | |

## Getting Started

- Select the amount and distribution of seed trees according to the requirements of species of interest)
- Decide on the variant to use
- Plan treatments in a good seed year and in the proper season
- Determine the right tree spacing according to species (see table below).
- Schedule the next re-entries so that the removal of seed trees does not damage regeneration (i.e. < 2m)

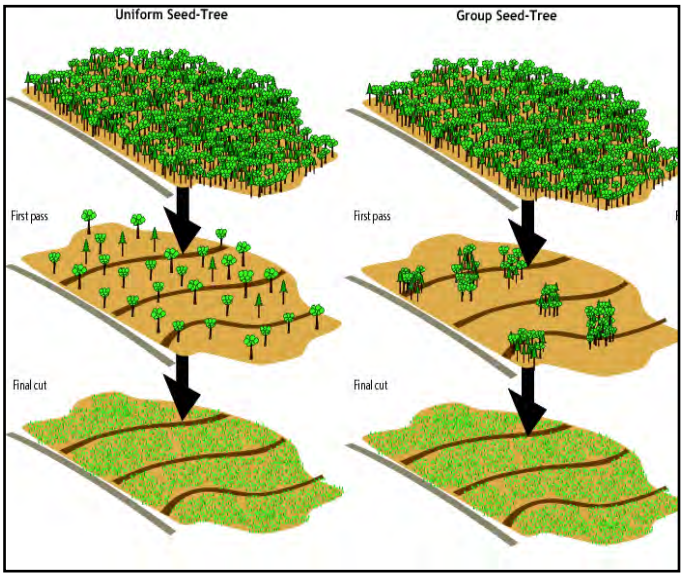
## Average Distance of Dissemination of Seeds by Species
(Source: *Guide Sylvicole du Québec*)

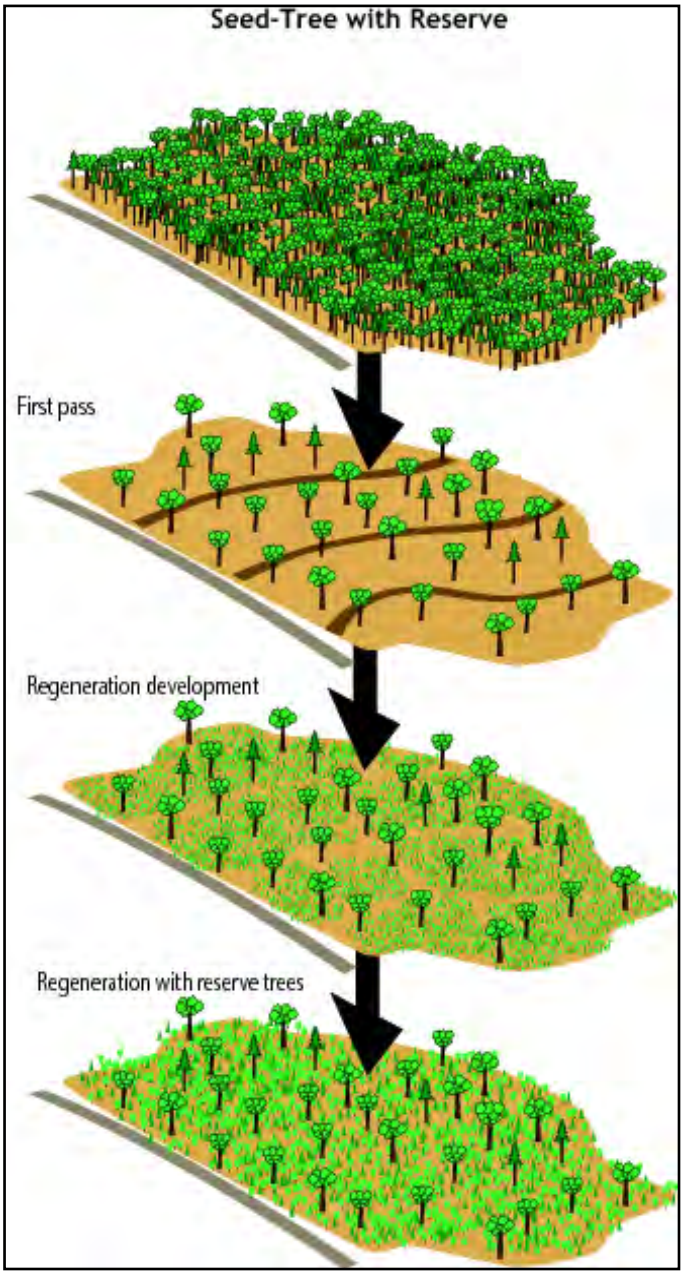
| Distance of Dissemination (m) | | | |
|---|---|---|---|
| **Hardwoods** | | **Softwoods** | |
| Trembling Aspen | Several km | White pine | 1H* |
| White birch | < 60 | Jack pine | 2H* |
| Yellow birch | > 100 | Balsam fir | 25-60 |
| Red maple | > 100 | Black spruce | 50-80 |
| White ash | 140 | Red spruce | < 100 |
| American elm | < 450 | White spruce | 20-30 |
| Basswood | < 150 | | |

*H=tree height

## Implementation Instructions

| | |
|---|---|
| Residual Density in Selection Strip: | 10—20 seed trees/ha |
| Cut Priority: | Cut all merchantable trees >22cm and maintain/release best AGS in pole size trees and saplings and/or trees capable of producing seeds |
| Cutting Instructions: | Year 1: cut but retain seed trees |




Source: CERFO

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*Variant/Treatment:*

# *UNIFORM SHELTERWOOD*

**USH**

System: **EVEN-AGED**

Sub-system: **SHELTERWOOD**

## Stand Eligibility

- **FUNA/Structure:** all except quality SMTH-M1 and YBTH-M1
- Presence of trees of desired species and quality to provide seeds
- Species that require some protection from exposure to regenerate successfully
- Mature to overmature development stage
- Poor quality stand or low stocking
- Even distribution of trees within stand
- No quality pole-sized and small trees

## Treatment Objectives

The shelterwood system removes the overstory in a series of harvest entries to regenerate the stands understory. The number of residual trees vary from one area to another depending on tree species, tree structure (diameter, height, and crown width), slope, and aspect.

This system is recommended for long-lived shade tolerant species and in poor quality stands made up of least 30% of long-lived and shade tolerance species.

The general considerations in the application of the shelterwood system are:

- Overstory condition (risk, form, structure and composition)
- Density of seed trees in the stand
- Site suitability to desired species
- Presence, abundance, and size of established regeneration of desired species
- Seedbed or site preparation
- Potential competition from undesirable vegetation.

## Description

The system is implemented in 1 to 4 stages, each with specific objectives and characteristics:

- preparatory cut is optional if there is a need to improve the vigor of prospective seed-bearing trees
- a seed or regeneration cut is undertaken to remove 30-70% of the canopy, taking into consideration the species's shade tolerance and site conditions
- optional removal cuts may then be used to release well established regeneration from overstory shade
- final cut (overstory removal) is done to remove most or all of the remaining canopy

All cuts must be undertaken within a 20 year cycle to ensure the establishment of a single cohort (<1/5 of a rotation). Intermediate silviculture treatments such as commercial thinning will normally be required.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Creation of openings in canopy<br>• Creation of germination beds<br>• Abundance of seeds for germination<br>• Adequate Soil exposure<br>• No site damage | • Recruitement of new cohort of desired species<br>• Sheltered seedlings by residual trees<br>• Good seedling survival<br>• OSR planned before regeneration is too tall | • Full regeneration and sapling stocking<br>• Low competition by residual trees<br>• High density to allow for quality development |

## Key Success Factors

**Seedling establishment cut**

- Adequate mineral soil exposure
- Planned on a good seed year
- Even distribution of residual trees

**Overstory removal (as above +)**

- Timed when regeneration is established but < 2m tall
- Snow cover preferred

# IMPLEMENTATION
## *UNIFORM SHELTERWOOD* — USH

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | X | | |
| **CTL System** | | X | |
| **Leaves Off** | X | X | |
| **Frozen Ground** | | | X |
| **High Trail Footprint (>20% ratio)** | | X | |

## Getting Started

- Plan treatment in a good seed year and in the proper season (spring, summer, fall)
- If possible, use a harvesting system that will prepare germination substrates (MFT or CTL plus scarification)
- Determine the right residual Basal area target for desired species (8-10 m2/ha)
- Decide if a preparatory cut is needed to make seed trees more vigourous
- Design appropriate trail pattern (5-6m wide and 15-16m center to center)
- Establish a pecking order for removal as per below
- Schedule the next re-entry (OSR when regeneration is < 2m tall)

## Implementation Instructions

| | |
|---|---|
| **Residual Density in Selection Strip:** | 8-10 m2/ha |
| **Cut Priority:** | Cut all trees >48cm, trees with high grade products at risk and those from the UGS group |
| **Cutting Instructions:** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/3<br>medium (22-38cm): 1/2<br>large (38-48cm): 1/1<br>very large (>48cm): all |

Seedling establishment cut *(courtecy CERFO)*

Regeneration established and ready for OSR

Saplings approx. 20 yrs. After OSR ready for CT

## Additional Considerations

This treatment is about starting a new stand within 20 years, so lower than usual emphasis is put on protecting crop trees. Rather put emphasis on creating seed beds. **SCHEDULE THE FINAL TREATMENT (OSR) WHEN REGENERATION IS ESTABLISHED BUT < 2M HIGH**

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*Variant/Treatment:*

# ONE-CUT SHELTERWOOD (OSH)

System: **EVEN-AGED**

Sub-system: **SHELTERWOOD**

**OSH**

## Stand Eligibility

- **FUNA/Structure:** all except quality SMTH-M1 and YBTH-M1
- Presence of trees of desired species and quality to provide seeds
- Mature to overmature development stage or poor quality stand or low stocking
- **Already established regeneration that does not require shelter any longer**
- Regeneration is not so tall that it risks being damaged during harvesting (<2m height)

## Treatment Objectives

The shelterwood system removes the overstory in a series of harvest entries to regenerate the stand under the shelter. The number of residual trees vary from one area to another depending on tree species, tree structure (diameter, height, and crown width), slope, and aspect.

This system is recommended for long-lived shade tolerant species and in poor quality stands made up of least 30% of long-lived and shade tolerance species.

The general considerations in the application of the shelterwood system are:

- Overstory condition (risk, form, structure and composition)
- Density of seed trees in the stand
- Site suitability to desired species
- Presence, abundance, and size of established regeneration of desired species
- Seedbed or site preparation
- Potential competition from undesirable vegetation.

## Description

The purpose of this overstory removal treatment is to liberate regeneration that has been established as a result of previous treatments (sometimes by accident) or through the process of stand dynamics notably in stratified mixture single cohort stands. It is typical of even-aged systems but can also be part of two-aged systems.

It is conducted when seedlings no longer require protection or shelter by a partial canopy. Its timing is critical as to not damage regeneration while we make growth resources available to the new cohort. The harvest is conducted with a priority on large trees of commercial size, unacceptable growing stock and trees at risk of loosing products and value. It is a good practice to keep and protect small trees with potential to grow quality products (AGS) but it is important to maintain a low residual basal area. In cases where there is a large proportion of small quality trees to maintain, a two-aged system may be more appropriate.

The subsequent treatment in a one-cut sub-system is likely to be a pre-commercial or a commercial thinning.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Release of established regeneration of desired species<br>• Adequate stocking of healthy regeneration<br>• No site damage<br>• Maintenance of small quality trees | • Good seedling survival<br>• High stocking and low competition on saplings of desires species (>2000/ha)<br>• High vigour and quality of regeneration<br>• Free-to-grow saplings and small trees of desired species | • Full stocking (between A and B lines of stocking diagram) of commercial species<br>• High AGS/UGS ratio |

## Key success factors

- Timed when regeneration is established but < 2m tall to minimize harvesting damage
- Timed with snow cover if possible
- Carefull planning of trail pattern and choice of harvesting system to minimize damage to regeneration

# IMPLEMENTATION
## *ONE-CUT SHELTERWOOD* — OSH

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | X | | |
| **CTL System** | X | | |
| **Leaves Off** | X | | |
| **Frozen Ground** | | X | |
| **High Trail Footprint (>20% ratio)** | | | X |

## Getting Started

- Chose a harvesting system that will reduce the likelyhood of damage to regeneration and try to schedule harvest when there is snow to protect seedlings
- Design appropriate trail pattern to use (promote low trail foot prints)
- Decide the residual density of small trees of desired species to retain
- Prepare work instructions for machine operators with regards to target residual densities, trail pattern, pecking order and considerations to protect regeneration and release small trees (AGS)
- Determine quality standards to protect small trees, regeneration and soil
- Schedule the next re-entry

Advanced regeneration in stratified mixture
*(maybe too tall and likely sustain harvesting damage)*

Regeneration established and ready for OSR

Saplings approx. 20 yrs. after OSR and ready for CT

## Implementation Instructions

| | |
|---|---|
| **Residual Density in Selection Strip:** | 5 $m^2$/ha |
| **Cut Priority:** | Cut all merchantable trees >22cm and maintain/release AGS in pole size trees and saplings when present |
| **Cutting Instructions:** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/2<br>medium (22-38cm): all<br>large (38-48cm): all<br>very large (>48cm): all |

## Additional Considerations

This treatment is about completely releasing regeneration that is already established by previous activities therefore, it is important to minimise damage to it. Treat when regeneration is less than 2m tall in order to avoid breakage when trees are felled. If possible, operate with snow cover and minimise trail footprint. Full-tree harvesting systems that utilise feller-buncher allow for controlled tree felling and positioning in trails to minimise damage.

NHRI SPS Prescription Tearsheet

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*Variant/Treatment:*

# *UNIFORM 2-AGED/EXTENSIVE*

**UTA**

System: **Two-aged/Extensive**

Sub-system: **Low Cover 2-Aged**

## Stand Eligibility

- **FUNA:** all
- **Structure:** all
- Irregular stand structure
- Species that require some protection from exposure to regenerate successfully
- Mature to overmature development stage
- Poor quality stand
- Species of different lifespans
- Lack of pre-established regeneration
- Relatively even distribution of trees in stand
- Presence of quality pole-sized and small trees

## System Objectives

The irregular high-forest system is characterized by a desire to regenerate the entire treated stand over a long period that is not continuous over time. It uses partial cuts of varying extents, allowing several vertical or horizontal stories of different age classes to be maintained: so forest cover is permanent but not necessarily dominated by mature trees throughout.

The main objective of this system is to generate stands with an irregular structure (two-story or uneven-aged structure including at least three age classes), preferably through natural seeding. This system is characterized therefore by the simultaneous presence of at least two cohorts of trees of different ages within the same stand. Because a wide spectrum of light conditions is created, this system allows species with different tolerances to shade and longevity to be grown together.

The re-entry after the first treatment is extended (30-35 years).

## Description

This pattern is used when cover is uniform. Cover is opened progressively throughout the whole stand, targeting uniform distribution of residual stems and avoiding creating gaps that are too large.

The degree to which cover is opened up varies according to the tolerance of the species involved and the aggressiveness of the competition. Several harvests are conducted over an extended period (30-40 years) until two distinct cohorts of crop trees have been established. As in other types of irregular shelterwood variants, trees in all mature size classes receive treatment.

Regenerated sections may be harvested completely, open non-regenerated areas may have to be scarified and closed portions may undergo partial harvesting and any needed site preparation.

Partial removal usually involves harvesting a third of the stems according to simple rules (e.g.: for each group of three stems, harvest the largest, or the ugliest). The last cut corresponds to a final cut and occurs a few years later, when the sections that regenerated under cover are tall enough.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Acceptable amount of quality residual trees throughout the block<br>• Creation of germination beds<br>• Abundance of seeds for germination<br>• Adequate Soil exposure<br>• No site damage (i.e. ruts)<br>• No residual trees at risk<br>• Quality pole-sized trees released on 3 sides | • Recruitement of new cohort of desired species<br>• Low competition by interfering plants<br>• Good seedling survival of desired species<br>• Moderate B.A. in vigourous residual trees<br>• No residual trees at risk | • Full stocking of seedlings and saplings<br>• Low competition<br>• Two distinct cohorts of crop trees<br>• No loss of merchantable volume |

## Key Success Factors

- Manage light in order to:
  - Control the establishment and growth of regeneration of desired species
  - Optimize increase in the diameter of the stems kept by providing optimal space for their crowns to spread
- Planned on good seed years
- Expose soil to create seed germination beds
- Maintain adequate cover to protect seedlings

# IMPLEMENTATION
## *UNIFORM 2-AGED/EXTENSIVE* UTA

## Operational Considerations

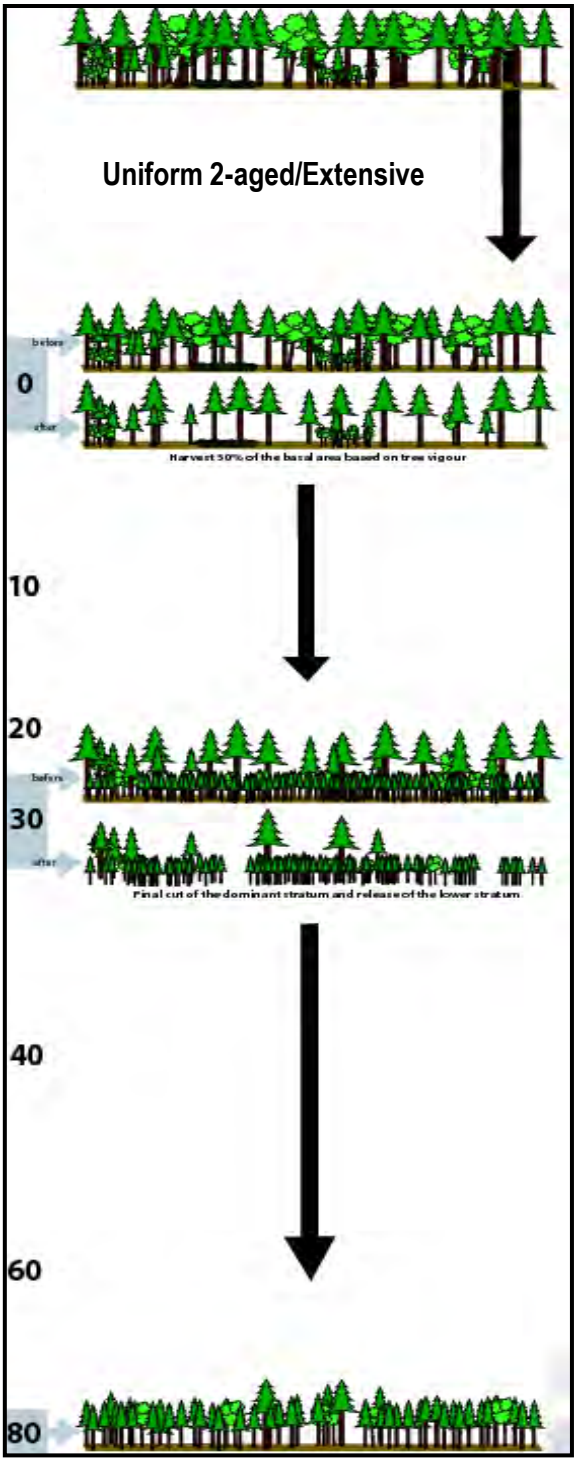
| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | X | | |
| **CTL System** | | X | |
| **Leaves Off** | X | X | |
| **Frozen Ground** | | X | |
| **Outside Sap Season** | X | | |

## Getting Started

- Determine the ideal trail pattern to use (5m wide and 15m center to center or, 6m wide and 16m center to center)
- Decide on the overall target residual basal area or crown cover (between 8-12 m2/ha)
- Plan treatments in a good seed year and in the proper season
- Provide operators with simple instructions for harvest by tree size ca-tegory as per below
- Provide visual guidelines for assessing residual density
- Prepare tree selection criteria (pecking order)
- Decide the timing of the next re-entry
- Prepare a checklist for implementation

## Implementation Instructions

| | |
|---|---|
| **Residual Density in se-lection strip:** | 8-12 m2/ha |
| **Cut Priority:** | Cut most trees >48cm, trees with high grade products at risk and those from the UGS group |
| **Cutting Instructions:** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/2<br>large (38-48cm): 2/3<br>very large (>48cm): all<br>openings <0.2 ha |




Source: CERFO

## Additional Considerations

- When releasing crop trees, leave some non-competing 'trainer trees to prevent the production of epicormic branches
- Large and very large trees in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings

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Northern Hardwoods Research Institute

*Variant/Treatment:*

# *CONTINUOUS COVER TWO-AGED/EXTENSIVE*

System: **Two-aged/Extensive**

Sub-system: **Moderate cover 2-aged**

**CTA**

## Stand Eligibility

**FUNA:** all

**Structure:** all

- Irregular stand structure
- Species that require some protection from exposure to regenerate successfully
- Mature to overmature development stage
- Medium quality stand
- Species of different lifespans
- Lack of pre-established regeneration
- Relatively even distribution of trees in stand
- Presence of quality pole-size and small trees

## Treatment Objectives

The irregular high-forest system is characterized by a desire to regenerate the entire treated stand over a long period that is not continuous over time. It uses partial cuts of varying extents, allowing several vertical or horizontal stories of different age classes to be maintained: so, forest cover is permanent but not necessarily dominated by mature trees throughout.

The main objective of this system is to generate stands with an irregular structure (two-story or uneven-aged structure including at least three age classes), preferably through natural seeding. This system is characterized therefore by the simultaneous presence of at least two cohorts of trees of different ages within the same stand. Because a wide spectrum of light conditions is created, this system allows species with different tolerances to shade and longevity to be grown together.

## Description

This process creates favorable conditions for seedlings to establish and survive while allowing for tending residual stems and harvesting mature trees of poor quality. It is also a way to extend harvesting long-lived species within a mix of species with varying lifespans.

It produces larger diameter stems and spreads revenues over a longer period but it requires thorough knowledge of species ecology and optimized harvesting operations.

This sub-system differs from other 2-aged systems because it ***maintains a minimum 40% cover***. Harvesting pattern, frequency and intensity are guided by species autecology. The preferred way of creating gaps is by removal of dying or defective over mature trees. They can also be designed to release groups of saplings or pockets of pole-sized trees and regeneration. As well, young quality trees should be released.
This process may be perceived as an extensive selection cutting, if the emphasis is on a balanced form of structure to ensure that cover is permanently renewed.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Acceptable amount of quality residual trees throughout the block<br>• Creation of germination beds<br>• Abundance of seeds for germination<br>• Adequate soil exposure<br>• No site damage (i.e ruts)<br>• No residual trees at risk<br>• Relesed quality pole-sized trees | • Recruitement of new cohort of desired species<br>• Low competition by interfering plants<br>• Good seedling survival of desired species<br>• Moderate B.A. in vigourous residual trees<br>• No residual trees at risk | • Full stocking of seedlings and saplings<br>• Low competition<br>• Healthy mature strata<br>• No loss of merchantable volume |

## Key Success Factors

Manage light in order to:

- Control the establishment and growth of regeneration of desired species;
- Optimize increase in the diameter of the stems kept by providing optimal space for their crowns to spread
- Planned on good seed years
- Expose soil to generate seed germination beds
- Maintain adequate cover to protect seedlings
- Released pole-sized trees
- Decision on wether trails will be re-used

# IMPLEMENTATION CTA

## *CONTINUOUS COVER 2-AGED/EXTENSIVE*

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | X | | |
| **CTL System** | | X | |
| **Leaves Off** | X | X | |
| **Frozen Ground** | | X | |
| **Outside Sap Season** | X | | |

## Getting Started

- Determine the ideal trail pattern to use (5 m wide and 20m center to center or, 4 m wide and 18 m center to center)
- Decide on the overall target residual basal area or crown cover (14-16 m2/ha)
- Plan treatments in a good seed year and in the proper season
- Provide operators with simple instructions for harvest by tree size category as per below.
- Provide visual guidelines for assessing residual density
- Prepare tree selection criteria (pecking order)
- Decide the timing of the next re-entry
- Prepare a checklist for implementation

## Implementation Instructions

| | |
|---|---|
| **Residual Density in Selection Strip:** | 14-16 m2/ha |
| **Cut Priority:** | Cut most trees >48cm, trees with high grade products at risk and those from the UGS group |
| **Cutting Instructions:** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/2<br>large (38-48cm): 1/2<br>very large (>48cm): all<br>openings <0.2 ha |

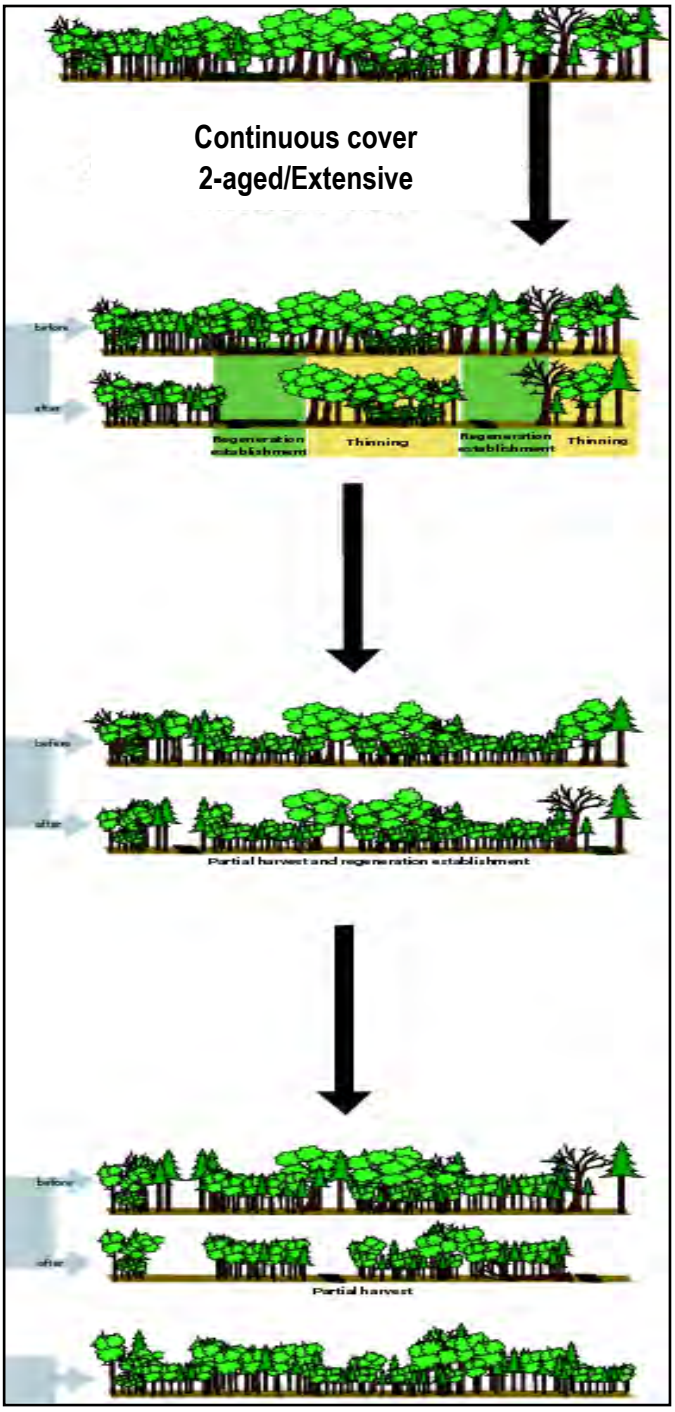


Image Source: CERFO

## Additional Considerations

- When releasing crop trees, leave some non-competing 'trainer trees ' to prevent the production of epicormic branches
- Large and very large trees in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings

NHRI SPS Prescription Tearsheet

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*Method/Treatment:*

# SINGLE-TREE WITH GROUP SELECTION

System: **UNEVEN-AGED**

Sub-system: **SELECTION**

**SGS**

## Stand Eligibility

- **FUNA:** SMTH, YBTH, TOHW, THMX
- **Structure:** Balanced multi-cohort
- The proportion of beech must be less than 30% and not prominent in the understory
- Ideally, there should be at least 25m² /ha of basal area and >60% crown cover to allow harvesting enough volume
- More than half the trees need to be of quality (AGS)
- Should have a high proportion of sugar maple and yellow birch
- Acceptable regeneration should be present
- Site should have high productivity

## Treatment Objectives

Production of high-quality sawlogs is a management goal. Under this method the highest-grade trees are selected and then "released" by removing lower grade trees which would otherwise compete with the selected tree for resources.

To continually create or maintain an uneven-aged stand by removing single trees or small groups of trees from various age and size classes. regeneration cut, tending operation and harvesting generally occur simultaneously, but may vary across the stand.

Specific objectives are:

- Create multiple cohort stand (at least 3 age classes)
- Perpetuate natural gap creation
- Regulate a balanced age-class distribution over the stand
- Promote conditions for good growth
- Control species composition and quality.
- Increase sawlog volume

## Description

Individual trees are harvested using the Arbogast method also known as the ***BDq* method**. Under this method, a harvest is specified by defining a maximum diameter to retain (***D***), a residual basal area (***B***), and a q-ratio (***q***). The q-ratio is the ratio of the number of trees in a diameter class to the number of trees in the next larger class.

Regular re-entries (approx. every 20 yrs) remove merchantable timber, reduce competition to crop trees and promote regeneration of desirable species. Treatments are done in all 3 age classes.

Single mature trees or small groups of trees from a range of diameter classes are removed, uniformly across the cutover area.

Generally, the size of gap created in this method is equivalent to the crown spread of a single tree or clumps of mature trees.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • BA>16m²/ha<br>• AGS>UGS<br>• <5% crop trees damaged<br>• Crop trees released on 2-3 sides<br>• No site damage (i.e. ruts) | • Recruitment of new cohort<br>• Healthy crowns<br>• Diameter growth<br>• Reduction of risk trees | • High Basal Area<br>• AGS>75%<br>• R1, R2 trees >75%<br>• Sm, Yb >75%<br>• Balanced age/DBH structure |

## Key Success Factors

- Small trail footprint with wide spacing and narrow trails
- Operate after sap season and with snow cover if possible
- Chose proper harvesting system
- Use trained operators dedicated to special harvesting
- Implement quality system
- Stratify stands correctly
- Develop BDQ methodology/targets

# IMPLEMENTATION

**SGS**

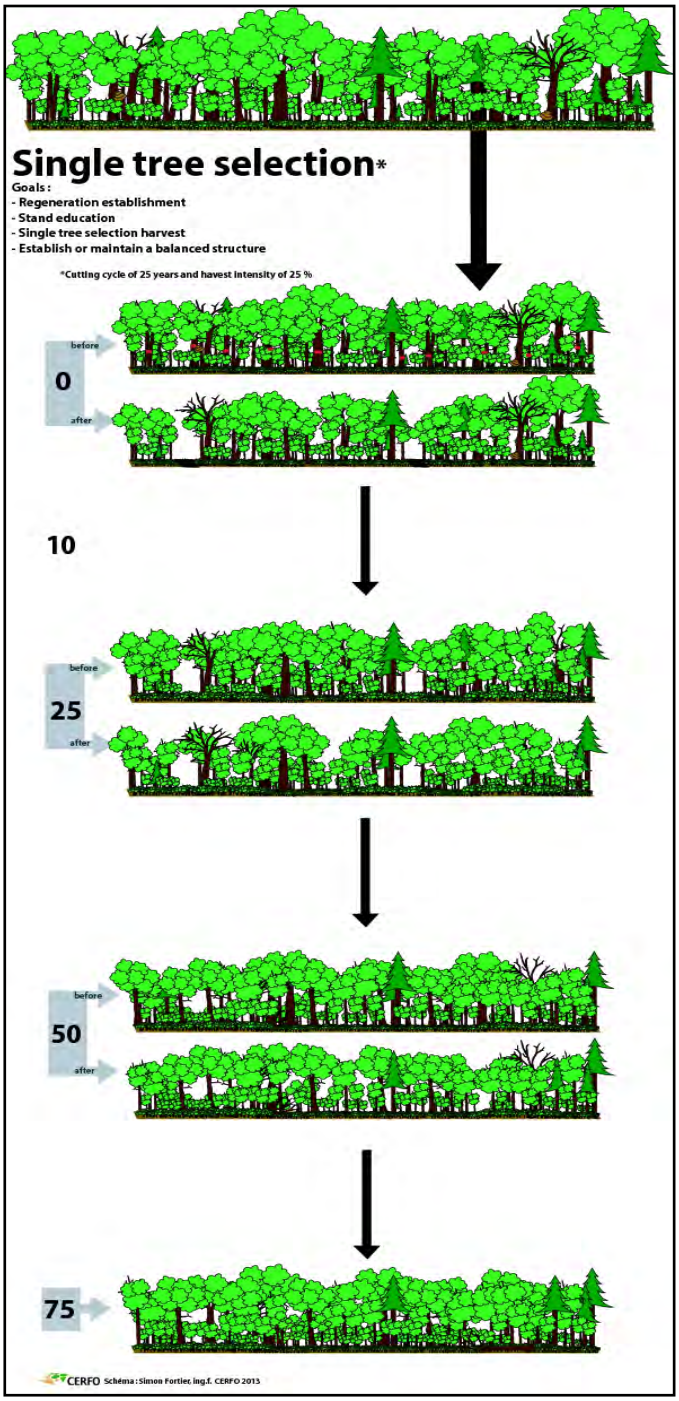
***SINGLE-TREE WITH GROUP SELECTION***

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | X | | |
| **CTL System** | X | | |
| **Sap-free Season** | X | | |
| **Frozen Ground** | X | | |
| **Leaves Off** | X | | |
| **High Trail Footprint** | | | X |

## Getting Started

- Determine the ideal trail pattern to use (4 m wide and 20m center to center or, 5m wide and 25m center to center)
- Decide on the overall target residual basal area or crown cover (17-18 m2/ha)
- Plan treatments in a good seed year and in the proper season
- Provide operators with simple instructions for harvest by tree size category as per below
- Provide visual guidelines for assessing residual density
- Prepare tree selection criteria (pecking order)
- Decide the timing of the next re-entry
- Prepare a checklist for implementation




## Implementation Instructions

| | |
|---|---|
| **Residual Density in Selection Strip:** | 17-18m2/ha |
| **Cut Priority:** | Cut most trees >48cm with high grade products at risk and those from the UGS group |
| **Cutting Instructions:** | saplings (<10cm): protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/4<br>large (38-48cm): 1/2<br>very large (>48cm): all<br>openings <0.2 ha |

## Additional Considerations

- When releasing crop trees, leave some non-competing 'trainer trees to prevent the production of epicormic branches
- Large and very large trees in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings

NHRI SPS Prescription Tearsheet

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# COMMERCIAL THINNING

## Intermediate Treatment

**CT**

## Stand Eligibility

- **FUNA:** SMTH, YBTH, TOHW, OKHW,FPHW, THHW
- **Structure:** E1, E2,
- Regular stand or patch structure
- AGS>UGS
- Young to immature development stage
- High stocking
- Productive site
- Even distribution of trees in stand
- QMD<20cm
- BA > 20m²/ha

## Treatment Objectives

Comercial thinning is a treatment common to many even-aged system where the goal is to release quality crop trees in even-aged stands so that they can transition into 2-aged and then uneven-aged stands.

The stands that were subjected to major disturbances generally develop as single cohort stand with one species or stratified mixture of more than two species (E1 and E2 stands). In this type of stands, trees grow without competition until the growing space is reoccupied. When the growing space is fully occupied, trees will compete for available light, moisture and nutrients. Thinning can redistribute the resources to the remaining trees and thus help produce larger diameter trees in a shorter period.

To fulfill this objective, trees that are (1) of undesirable species, (2) poor-quality (damaged or defective) and (3) good quality but in strong competition can be removed. Hence, this treatment is to improve stand composition, structure, growth, quality, and health.

## Description

Commercial thinning is implemented to single cohort fully stocked tolerant-hardwood stands (BA>20 m2/ha), which have quadratic mean diameter less than 20 cm. Individual tree form and vigor are important considerations for CT. The objective of producing quality saw timber will only be met if the stand has larger proportion of trees with better form and vigor. Unlike in the case of softwoods, the **preferred method is a crown thinning (or thinning from above) where the emphasis is put on the release of quality Th trees that are often in the co-dominant layer.**

The stand is recommended for CT only if the proportion of AGS>UGS. Branch free bole length is another consideration that helps to determine thinning intensity.

The treatment is regulated by use of stocking guides and stand density management diagrams. If more than 50% of the trees have branch free bole greater than 4 m then the stand can be thinned to B-line. If not, then the stand need to be thinned to quality line for promoting natural pruning. This will help to maintain desired length of branch free bole.

A crop-tree variant can be considered where less emphasis is put on stand but more on elite trees and therefor results in a less uniform spacing.

## Desired Outcomes

| Immediate | Mid-term | Long-term |
|---|---|---|
| • Well stocked stand of crop trees after treatment<br>• Crop trees released on 3 sides<br>• Low damage on residual trees<br>• Increased proportion of desired species and AGS<br>• No site damage<br>• Reduced proportion of trees at risk | • Increased growth on crop trees<br>• Low competition by interfering plants<br>• Good development of crowns on crop trees<br>• Low tree mortality | • High proportion of sawtimber<br>• Clear boles (5m) on elite trees<br>• Stand ready for other intermediate treatment |

## Key Success Factors

- Fine determination of the target basal area by using stocking guides
- Very low trail ratio
- Use of specialized and smaller harvesters
- Focus on residual quality (low level of damage to crop trees, species selection, etc.)
- Implement in the dormant season (fall and winter) to minimize mechanical damage to trees.

# IMPLEMENTATION
## *COMMERCIAL THINNING*

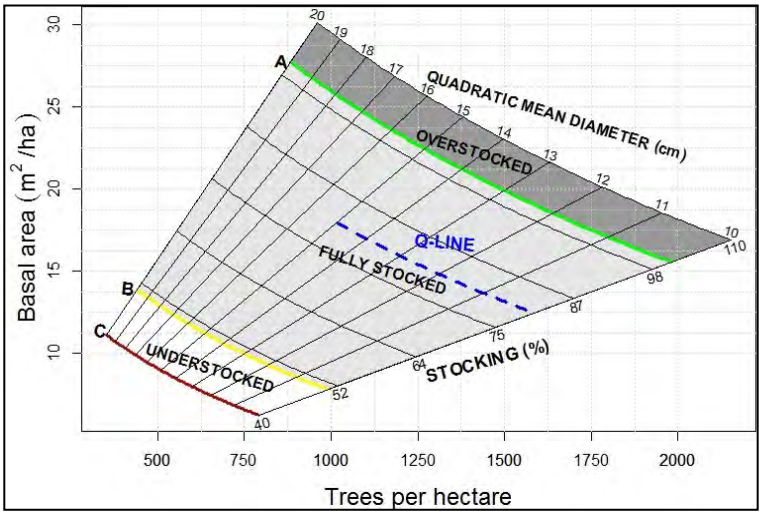
**CT**

## Operational Considerations

| | Prefered | Tolerated | Avoid |
|---|---|---|---|
| **Full Tree System** | | X | |
| **CTL System** | X | | |
| **Leaves Off** | X | | |
| **Frozen Ground** | X | | |
| **Outside Sap Season** | X | | |

## Northern Hardwoods Stocking Guide (New Brunswick)

'A', 'B' and 'C lines are the stocking levels. The `A' line represents the normal condition of maximum stocking for undisturbed stands of average structure. The 'B' line is the lower limit of stocking needed for full occupancy of the site. Stands at 'C'-level stocking are expected to reach the 'B' level within 10 years.




## Pre-planning

- Conduct a pre-treatment inventory to determine elligibility
- Decide on the thinning type based on managment objectives
- Use stocking guide to determine removal intensity and residual basal area.
- If BLC>4m, thin to B line
- Prepare quality standards and pecking order

## Hardwoods Thinning Types

**Crown Thinning (High Thinning, Thinning from Above):**

The removal of trees from the dominant and co-dominant crown classes in order to favor the best trees of those same crown classes. As the trees removed are relatively large, it is often conducted as commercial operations. In this method, best dominant and co-dominant crop trees are ideally selected, favoured and carried through the entire rotation. The number of crop trees to leave is usually between 100 and 400 per hectare.

**Free Thinning:**

Trees are removed to control stand density and favor desired crop trees using a combination of low and crown thinning despite of the crown position. This type of thinning is used to develop and manage quality hardwood stands for the production of high value sawtimber and veneer logs.

**Low Thinning (Thinning From Below):**

The removal of trees from the lower crown classes to favor those in the upper crown classes. Least desirable competitors (high risk, low vigor, poor quality) are generally removed. The removal of some co-dominants may create canopy openings and releases the crowns of crop trees to stimulate their growth. This thinning type puts equal emphasis on the production of volume and quality.

## Implementation Instructions

| | |
|---|---|
| **Residual Density in Selection Strip:** | Thin to Q-line or B–line but leave a minimum of 14m2/ha |
| **Cut Priority:** | Cut mostly large trees of poor quality or undesired species then, those from the UGS group |
| **Cutting Instructions:** | Saplings (<10cm) : protect AGS<br>Small (10-22cm): 1/4<br>Medium (22-38cm): 1/4<br>Large (38-48cm): all<br>Very Large (>48cm): all<br>Openings <0.2 ha |

## Additional Considerations

- When releasing crop trees, leave some non-competing 'trainer trees to prevent the production of epicormic branches.
- Large and very large trees in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings.

# Appendix IV

# SPS Implementation Tools

## Work Instructions

# NHRI SPS - Work Instructions

# **(PCC)** Progressive Strip Clear Cut

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **EVEN-AGED** |
| **SUB-SYSTEM** | **CLEAR CUT** |
| **OBJECTIVES** | To regenerate a new stand within 20 years in situations *where the existing stand is not acceptable* in terms of species composition, stocking and quality and, does not contain quality pole size trees |
| **VARIANTS** | **(PCC)** Progressive Strip Clear Cut |
| **GOALS** | This regime will regenerate mostly yellow birch and mid-tolerant species through the use of 3 or 4 strips cut progressively within 20 years. |

## (PCC) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | MFT (prefered), CTL (adapted to increase scarification) |
| **#2 - Harvest Season** | Spring, Summer, Fall<br>(*see* Note 2) |
| **#3 - Trail Network** | at the discretion of management |
| **#4 - Green/Treatment Strip** | Leave untreated |
| **#5 - Cut Priority** | Cut all merchantable trees |
| **#6 - Cutting Instructions** | Year1: establish first strip<br>Year 10: cut 2nd strip<br>Year 20: cut final strips<br>width: 1.5 X tree height<br>(20m to 30m average width depending on tree height) |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Germination Beds): Put emphasis on the creation of seed germination beds.
**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.
**NOTE 3** (Strip Patterns): Strip patterns can be altered but try to maintain 1-1.5 tree heights as width of strips.

# **(RST)** Retention Seed-Tree Cut

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **EVEN-AGED** |
| **SUB-SYSTEM** | **SEED-TREE CUT** |
| **OBJECTIVES** | To regenerate a new stand within 20 years in situations *where the existing stand is not acceptable* in terms of species composition, stocking and quality and, does not contain quality pole size trees |
| **VARIANTS** | **(RST)** Retention Seed-Tree Cut |
| **GOALS** | Regeneration of new cohort through the permanent retention of seed trees of desired species in clumps |

## (RST) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | MFT (prefered), CTL (adapted to increase scarification) |
| **#2 - Harvest Season** | Spring, Summer, Fall<br>(*see* Note 1 & Note 2) |
| **#3 - Trail Network** | 5 wide and 15m center to center or, 6m wide and 16m center to center<br>(Trail ratio: 33%-38%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 10-20 seed trees / ha |
| **#5 - Cut Priority** | |
| **#6 - Cutting Instructions** | Yr1: cut but retain seed trees |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Key Success Factors): Conduct in proper time to obtain scarification.
**NOTE 2** (Key Success Factors): Avoid conducting under snow and plan on good seed years.

# NHRI SPS - Work Instructions

# **(USH)** Uniform Shelterwood

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **EVEN-AGED** |
| **SUB-SYSTEM** | **SHELTERWOOD** |
| **OBJECTIVES** | To regenerate a new stand within 20 years in situations *where the existing stand is not acceptable* in terms of species composition, stocking and quality and, does not contain quality pole size trees |
| **VARIANTS** | **(USH)** Uniform Shelterwood |
| **GOALS** | Within 20 years, completely start a new stand through 2 separate entries. First treatment is a seedling establishment cut applied uniformly throughout the stand. |

## (USH) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | MFT (prefered), CTL (adapted to increase scarification) |
| **#2 - Harvest Season** | Spring, Summer, Fall<br>(*see* Note 2 & Note 3) |
| **#3 - Trail Network** | 5m wide and 15m center to center or, 6m wide and 16m center to center<br>(Trail ratio: 33%-38%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 8-10$m^2$/ha |
| **#5 - Cut Priority** | Cut all trees >48cm, trees with high grade products at risk and those from the UGS group |
| **#6 - Cutting Instructions** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/3<br>medium (22-38cm): 1/2<br>large (38-48cm): 1/2<br>very large (>48cm): all |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Creating Seed Beds): This treatment is about starting a new stand within 20 years so lower than usual emphasis is put on protecting crop trees. Rather put emphasis on creating seed beds. SCHEDULE THE FINAL TREATMENT (OSR) WHEN REGENERATION IS ESTABLISHED BUT < 2M HIGH.

**NOTE 2** (Key Success Factors)**:** Conduct after sap season tom minimize damage to crop trees.

**NOTE 3** (Key Success Factors): Conduct before snow cover in order to increase scarification.

# NHRI SPS - Work Instructions

# (**OSH**) One-Cut Shelterwood

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **EVEN-AGED** |
| **SUB-SYSTEM** | **SHELTERWOOD** |
| **OBJECTIVES** | To regenerate a new stand within 20 years in situations *where the existing stand is not acceptable* in terms of species composition, stocking and quality and, does not contain quality pole size trees |
| **VARIANTS** | (**OSH**) One-Cut Shelterwood (also known as Overstory removal) |
| **GOALS** | Complete or substancial removal of overstory in stands to **protect and release well established and desirable regeneration** but with unacceptable merchantable statum |

## (OSH) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | All |
| **#2 - Harvest Season** | Winter (under snow)<br>(*see* Note 2) |
| **#3 - Trail Network** | 5m wide and 25m center to center or, 4m wide and 20m center to center<br>(Trail ratio: 20%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: <5$m^2$/ha |
| **#5 - Cut Priority:** | Cut all merchantable trees >22cm and maintain/release AGS in pole size trees and saplings when present |
| **#6 - Cutting Instructions:** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/2<br>medium (22-38cm): all<br>large (38-48cm): all<br>very large (>48cm): all |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Regeneration): This treatment is about completely releasing regeneration that is already established by previous activities therefore, it is important to minimise damage to it. Treat when regeneration is less than 2m tall in order to avoid breakage when trees are felled. If possible, operate with snow cover and minimise trail footprint. Full-tree harvesting systems that utilise feller-buncher allow for controlled tree felling and positioning in trails to minimise damage.

**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.

# NHRI SPS - Work Instructions

# (**UTA**) Uniform 2-Age

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **TWO-AGE, EXTENSIVE** |
| **SUB-SYSTEM** | **LOW COVER** |
| **OBJECTIVES** | To promote a two cohort stand by removing financially mature trees, tending small trees and establishing a new cohort. This regime is favoured when in the presence of a low quality mature statum but with the presence of a substantial amount of quality pole-sized trees |
| **VARIANTS** | (**UTA**) Uniform 2-Age |
| **GOALS** | Promote a 2-age class stand by putting emphasis on establishing regeneration. The entries are extended longer than in other regimes (25-35 years) and the resulting stand is homogenous |

## (UTA) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | MFT (prefered), CTL (adapted to increase scarification) |
| **#2 - Harvest Season** | Fall, early Summer when beech present<br>(*see* Note 2) |
| **#3 - Trail Network** | 5m wide and 15m center to center or, 6m wide and 16m center to center<br>(Trail ratio: 33%-38%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 8-12m$^2$/ha |
| **#5 - Cut Priority** | Cut most trees >48cm, trees with high grade products at risk and those from the UGS group |
| **#6 - Cutting Instructions** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/2<br>large (38-48cm): 2/3<br>very large (>48cm): all<br>openings <0.2 ha |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Trainer Trees): When releasing crop trees, leave some non-competing 'trainer trees ' to prevent the production of epicormic branches. Large and very large trees of desired species but in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings.

**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.

**NOTE 3** (Key Success Factors): Release crop trees of all size on 3 sides when possible.

# NHRI SPS - Work Instructions

# (**CTA**) Continuous Cover 2-Age

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **TWO-AGE, EXTENSIVE** |
| **SUB-SYSTEM** | **MODERATE COVER** |
| **OBJECTIVES** | To promote a two cohort stand by removing financially mature trees, tending small trees and establishing a new cohort. This regime is favoured when in the presence of a low quality mature statum but with the presence of a substantial amount of quality pole-sized trees |
| **VARIANTS** | (**CTA**) Continuous Cover 2-Age |
| **GOALS** | Promote a 2-age class stand but maintain significant crown cover at all time. The entries are extended longer than in other regimes (25-35 years) |

## (CTA) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | MFT (prefered), CTL (adapted to increase scarification) |
| **#2 - Harvest Season** | Fall, Winter, early Summer when beech present<br>(*see* Note 2) |
| **#3 - Trail Network** | 5 wide and 20m center to center or, 4m wide and 18m center to center<br>(Trail ratio: 22%-25%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 14-16$m^2$/ha |
| **#5 - Cut Priority** | Cut most trees >48cm, trees with high grade products at risk and those from the UGS group |
| **#6 - Cutting Instructions** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/2<br>large (38-48cm): 1/2<br>very large (>48cm): all<br>openings <0.2 ha |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Trainer Trees): When releasing crop trees, leave some non-competing 'trainer trees ' to prevent the production of epicormic branches. Large and very large trees of desired species but in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings.

**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.

**NOTE 3** (Key Success Factors): Release crop trees of all sizes on 3 sides when possible.

# (**SGS**) SingleTree with Group Selection

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **UNEVEN-AGED** |
| **SUB-SYSTEM** | **SELECTION** |
| **OBJECTIVES** | To maintain a multi-cohort stand with 3 or more age classes through periodic and regular harvest entries. Each entry accomplishes 3 main tasks: the harvest of financially mature trees, the tending of trees in the smaller sizes and the recruitment of a new cohort |
| **VARIANTS** | (**SGS**) Single Tree with Group Selection |
| **GOALS** | Regulate Basal Area, chose a maximum DBH to retain and the proportion of trees in each size class. The treatment is executed by focussing on individual trees but allowing the removal of groups of UGS trees. |

## (SGS) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | All |
| **#2 - Harvest Season** | Fall, Winter<br>(*see* Note 2) |
| **#3 - Trail Network** | 5 m wide and 25m center to center or, 4m wide and 20m center to center<br>(Trail ratio: 20%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 17-18 $m^2$/ha |
| **#5 - Cut Priority** | Cut most trees >48cm, trees with high grade products at risk and those from the UGS group |
| **#6 - Cutting Instructions** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/4<br>large (38-48cm): 1/2<br>very large (>48cm): all<br>openings <0.2 ha |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Trainer Trees)**:** When releasing crop trees, leave some non-competing 'trainer trees ' to prevent the production of epicormic branches. Large and very large trees of desired species but in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings.

**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.

**NOTE 3** (Key Success Factors): Release crop trees of all sizes on 3 sides when possible.

# NHRI SPS - Work Instructions

# (**CT**) Commercial Thinning

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **N/A part of all even-aged sub-systems** |
| **SUB-SYSTEM** | **N/A part of all even-aged sub-systems** |
| **OBJECTIVES** | In young stands with an even-aged structure, regulate competition by releasing crop trees |
| **VARIANTS** | (**CT**) Thin to B-line or thin to Q-line |
| **GOALS** | Apply the concept of a stand density management diagram to reduce crop tree competition without creating conditions for branching |

## (CT) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | CTL |
| **#2 - Harvest Season** | Fall, Winter<br>(see Note 2) |
| **#3 - Trail Network** | 5m wide and 25m center to center or, 4m wide and 20m center to center<br>(Trail ratio: 20%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 14$m^2$/ha, thin to Q line or B line |
| **#5 - Cut Priority** | Cut mostly large trees of poor quality or undesired species then, those from the UGS group |
| **#6 - Cutting Instructions** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/4<br>large (38-48cm): all<br>very large (>48cm): all<br>openings <0.2 ha |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Trainer Trees): When releasing crop trees, leave some non-competing 'trainer trees ' to prevent the production of epicormic branches. Large and very large trees of desired species but in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings.

**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.

**NOTE 3** (Key Success Factors): Release crop trees of all sizes on 3 sides when possible.

# NHRI SPS - Work Instructions

# (**CT**) Commercial Thinning

| | |
|---|---|
| **SILVICULTURE SYSTEM** | **N/A part of all even-aged sub-systems** |
| **SUB-SYSTEM** | **N/A part of all even-aged sub-systems** |
| **OBJECTIVES** | In young stands with an even-aged structure, regulate competition by releasing crop trees |
| **VARIANTS** | (**CT**) Thin to B-line or thin to Q-line |
| **GOALS** | Apply the concept of a stand density management diagram to reduce crop tree competition without creating conditions for branching |

## (CT) IMPLEMENTATION SEQUENCE

| | |
|---|---|
| **#1 - Harvesting System** | CTL |
| **#2 - Harvest Season** | Fall, Winter<br>(see Note 2) |
| **#3 - Trail Network** | 5m wide and 25m center to center or, 4m wide and 20m center to center<br>(Trail ratio: 20%) |
| **#4 - Green/Treatment Strip** | Residual Basal Area: 14$m^2$/ha, thin to Q line or B line |
| **#5 - Cut Priority** | Cut mostly large trees of poor quality or undesired species then, those from the UGS group |
| **#6 - Cutting Instructions** | saplings (<10cm) : protect AGS<br>small (10-22cm): 1/4<br>medium (22-38cm): 1/4<br>large (38-48cm): all<br>very large (>48cm): all<br>openings <0.2 ha |

## ADDITIONAL CONSIDERATIONS

**GENERAL NOTICE:** The cutting instructions provided above are for the objectives of timber production only; other guidelines for wildlife habitat, conservation and diversity can override these recomendations.

**IMPLEMENTATION SEQUENCE:** First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), than target residual basal area in the green/treatment strip (#4). Finally follow the cut priorities (#5) and cutting instructions (#6) to meet the basal area target.

**NOTE 1** (Trainer Trees): When releasing crop trees, leave some non-competing 'trainer trees ' to prevent the production of epicormic branches. Large and very large trees of desired species but in deteriorating health, and without high grade potential that do not compete with crop trees can be left for the production of seedlings.

**NOTE 2** (Key Success Factors): Conduct after sap season to minimize damage to crop trees.

**NOTE 3** (Key Success Factors): Release crop trees of all sizes on 3 sides when possible.

# Appendix V

# SPS Implementation Tools

## Implementation Checklists

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# SPS Implementation Checklist

## PROGRESSIVE STRIP CLEAR CUT — PCC

### GENERAL INFORMATION

Block #: _____ NOTES: _____

Date: _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with strip cuts: True: ☐ False: ☐

Strip cuts 20-30m wide (depending on tree height): True: ☐ False: ☐

Recommended harvest system (MFT preferred/CTL adapted to increase scarification): True: ☐ False: ☐

Recommended season (Spring, Summer, Fall): True: ☐ False: ☐

Notes: _____

_____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

Strips are oriented to maximize seed dispersion: True: ☐ False: ☐

Treatment completed un good seed year: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

_____

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# SPS Implementation Checklist

## RETENTION SEED-TREE CUT — RST

### GENERAL INFORMATION

Block #: _____ NOTES: _____

Date: _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trail: True: ☐ False: ☐

Trail spacing (5m wide/15m center to center or, 6m wide/16m center to center): True: ☐ False: ☐

Recommended harvest system (MFT preferred/CTL adapted to increase scarification): True: ☐ False: ☐

Recommended season (Spring, Summer, Fall): True: ☐ False: ☐

Notes: _____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

No large trees with quality products were left (except for wildlife habitat purposes): True: ☐ False: ☐

Minimum Basal Area (10-20 seed trees/ha) was kept in the treated stand: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

_____

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# SPS Implementation Checklist

## UNIFORM SHELTERWOOD — USH

### GENERAL INFORMATION

Block #: _____ NOTES: _____

Date: _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trails: True: ☐ False: ☐

Trail spacing: 5m wide/15m center to center or, 6m wide/16m center to center: True: ☐ False: ☐

Recommended harvest system (MFT preferred/CTL adapted to increase scarification): True: ☐ False: ☐

Recommended season (Spring, Summer, Fall): True: ☐ False: ☐

Notes: _____

_____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

No large trees with quality products are left (except for wildlife habitat purposes): True: ☐ False: ☐

Minimum basal area (8-10$m^2$/ha) was kept in the treated strip: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

_____

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# SPS Implementation Checklist

## ONE-CUT SHELTERWOOD — OSH

### GENERAL INFORMATION

Block #: _____ NOTES: _____

Date: _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trails: True: ☐ False: ☐

Trail spacing: 4m wide/20m center to center or, 5m wide/25m center to center: True: ☐ False: ☐

Recommended harvest system (All): True: ☐ False: ☐

Recommended season (Winter-under snow): True: ☐ False: ☐

Notes: _____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

All Trees > 22cm removed: True: ☐ False: ☐

Pole size trees and saplings are present: True: ☐ False: ☐

No large trees with quality products are left (except for wildlife habitat purposes): True: ☐ False: ☐

Minimum basal area ($5m^2/ha$) was kept in the treated strip: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

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# SPS Implementation Checklist

## UNIFORM TWO-AGED/EXTENSIVE — UTA

### GENERAL INFORMATION

**Block #:** _____ **NOTES:** _____

**Date:** _____ _____

**By:** _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trails: True: ☐ False: ☐

Trail spacing: 5m wide/15m center to center or, 6m wide/16m center to center: True: ☐ False: ☐

Recommended harvest system (MFT preferred/CTL with extra scarification): True: ☐ False: ☐

Recommended season (no snow): True: ☐ False: ☐

Notes: _____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Quality pole-sized trees are released on 3 sides: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

No large trees with quality products are left (except for wildlife habitat purposes): True: ☐ False: ☐

Minimum basal area (8-10$m^2$/ha) was kept in the treated strip: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

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# SPS Implementation Checklist

## CONTINUOUS COVER TWO-AGED/EXTENSIVE — CTA

### GENERAL INFORMATION

**Block #:** _____ NOTES: _____

**Date:** _____ _____

**By:** _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trails: True: ☐ False: ☐

Trail spacing: 4m wide/18m center to center or, 5 m wide/20m center to center: True: ☐ False: ☐

Recommended harvest system (MFT preferred/CTL adapted to increase scarification): True: ☐ False: ☐

Recommended season (Fall, Winter, early Summer - when beech present): True: ☐ False: ☐

Notes: _____

_____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Quality pole-sized trees are released on 3 sides: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

No large trees with quality products are left (except for wildlife habitat purposes): True: ☐ False: ☐

Minimum Basal Area (14-16m2/ha) was kept in the treated strip: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

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# SPS Implementation Checklist

## SINGLE-TREE WITH GROUP SELECTION — SGS

### GENERAL INFORMATION

Block #: _____ NOTES: _____

Date: _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trails: True: ☐ False: ☐

Trail spacing: 4m wide/20m center to center or, 5 m wide/25m center to center: True: ☐ False: ☐

Recommended harvest system (All): True: ☐ False: ☐

Recommended season (Fall, Winter): True: ☐ False: ☐

Are openings < 0.2 ha: True: ☐ False: ☐

Notes: _____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Quality pole-sized trees are released on 3 sides: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

No large trees with quality products are left (except for wildlife habitat purposes): True: ☐ False: ☐

Minimum Basal Area (17-18$m^2$/ha) was kept in the treated strip: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

_____

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# SPS Implementation Checklist

## COMMERCIAL THINNING — CT

### GENERAL INFORMATION

Block #: _____ NOTES: _____

Date: _____ _____

### STAND ELIGIBILITY

Conditions within the block were suitable for the treatment: True: ☐ False: ☐

Block was not too variable where further stratification was needed: True: ☐ False: ☐

Notes: _____

_____

### TRAIL PATTERN/PLANNING

Block is uniformly covered with trails: True: ☐ False: ☐

Trail spacing: 4m wide/20m center to center or, 5 m wide/25m center to center: True: ☐ False: ☐

Recommended harvest system (CTL): True: ☐ False: ☐

Recommended season (Fall, Winter): True: ☐ False: ☐

Are openings < 0.2 ha : True: ☐ False: ☐

Notes: _____

### DESIRED SHORT-TERM OUTCOMES

The block is free of site and environmental damage: True: ☐ False: ☐

Quality pole-sized trees are released on 3 sides: True: ☐ False: ☐

Forest floor was lightly scarified to create germination substrate: True: ☐ False: ☐

Quality residual trees are free of damage from operation: True: ☐ False: ☐

No large trees with quality products are left (except for wildlife habitat purposes): True: ☐ False: ☐

Residual Basal Area (14m$^2$/ha), thin to Q line or B line: True: ☐ False: ☐

Tree selection was conducted to increase AGS/UGS ratio: True: ☐ False: ☐

### ASSESSMENT

Treatment - **Pass** or **Fail**: _____

Preventive Measures/Improvements: _____

_____

Corrective Measures: _____

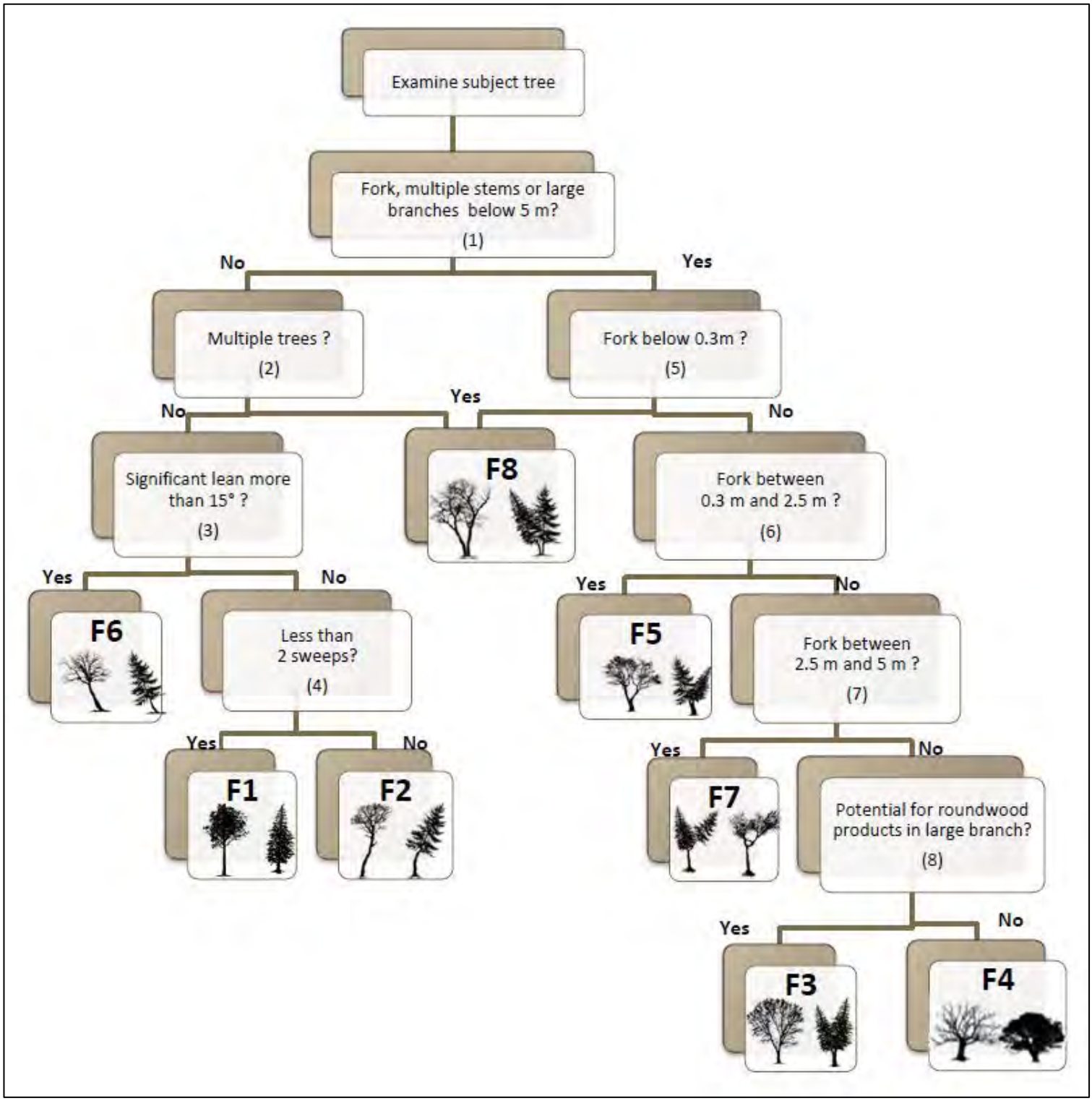
_____

# Appendix VI

# SPS Implementation Tools

## Tree Classification System and AGS/UGS Matrix

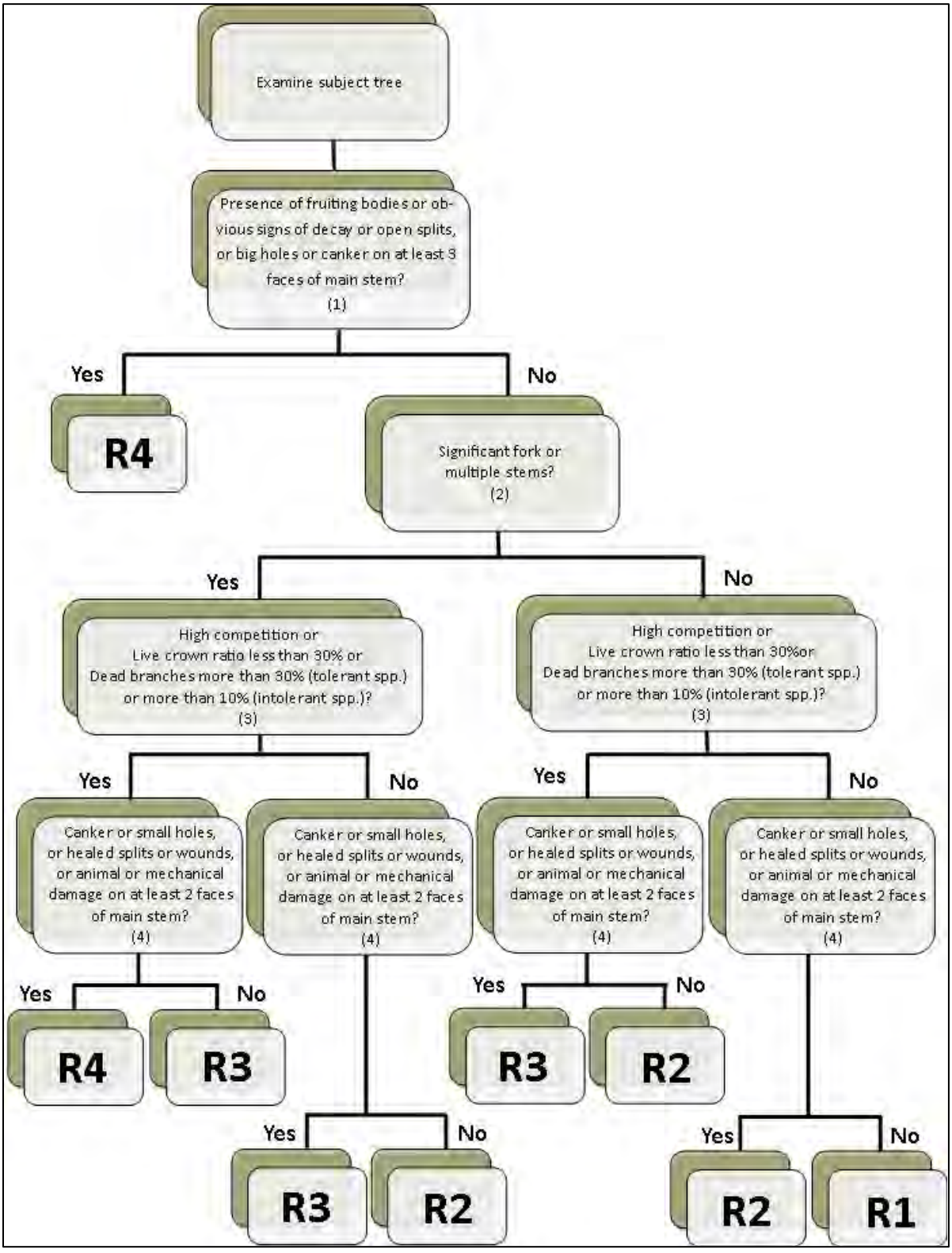
# Tree Form Determination Key



# Tree Form Summary

| Code | Silhouettes | Stem count | Stem curve | Stem inclination angle (°) | Comment |
|---|---|---|---|---|---|
| F1 |  | Single stem below 5 m | Sweep on max. 1 axis | Less than 15° | N/A |
| F2 |  | Single stem below 5 m | Sweep on 2 axes or 1 significant curve | Less than 15° | N/A |
| F3 |  | Single stem, large branches below 5 m | N/A | N/A | Presence of large branches<br>Potentially carrying roundwood products |
| F4 |  | Single stem, large branches below 5 m | N/A | N/A | Presence of large branches<br>No roundwood products |
| F5 |  | Multiple stem, Fork between 0.3 m and 2.5 m | N/A | N/A | N/A |
| F6 |  | Single stem below 5 m | Sweep on max. 1 axis | Significant lean more than 15° | N/A |
| F7 |  | Multiple stem, Fork between 2.5 m and 5 m | N/A | N/A | N/A |
| F8 |  | Multiple trees or fork below 0.3 m | N/A | N/A | N/A |

# Tree Risk Determination Key



# Tree Risk Summary

| Rating | Probability of mortality | Value ($) projected in time | Probability of product downgrade |
|---|---|---|---|
| **R1** | Nil, > 25 years | Improve | Low |
| **R2** | Low, 15-25 years | Stable | Moderate |
| **R3** | Medium, 5-15 years | Deteriorate | High |
| **R4** | High < 5 years | Substantial loss | Very high |

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# Conversion matrix to link the Tree Classification System for New Brunswick to the AGS/UGS System.

Version: Sept 2019

| Species | Good form (F1, F2) | | | | Acceptable Form (F5, F6, F7, F8) | | | | Poor form (F3, F4) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | R1 | R2 | R3 | R4 | R1 | R2 | R3 | R4 | R1 | R2 | R3 | R4 |
| **Beech** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Poplar** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Red maple** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Red oak** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | AGS | UGS | UGS | UGS |
| **Sugar maple** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | AGS | UGS | UGS | UGS |
| **White ash** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | AGS | UGS | UGS | UGS |
| **White birch** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Yellow birch** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | AGS | UGS | UGS | UGS |
| **Black spruce** | AGS | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Cedar** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | AGS | UGS | UGS | UGS |
| **Fir** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Hemlock** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Jack pine** | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Red pine** | AGS | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Red spruce** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **Eastern white pine** | AGS | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |
| **White spruce** | AGS | AGS | UGS | UGS | AGS | UGS | UGS | UGS | UGS | UGS | UGS | UGS |

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