

NHRI SPS 2.0 IMPLEMENTATION TOOLS



SILVICULTURE PRESCRIPTION SYSTEM
VERSION 2.0 - JANUARY 2020



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Tree Classification System and AGS/UGS Matrix



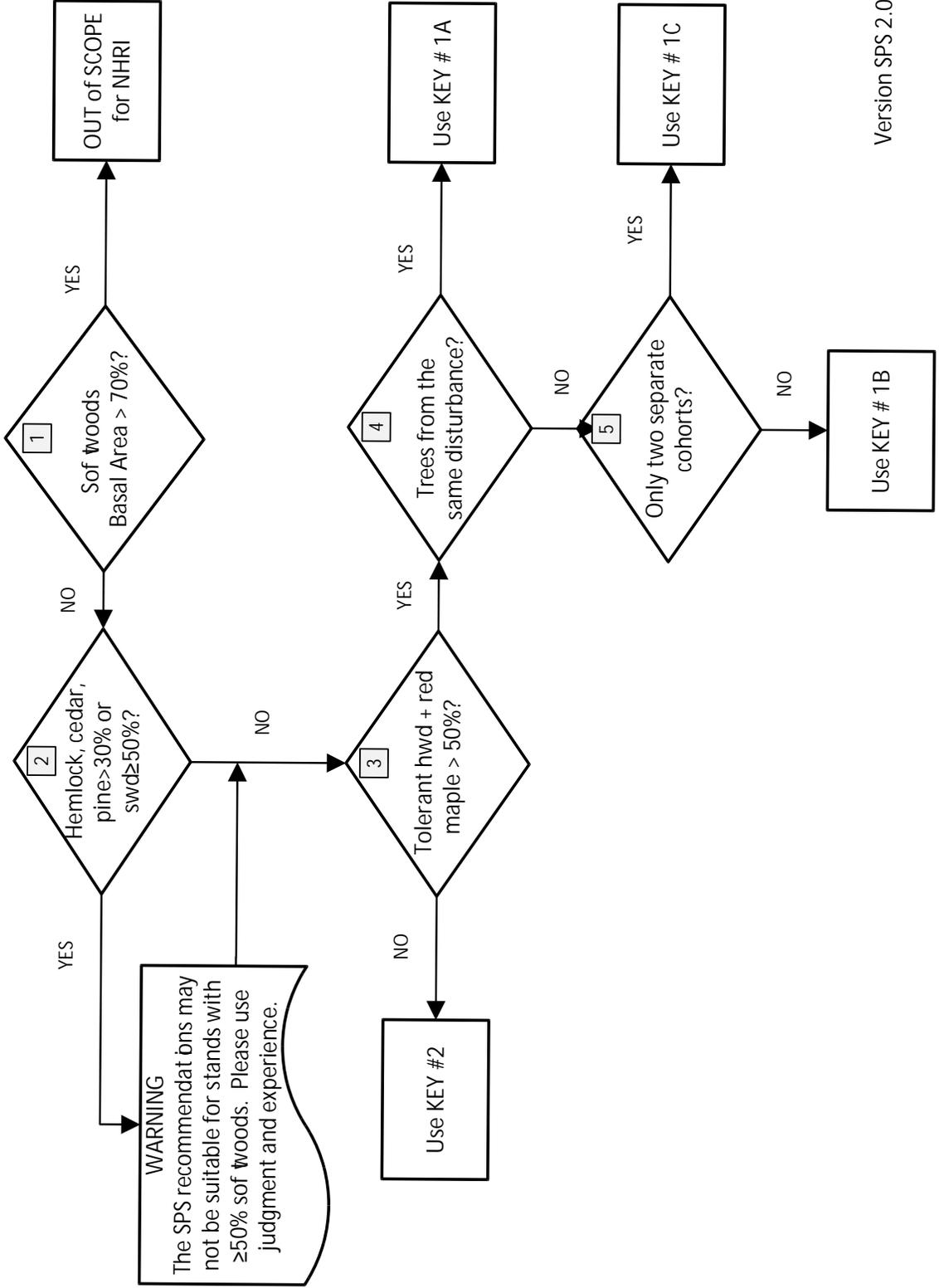
Appendix I

SPS Implementation Tools

Master Key

NHRI Silviculture Prescription System (SPS) Master Key

START



Appendix II

SPS Implementation Tools

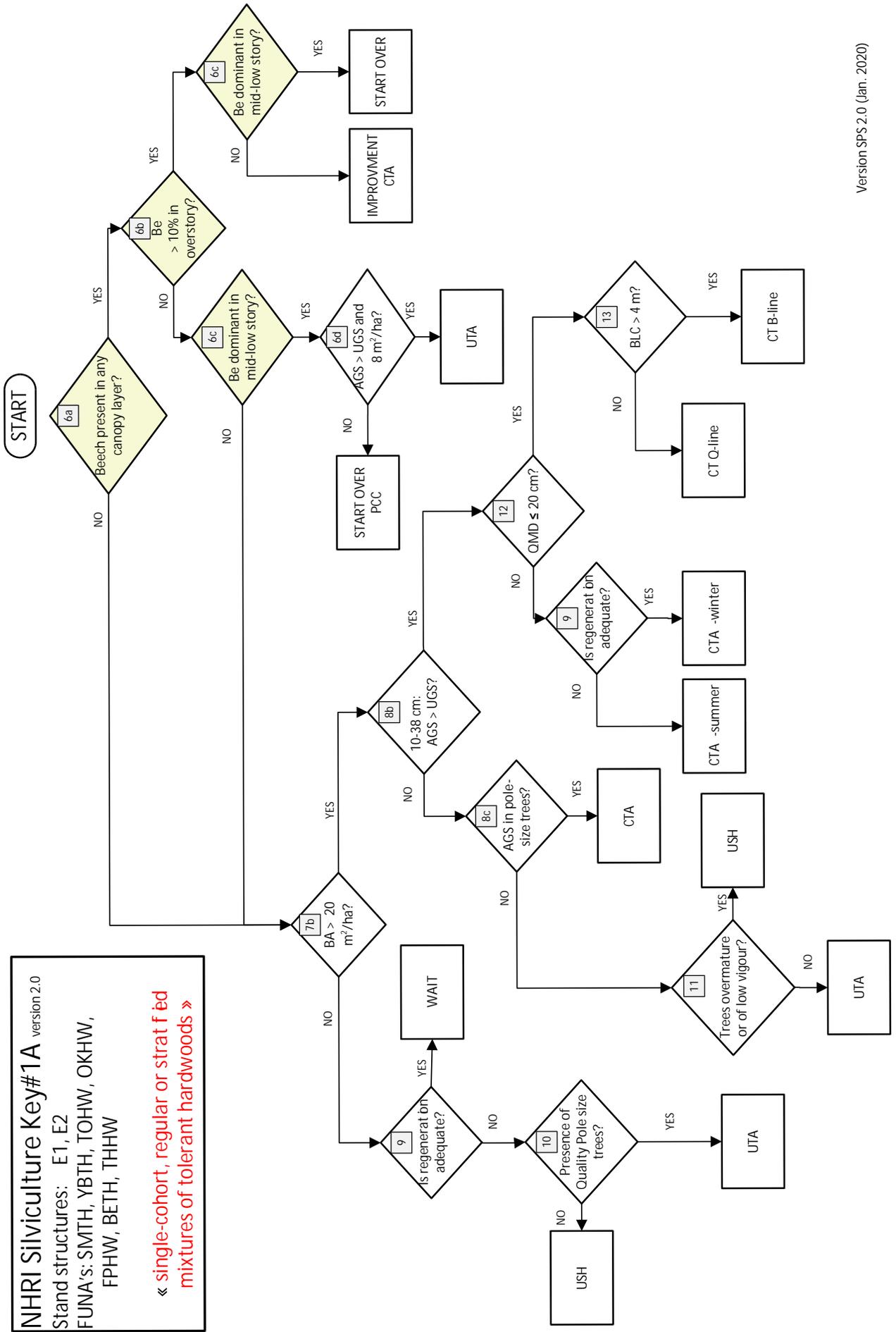
Treatment Keys

NHRI Silviculture Key#1A version 2.0

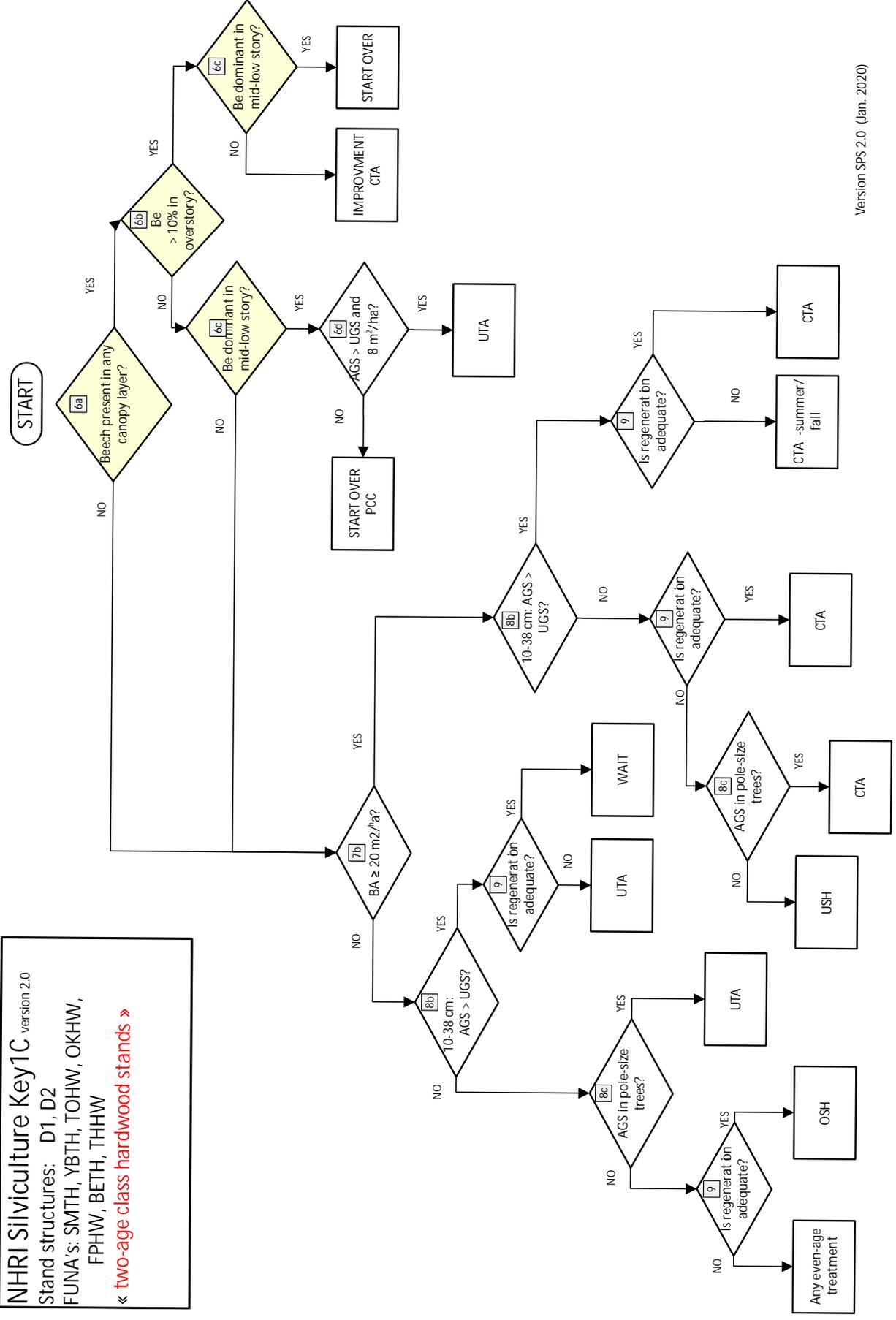
Stand structures: E1, E2

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

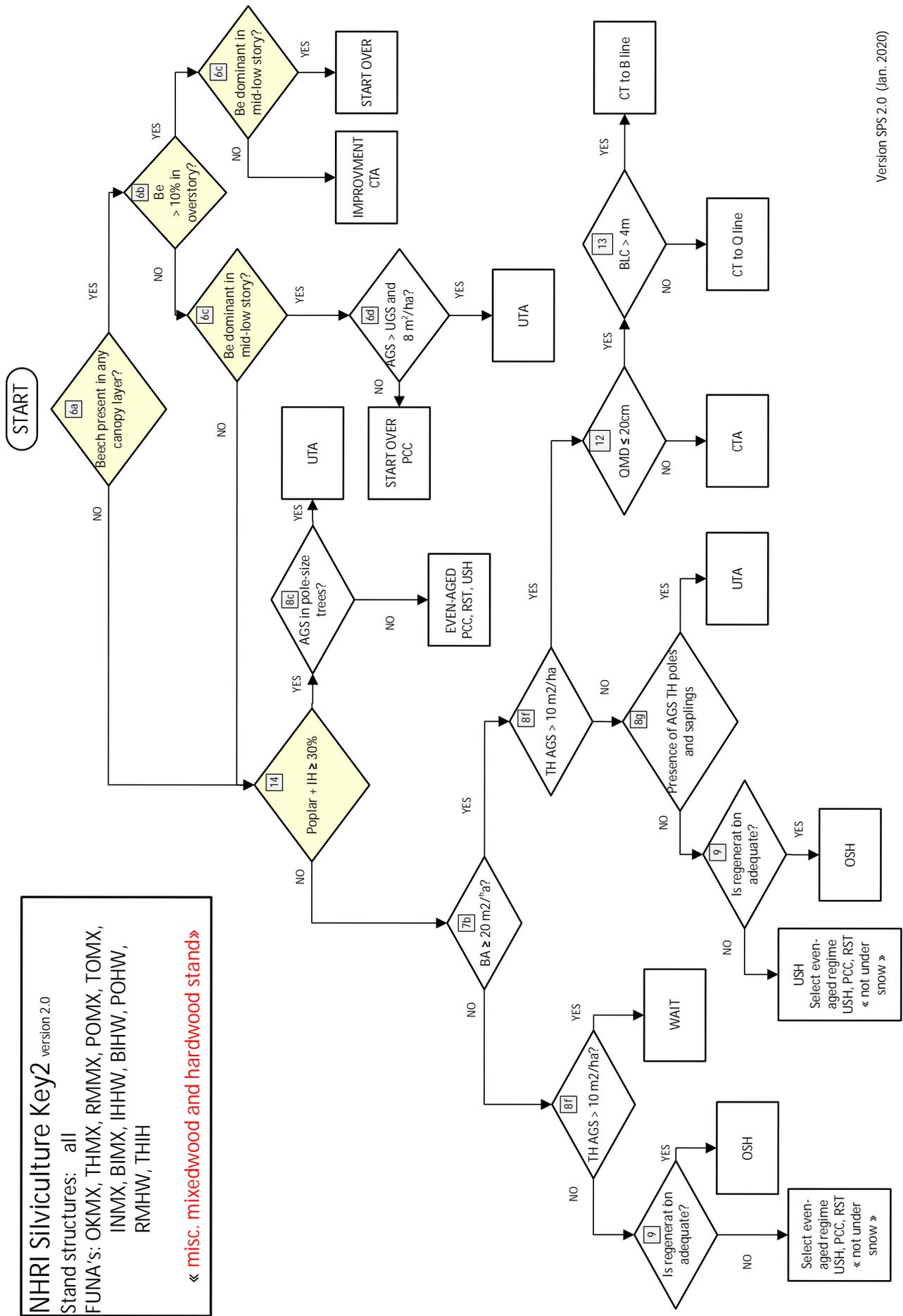
« **single-cohort, regular or stratifed mixtures of tolerant hardwoods** »



NHRI Silviculture Key1C version 2.0
 Stand structures: D1, D2
 FUNA's: SMTH, YBTH, TOHW, OKHW,
 FPHW, BETH, THHW
 « two-age class hardwood stands »



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** »

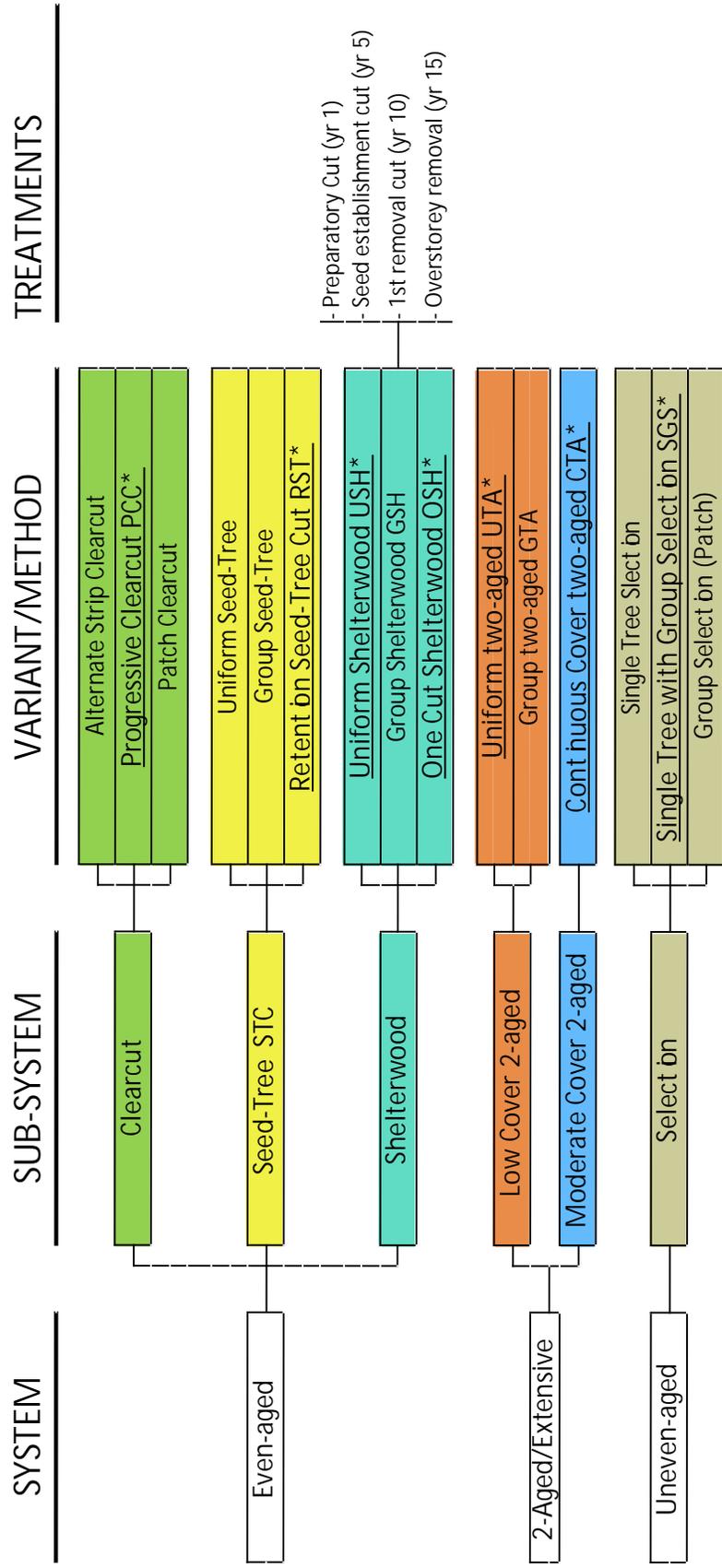


Appendix III

SPS Implementation Tools

Framework and Tearsheets

The hierarchy of the NHRI silviculture framework



* Most common, used in strategic planning



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
<ul style="list-style-type: none"> • Creation of progressive strips in the stand. • Creation of germination beds • Abundance of seeds for germination • Adequate soil exposure • No site damage • No valuable trees at risk left standing 	<ul style="list-style-type: none"> • Recruitment of new cohort of desired species • Low competition by interfering plants • Good seedling survival • Low tree mortality 	<ul style="list-style-type: none"> • Full stocking of seedlings and saplings • Low competition and High relative stand density to allow for quality development • 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

	Preferred	Tolerated	Avoid
Full Tree System	X		
CTL System		X	
Leaves Off	X	X	
Frozen Ground		X	

Getting Started

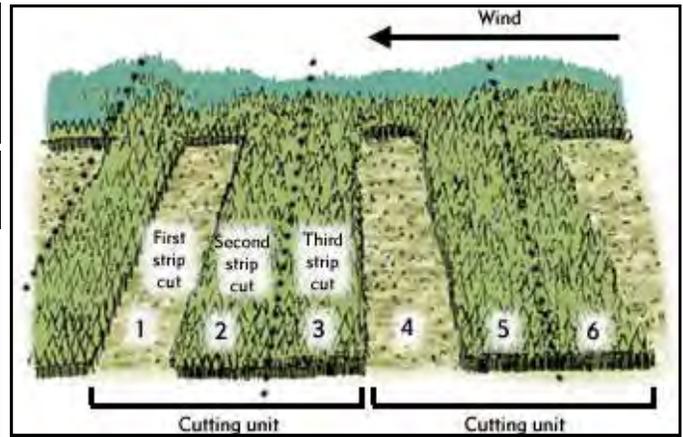
- Select the # of strips required (function of # entries desired)
- Plan treatments in a good seed year and in the proper season
- Determine the right strip width according to species (see table below)
- When possible, orient strips so that they are mostly perpendicular to dominant winds but avoid prolonged 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 m ² /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 Year 10:: cut 2nd strip Year 20: cut final strips Width: 1.5 x tree height (20-30 m average width depending on tree height)

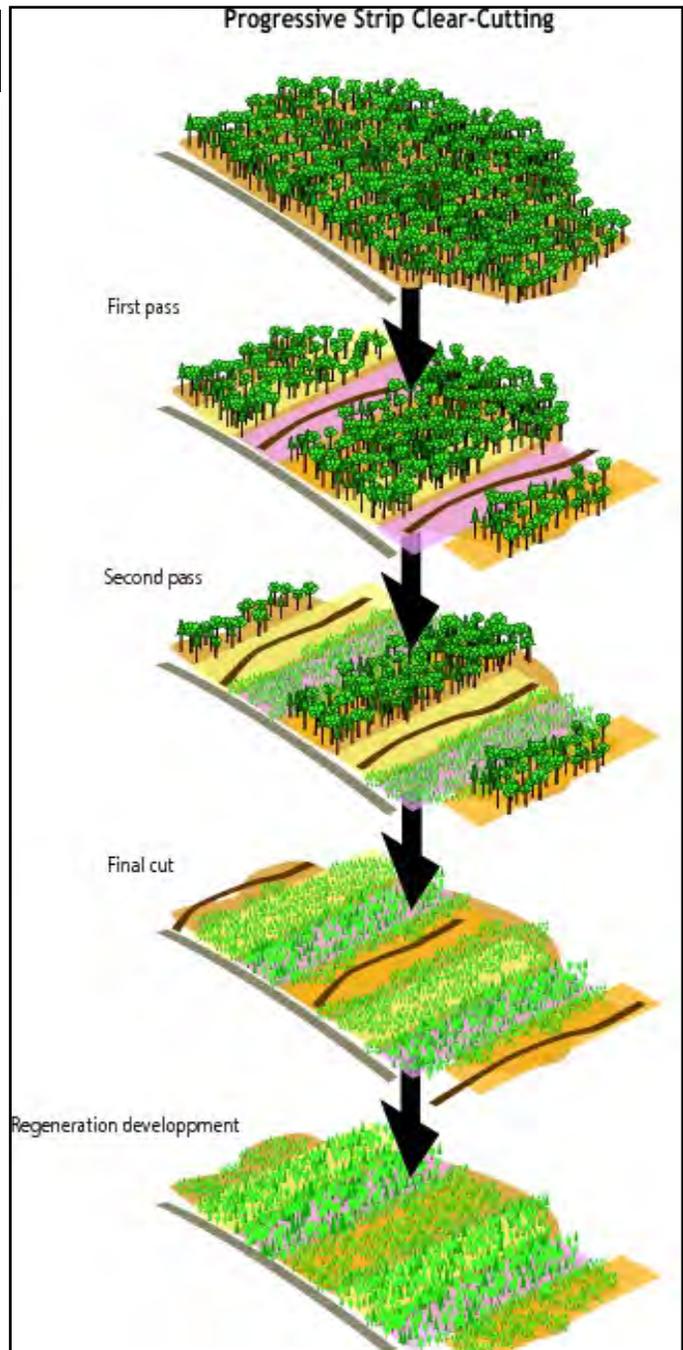
Additional Considerations

- Put emphasis on the creation of seed germination beds.



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

Progressive Strip Clear-Cutting



Source: CERFO

Version SPS 2.0 (Jan. 2020)



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 seed dissemination 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
<ul style="list-style-type: none"> • Acceptable amount of quality seed trees throughout the block • Creation of germination beds • Abundance of seeds for germination • Adequate Soil exposure • No site damage 	<ul style="list-style-type: none"> • Recruitment of new cohort of desired species • Low competition by interfering plants • Good seedling survival 	<ul style="list-style-type: none"> • Full stocking of seedlings and saplings • Low competition • High density to allow for quality development • 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

	<u>Preferred</u>	<u>Tolerated</u>	<u>Avoid</u>
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)

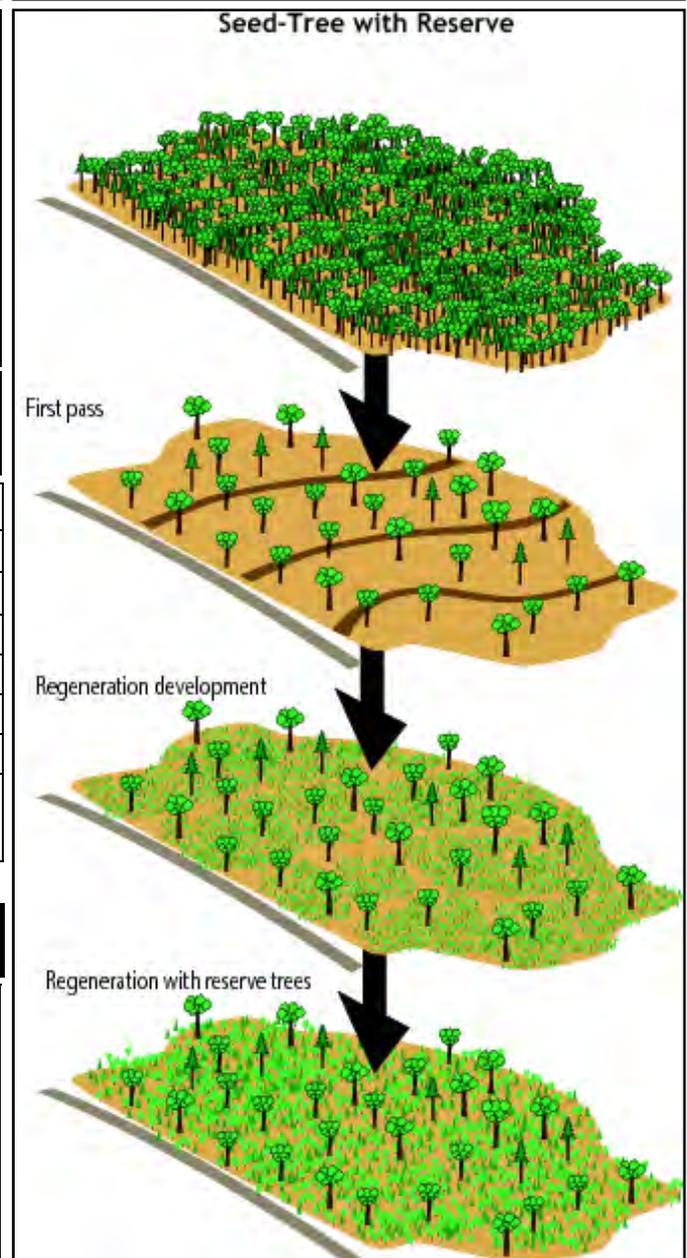
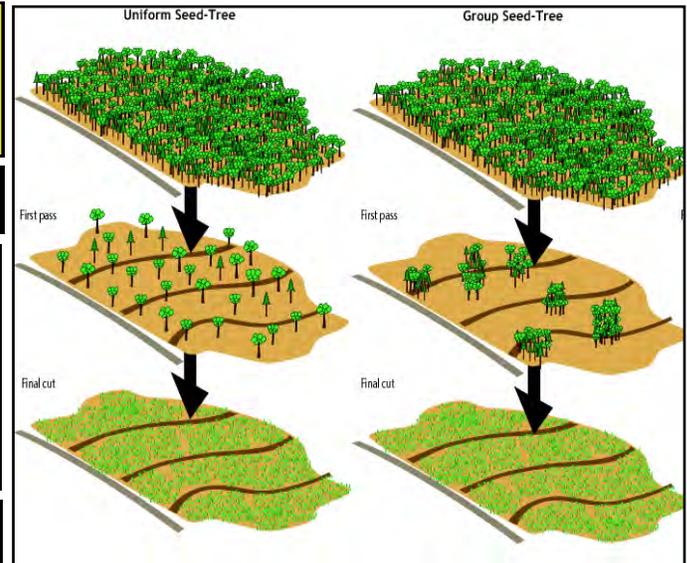
Average Distance of Dissemination of Seeds by Species (Source: Guide Sylvicole du Québec)

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



Variant/Treatment:

UNIFORM SHELTERWOOD

USH

System:
EVEN-AGED

Sub-system:
SHELTERWOOD

Stand Eligibility			Treatment Objectives			Description		
<ul style="list-style-type: none"> • 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 			<p>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.</p> <p>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.</p> <p>The general considerations in the application of the shelterwood system are:</p> <ul style="list-style-type: none"> • 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. 			<p>The system is implemented in 1 to 4 stages, each with specific objectives and characteristics:</p> <ul style="list-style-type: none"> • 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 <p>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.</p>		
Desired Outcomes			Key Success Factors					
Immediate	Mid-term	Long-term	<p>Seedling establishment cut</p> <ul style="list-style-type: none"> • Adequate mineral soil exposure • Planned on a good seed year • Even distribution of residual trees <p>Overstory removal (as above +)</p> <ul style="list-style-type: none"> • Timed when regeneration is established but < 2m tall • Snow cover preferred 					
<ul style="list-style-type: none"> • Creation of openings in canopy • Creation of germination beds • Abundance of seeds for germination • Adequate Soil exposure • No site damage 	<ul style="list-style-type: none"> • Recruitement of new cohort of desired species • Sheltered seedlings by residual trees • Good seedling survival • OSR planned before regeneration is too tall 	<ul style="list-style-type: none"> • Full regeneration and sapling stocking • Low competition by residual trees • High density to allow for quality development 						

IMPLEMENTATION

UNIFORM SHELTERWOOD

USH

Operational Considerations

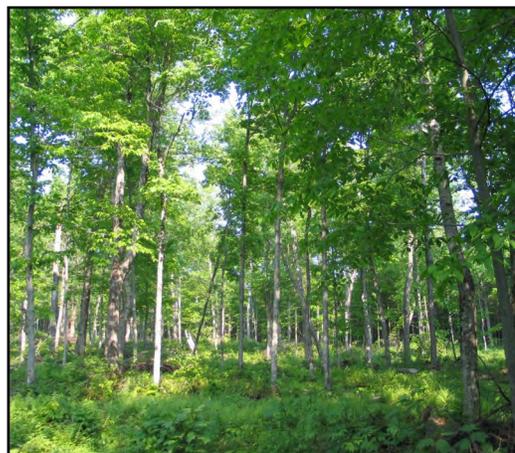
	Preferred	Tolerated	Avoid
Full Tree System	X		
CTL System		X	
Leaves Off	X	X	
Frozen Ground			X
High Trail Footprint (>20% ratio)		X	

Getting Started

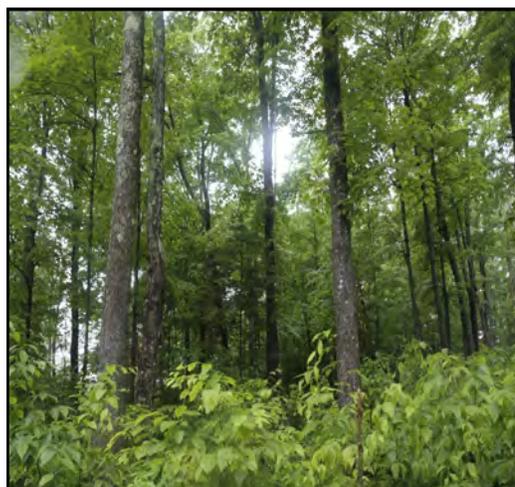
- Plan treatment in a good seed year and in the proper season (spring, summer, fall)
- If possible, use a harvesting system that will prepare germination substrates (MFT or CTL plus scarification)
- Determine the right residual Basal area target for desired species (8-10 m²/ha)
- Decide if a preparatory cut is needed to make seed trees more vigorous
- 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

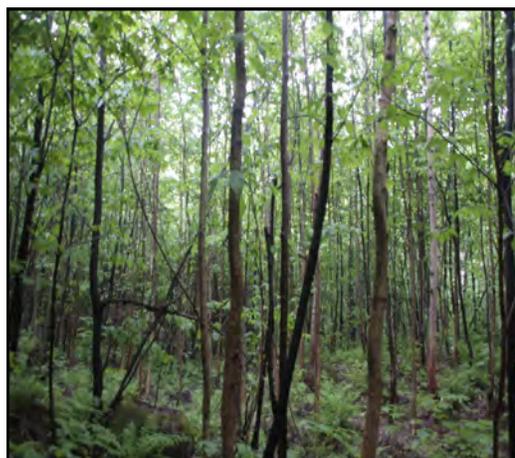
Residual Density in Selection Strip:	8-10 m ² /ha
Cut Priority:	Cut all trees >48cm, trees with high grade products at risk and those from the UGS group
Cutting Instructions:	saplings (<10cm) : protect AGS small (10-22cm): 1/3 medium (22-38cm): 1/2 large (38-48cm): 1/1 very large (>48cm): all



Seedling establishment cut (courtesy 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**



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 overstorey 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:

- Overstorey 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 overstorey 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 losing 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

Key success factors

Immediate	Mid-term	Long-term
<ul style="list-style-type: none"> • Release of established regeneration of desired species • Adequate stocking of healthy regeneration • No site damage • Maintenance of small quality trees 	<ul style="list-style-type: none"> • Good seedling survival • High stocking and low competition on saplings of desired species (>2000/ha) • High vigour and quality of regeneration • Free-to-grow saplings and small trees of desired species 	<ul style="list-style-type: none"> • Full stocking (between A and B lines of stocking diagram) of commercial species • High AGS/UGS ratio

- 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



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

Operational Considerations

	Preferred	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 likelihood 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

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 small (10-22cm): 1/2 medium (22-38cm): all large (38-48cm): all 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.



Variant/Treatment:

UNIFORM 2-AGED/EXTENSIVE

UTA

System:
Two-aged/Extensive

Sub-system:
Low Cover 2-Aged

Stand Eligibility			System Objectives			Description		
<ul style="list-style-type: none"> • 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 			<p>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.</p> <p>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.</p> <p>The re-entry after the first treatment is extended (30-35 years).</p>			<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>		
Desired Outcomes						Key Success Factors		
Immediate		Mid-term		Long-term		<ul style="list-style-type: none"> • Manage light in order to: <ul style="list-style-type: none"> • 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 		
<ul style="list-style-type: none"> • Acceptable amount of quality residual trees throughout the block • Creation of germination beds • Abundance of seeds for germination • Adequate Soil exposure • No site damage (i.e. ruts) • No residual trees at risk • Quality pole-sized trees released on 3 sides 		<ul style="list-style-type: none"> • Recrutement of new cohort of desired species • Low competition by interfering plants • Good seedling survival of desired species • Moderate B.A. in vigorous residual trees • No residual trees at risk 		<ul style="list-style-type: none"> • Full stocking of seedlings and saplings • Low competition • Two distinct cohorts of crop trees • No loss of merchantable volume 				

IMPLEMENTATION

UNIFORM 2-AGED/EXTENSIVE

UTA

Operational Considerations

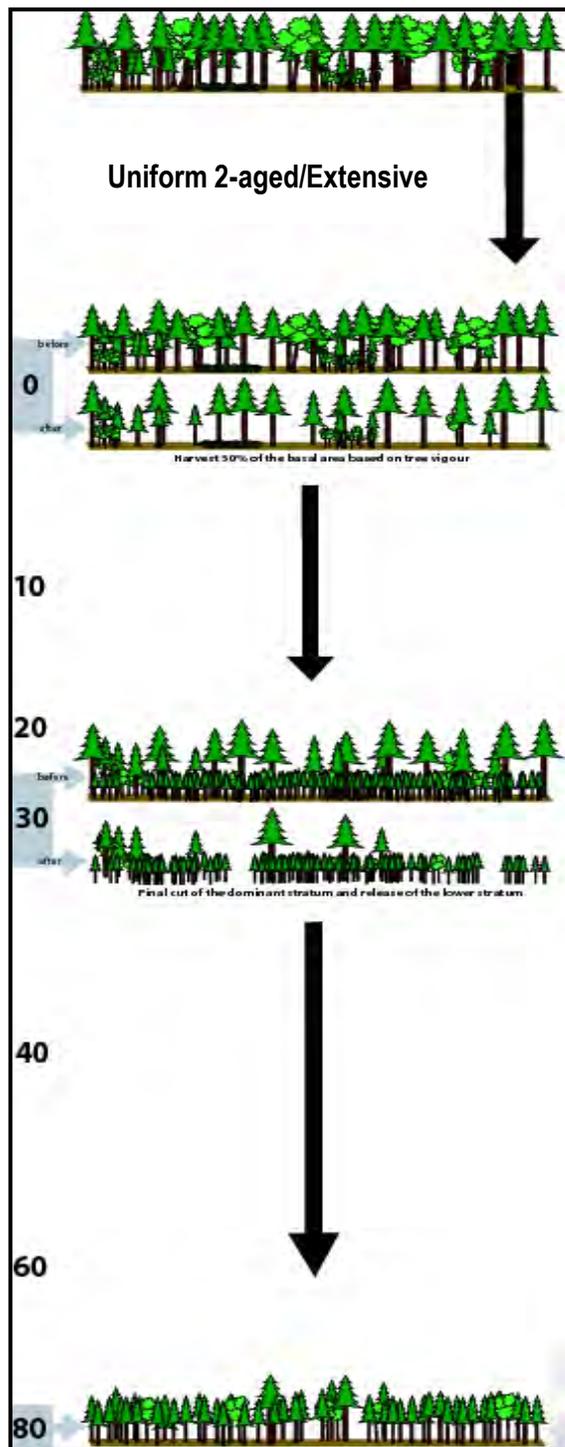
	Preferred	Tolerated	Avoid
Full Tree System	X		
CTL System		X	
Leaves Off	X	X	
Frozen Ground		X	
Outside Sap Season	X		

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 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:	8-12 m ² /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 small (10-22cm): 1/4 medium (22-38cm): 1/2 large (38-48cm): 2/3 very large (>48cm): all 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



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
<ul style="list-style-type: none"> • Acceptable amount of quality residual trees throughout the block • Creation of germination beds • Abundance of seeds for germination • Adequate soil exposure • No site damage (i.e. ruts) • No residual trees at risk • Released quality pole-sized trees 	<ul style="list-style-type: none"> • Recruitement of new cohort of desired species • Low competition by interfering plants • Good seedling survival of desired species • Moderate B.A. in vigorous residual trees • No residual trees at risk 	<ul style="list-style-type: none"> • Full stocking of seedlings and saplings • Low competition • Healthy mature strata • 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 whether trails will be re-used

IMPLEMENTATION

CONTINUOUS COVER 2-AGED/EXTENSIVE

CTA

Operational Considerations

	Preferred	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 m ² /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 small (10-22cm): 1/4 medium (22-38cm): 1/2 large (38-48cm): 1/2 very large (>48cm): all openings <0.2 ha

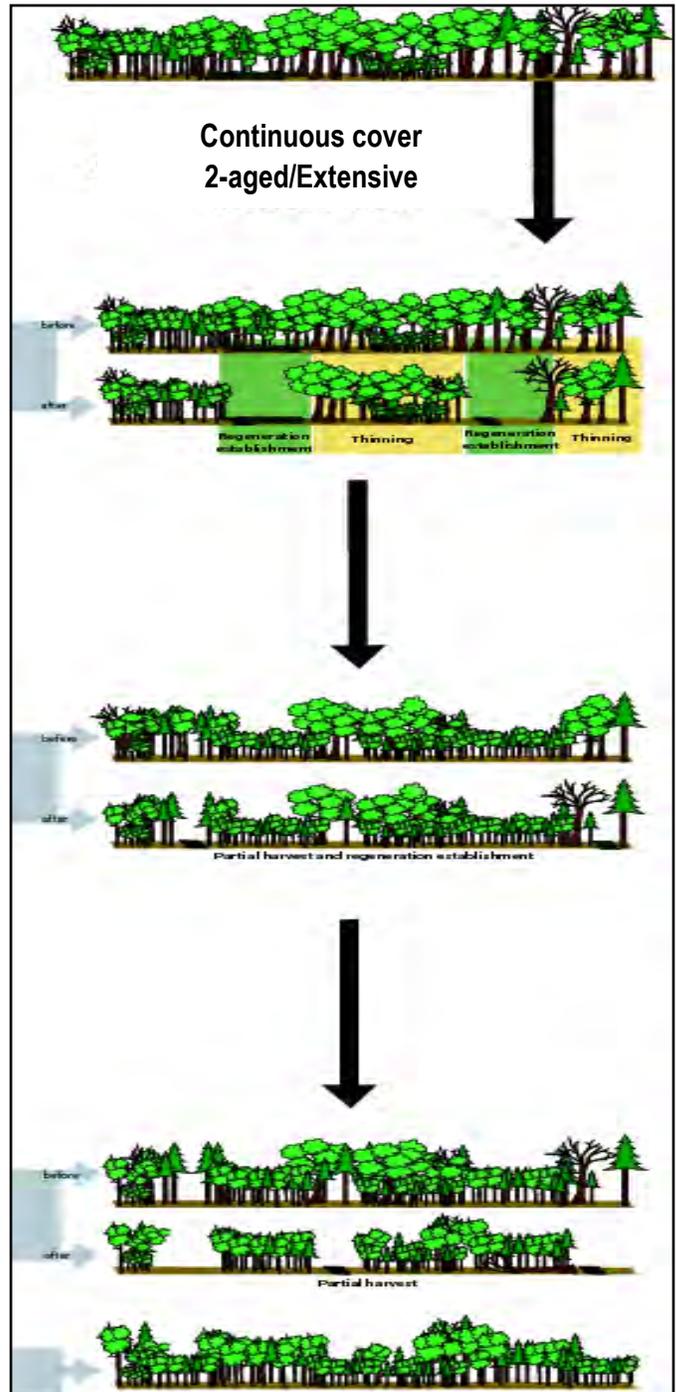


Image Source: CERFO

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



Method/Treatment:

SINGLE-TREE WITH GROUP SELECTION

System:
UNEVEN-AGED

Sub-system:
SELECTION

SGS

Stand Eligibility	Treatment Objectives	Description
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- **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

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

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	Key Success Factors
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Immediate	Mid-term	Long-term
<ul style="list-style-type: none"> • BA>16m²/ha • AGS>UGS • <5% crop trees damaged • Crop trees released on 2-3 sides • No site damage (i.e. ruts) 	<ul style="list-style-type: none"> • Recruitment of new cohort • Healthy crowns • Diameter growth • Reduction of risk trees 	<ul style="list-style-type: none"> • High Basal Area • AGS>75% • R1, R2 trees >75% • Sm, Yb >75% • Balanced age/DBH structure

- 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

SINGLE-TREE WITH GROUP SELECTION

SGS

Operational Considerations

	Preferred	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:	17-18m ² /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 small (10-22cm): 1/4 medium (22-38cm): 1/4 large (38-48cm): 1/2 very large (>48cm): all openings <0.2 ha

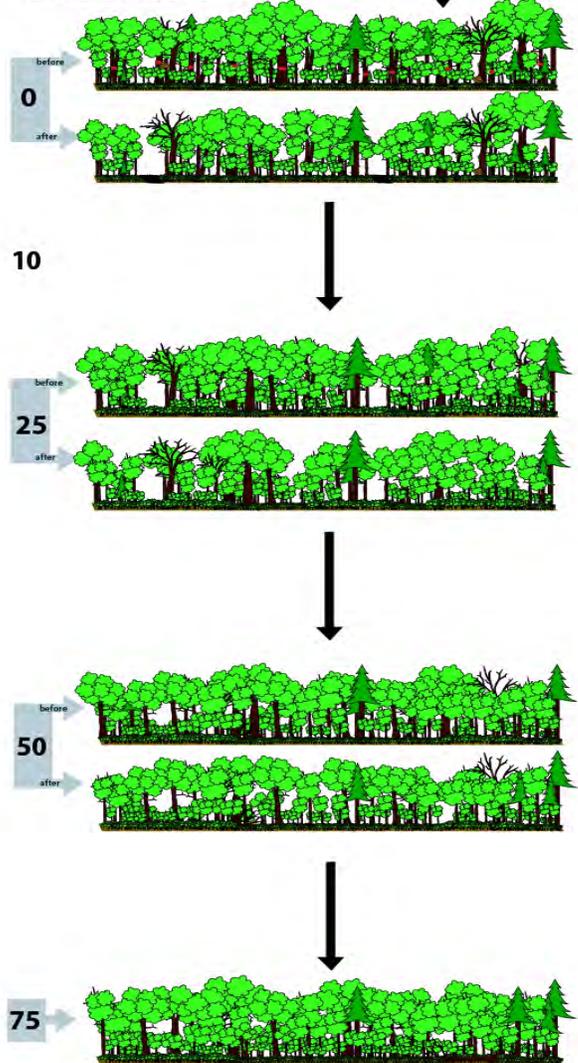


Single tree selection*

Goals:

- Regeneration establishment
- Stand education
- Single tree selection harvest
- Establish or maintain a balanced structure

*Cutting cycle of 25 years and harvest intensity of 25 %



CERFO Schéma: Simon Fortlec, Ing.Š. CERFO 2013

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



COMMERCIAL THINNING

Intermediate Treatment

CT

Stand Eligibility	Treatment Objectives	Description
<ul style="list-style-type: none"> • 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 	<p>Commercial 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.</p> <p>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.</p> <p>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.</p>	<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>

Desired Outcomes			Key Success Factors
Immediate	Mid-term	Long-term	
<ul style="list-style-type: none"> • Well stocked stand of crop trees after treatment • Crop trees released on 3 sides • Low damage on residual trees • Increased proportion of desired species and AGS • No site damage • Reduced proportion of trees at risk 	<ul style="list-style-type: none"> • Increased growth on crop trees • Low competition by interfering plants • Good development of crowns on crop trees • Low tree mortality 	<ul style="list-style-type: none"> • High proportion of sawtimber • Clear boles (5m) on elite trees • Stand ready for other intermediate treatment 	<ul style="list-style-type: none"> • 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

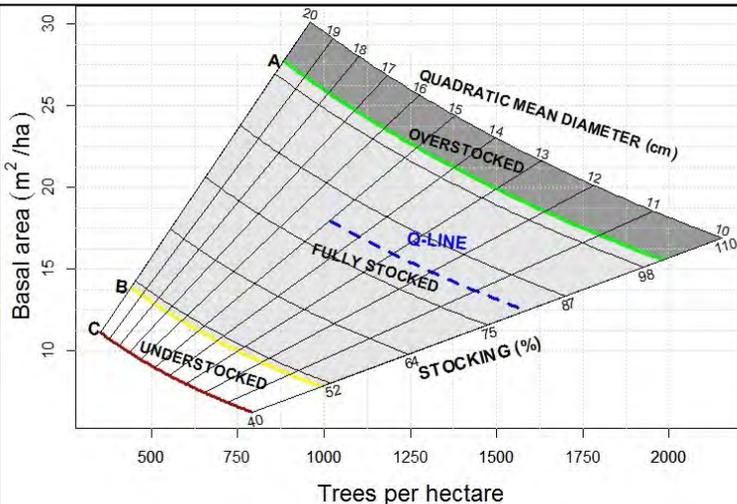
CT

Operational Considerations

	Preferred	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 eligibility
- Decide on the thinning type based on management 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 14m ² /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 Small (10-22cm): 1/4 Medium (22-38cm): 1/4 Large (38-48cm): all Very Large (>48cm): all 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 <i>where the existing stand is not acceptable</i> in terms of species composition, stocking and quality and, <u>does not contain quality pole size trees</u>
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 (preferred), CTL (adapted to increase scarification)
#2 - Harvest Season	Spring, Summer, Fall (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 Year 10: cut 2 nd strip Year 20: cut final strips width: 1.5 X tree height (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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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.



NHRI SPS - Work Instructions

(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 <i>where the existing stand is not acceptable</i> in terms of species composition, stocking and quality and, <u>does not contain quality pole size trees</u>
VARIANTS	(RST) Retention Seed-Tree Cut
GOALS	Regeneration of new cohort through the <u>permanent</u> retention of seed trees of desired species in clumps

(RST) IMPLEMENTATION SEQUENCE

#1 - Harvesting System	MFT (preferred), CTL (adapted to increase scarification)
#2 - Harvest Season	Spring, Summer, Fall (see Note 1 & Note 2)
#3 - Trail Network	5 wide and 15m center to center or, 6m wide and 16m center to center (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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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 <i>where the existing stand is not acceptable</i> 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 (preferred), CTL (adapted to increase scarification)
#2 - Harvest Season	Spring, Summer, Fall (see Note 2 & Note 3)
#3 - Trail Network	5m wide and 15m center to center or, 6m wide and 16m center to center (Trail ratio: 33%-38%)
#4 - Green/Treatment Strip	Residual Basal Area: 8-10m 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 small (10-22cm): 1/3 medium (22-38cm): 1/2 large (38-48cm): 1/2 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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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 to 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 <i>where the existing stand is not acceptable</i> 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 substantial removal of overstory in stands to protect and release well established and desirable regeneration but with unacceptable merchantable status

(OSH) IMPLEMENTATION SEQUENCE

#1 - Harvesting System	All
#2 - Harvest Season	Winter (under snow) (see Note 2)
#3 - Trail Network	5m wide and 25m center to center or, 4m wide and 20m center to center (Trail ratio: 20%)
#4 - Green/Treatment Strip	Residual Basal Area: <math><5m^2/ha</math>
#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 small (10-22cm): 1/2 medium (22-38cm): all large (38-48cm): all 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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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 stand 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 (preferred), CTL (adapted to increase scarification)
#2 - Harvest Season	Fall, early Summer when beech present (see Note 2)
#3 - Trail Network	5m wide and 15m center to center or, 6m wide and 16m center to center (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 small (10-22cm): 1/4 medium (22-38cm): 1/2 large (38-48cm): 2/3 very large (>48cm): all 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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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 stand 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 (preferred), CTL (adapted to increase scarification)
#2 - Harvest Season	Fall, Winter, early Summer when beech present (see Note 2)
#3 - Trail Network	5 wide and 20m center to center or, 4m wide and 18m center to center (Trail ratio: 22%-25%)
#4 - Green/Treatment Strip	Residual Basal Area: 14-16m 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 small (10-22cm): 1/4 medium (22-38cm): 1/2 large (38-48cm): 1/2 very large (>48cm): all 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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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

(SGS) Single Tree 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 (see Note 2)
#3 - Trail Network	5 m wide and 25m center to center or, 4m wide and 20m center to center (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 small (10-22cm): 1/4 medium (22-38cm): 1/4 large (38-48cm): 1/2 very large (>48cm): all 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 recommendations.

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 (see Note 2)
#3 - Trail Network	5m wide and 25m center to center or, 4m wide and 20m center to center (Trail ratio: 20%)
#4 - Green/Treatment Strip	Residual Basal Area: 14m 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 small (10-22cm): 1/4 medium (22-38cm): 1/4 large (38-48cm): all very large (>48cm): all 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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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 (see Note 2)
#3 - Trail Network	5m wide and 25m center to center or, 4m wide and 20m center to center (Trail ratio: 20%)
#4 - Green/Treatment Strip	Residual Basal Area: 14m 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 small (10-22cm): 1/4 medium (22-38cm): 1/4 large (38-48cm): all very large (>48cm): all 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 recommendations.

IMPLEMENTATION SEQUENCE: First choose harvesting system (#1) and harvest season (#2). Select a trail network (#3), then 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



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: _____



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: _____



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 (8-10m²/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: _____



ONE-CUT SHELTERWOOD		OSH
GENERAL INFORMATION		
Block #: _____	NOTES: _____	
Date: _____		
STAND ELIGIBILITY		
Conditions within the block were suitable for the treatment:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Block was not too variable where further stratification was needed:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Notes: _____		
TRAIL PATTERN/PLANNING		
Block is uniformly covered with trails:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Trail spacing: 4m wide/20m center to center or, 5m wide/25m center to center:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Recommended harvest system (All):	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Recommended season (Winter-under snow):	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Notes: _____		
DESIRED SHORT-TERM OUTCOMES		
The block is free of site and environmental damage:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Forest floor was lightly scarified to create germination substrate:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Quality residual trees are free of damage from operation:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
All Trees > 22cm removed:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Pole size trees and saplings are present:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
No large trees with quality products are left (except for wildlife habitat purposes):	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Minimum basal area (5m ² /ha) was kept in the treated strip:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Tree selection was conducted to increase AGS/UGS ratio:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
ASSESSMENT		
Treatment - Pass or Fail : _____		
Preventive Measures/Improvements: _____		
Corrective Measures: _____		



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 (8-10m²/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: _____



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: _____



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: <input type="checkbox"/> False: <input type="checkbox"/>	
Block was not too variable where further stratification was needed:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Notes: _____	_____	
_____	_____	
TRAIL PATTERN/PLANNING		
Block is uniformly covered with trails:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Trail spacing: 4m wide/20m center to center or, 5 m wide/25m center to center:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Recommended harvest system (All):	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Recommended season (Fall, Winter):	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Are openings < 0.2 ha:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Notes: _____	_____	
DESIRED SHORT-TERM OUTCOMES		
The block is free of site and environmental damage:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Quality pole-sized trees are released on 3 sides:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Forest floor was lightly scarified to create germination substrate:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Quality residual trees are free of damage from operation:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
No large trees with quality products are left (except for wildlife habitat purposes):	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Minimum Basal Area (17-18m ² /ha) was kept in the treated strip:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
Tree selection was conducted to increase AGS/UGS ratio:	True: <input type="checkbox"/> False: <input type="checkbox"/>	
ASSESSMENT		
Treatment - Pass or Fail : _____		
Preventive Measures/Improvements: _____		

Corrective Measures: _____		



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 (14m²/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: _____

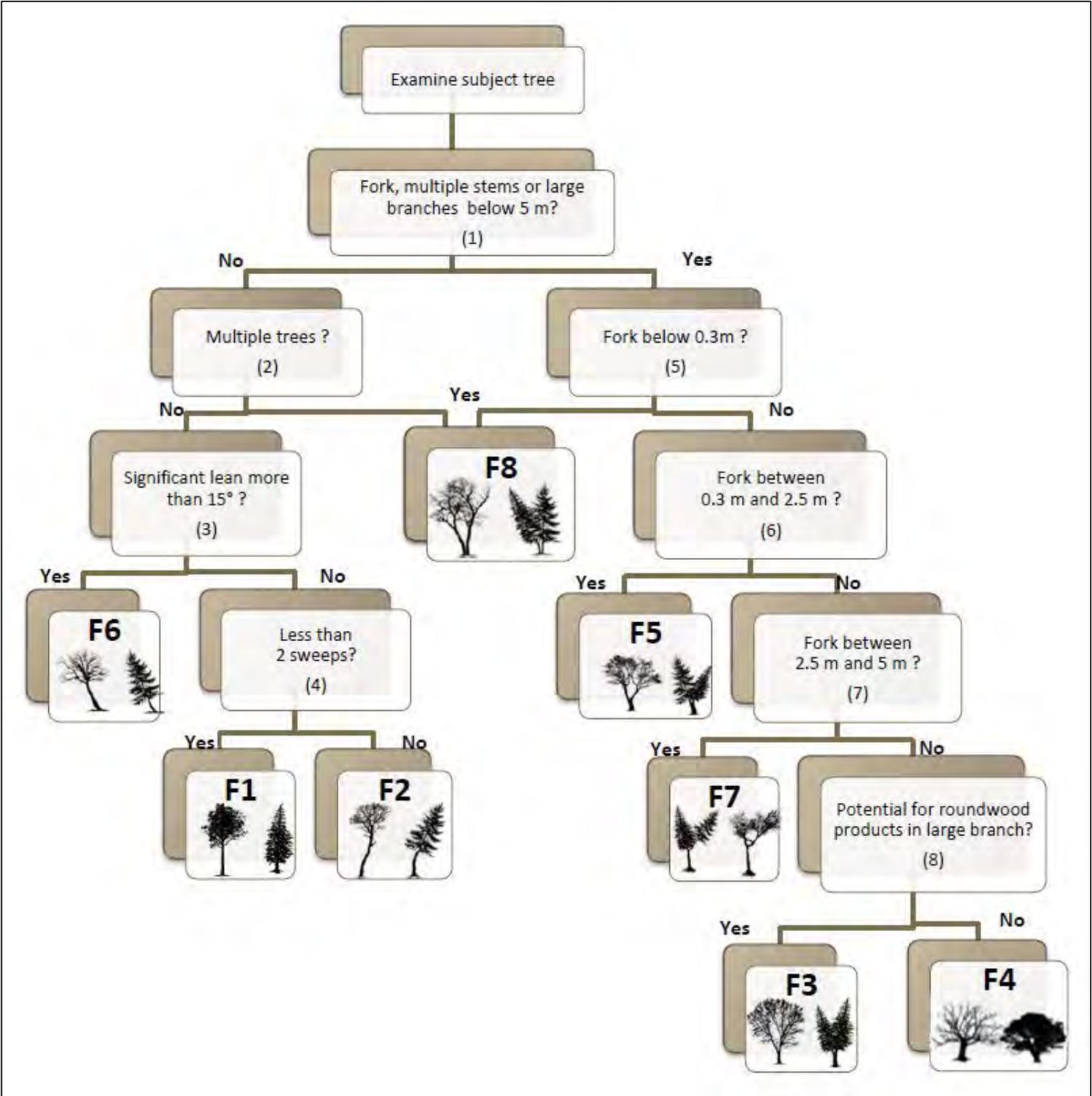
Corrective Measures: _____

Appendix VI

SPS Implementation Tools

Tree Classification System
and AGS/UGS Matrix

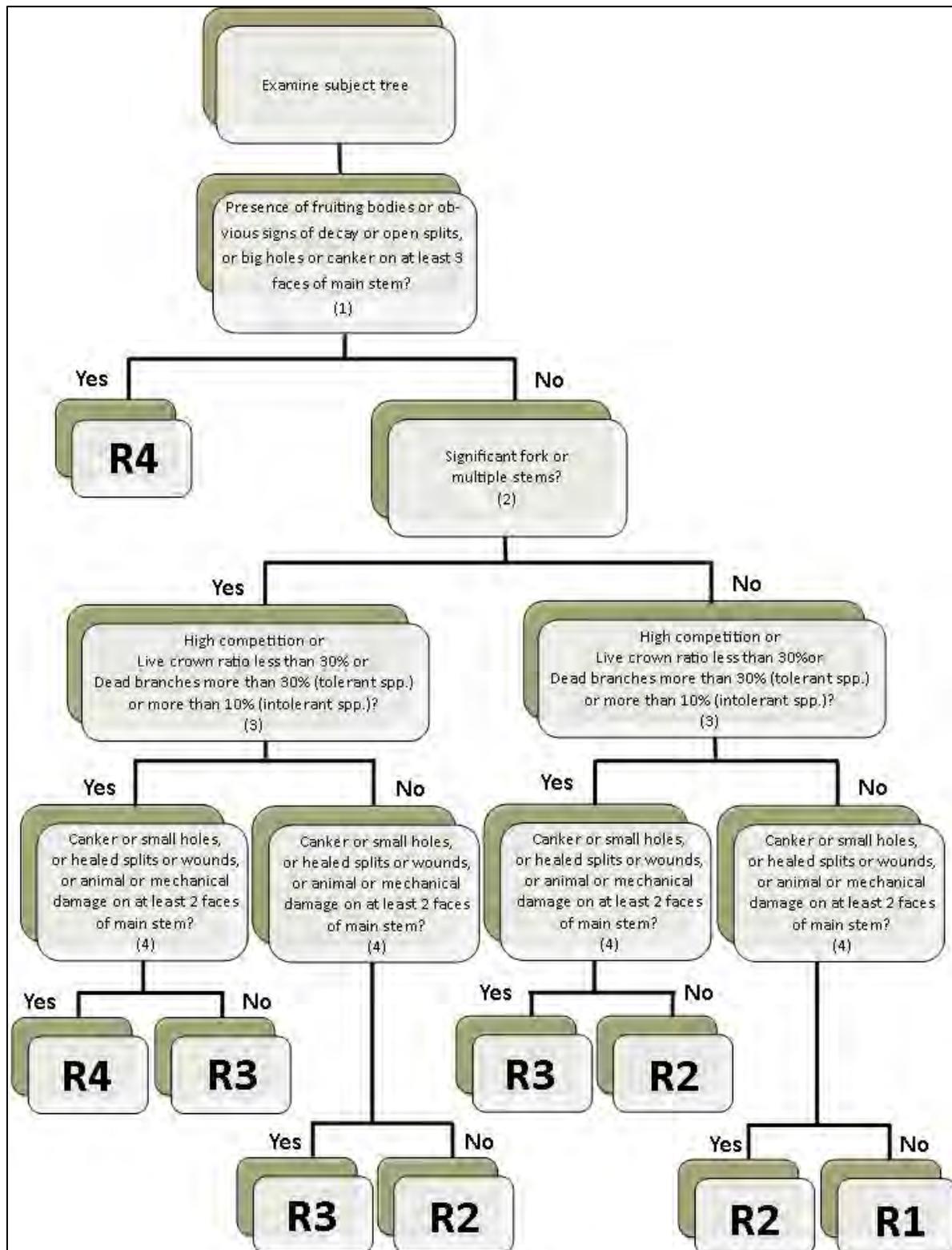
Tree Form Determination Key



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 Potentially carrying roundwood products
F4		Single stem, large branches below 5 m	N/A	N/A	Presence of large branches 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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Northern Hardwoods Research Institute Inc.

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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