Family Forest Network

Restoration Silviculture Project

Technical Note #S2

Restoration Thinning Specifications

January 2024

Kevin Keys, PhD, RPF
FFN Project Scientist

Ryan Dickie
FFN Forest Operations Coordinator

Patricia Amero, RPF
WWSC General Manager

Peter Neily, RPF
FFN Consultant Project Scientist

Background

Under the general guidance of ecological forestry recommendations contained in *An Independent Review of Forest Practices in Nova Scotia* (Lahey 2018) the Family Forest Network (FFN) is working with partners, landowners, and contractors to demonstrate and document the costs and benefits of implementing ecologically sensitive harvest treatments on small private woodlands across a wide range of forest conditions. Results will be used to refine or develop management guidelines and tools for small private woodland owners, and to inform provincial policies related to ecological forest management.

As an addition to this project, the FFN has signed an agreement with the Nova Scotia Department of Natural Resources and Renewables (Department) to include research into restoration-oriented silviculture treatments that are not currently supported by provincial silviculture policy or funding. The main goals of this research are:

- To promote the establishment and/or growth of site appropriate, long-lived, shade-intermediate, and shade-tolerant (LIT) tree species.
- To help restore appropriate species mixes and stand structure on sites where past management may have been inappropriate or unsuccessful.
- To investigate new ways to use silviculture interventions to simultaneously address concerns about (i) future growth and value of the forest resource, (ii) biodiversity, (iii) climate adaptation, and (iv) carbon management.

Three treatments have been chosen for investigation: (i) Restoration Thinning – both manual and machine applications, (ii) Understory Thinning, and (iii) Understory Planting (Keys et al. 2023). This Technical Note outlines and discusses requirements related to Treatment 1 – Restoration Thinning.

Restoration Thinning

Restoration Thinning (RT) – *A combination of pre-commercial thinning (PCT) and weeding of relatively even-aged, juvenile stands that are beyond the height criteria for current PCT funding (7 m for softwoods and 9 m for hardwoods)*.

Objective: The goal of this treatment is to reduce overall stem density in these “too tall” stands while favouring LIT crop trees that can (i) provide increased economic value, (ii) provide more management options for continued restoration, and (iii) be more resilient to climate impacts by promoting species diversity and wind-firmness in residual trees.

Overview: There are many stands that are beyond the height criteria for current PCT funding, but which would benefit from tending operations that speed up the transition to more desirable conditions. However, because trees in these more developed stands are (on average) larger than those associated with typical PCT operations, and stand conditions are often more variable, RT will require a different treatment approach and operator skill set than traditional PCT work. For example, the use of both spacing saws and chainsaws will likely be needed for treatment efficiency, while some areas within a stand may require more or less intervention to reduce costs while still meeting overall treatment objectives (i.e., a non-uniform treatment). There is also a mechanical option for this type of treatment which will be explored and compared with manual treatments.

Ecological Considerations: In keeping with ecological management approaches, all sites being considered for treatment must be accurately assessed and mapped for ecosystem conditions: vegetation type (VT), soil type (ST), and especially ecosite. This requires FEC classification (Neily et al. 2023) at plot locations and recording of FEC transitions and inclusions between plots (as needed). It may be difficult to fully classify VT in stands less than 40 years old, but ST and ecosite can be assessed regardless of stand age based on direct measurement of ST and assessment of site features that provide enough information to at least classify vegetation to the Forest Group level. Classification of ecosite and VT (or Forest Group) allows tree species and successional development targets to be determined before treatment which, in turn, informs treatment prescriptions and measures of success.

In addition, all sites will receive a desktop biodiversity assessment along with onsite assessment of biodiversity features as part of pre- and post-treatment survey work. Onsite assessment will include identification of ecological growing stock (EGS), presence of species-at-risk (SAR), wildlife habitat features, hydrology features (including seeps, vernal pools, wet forest units, unmapped streams, etc.), and geological features.

Research Considerations: As this is a research project looking at the operational requirements and viability of selected treatments, upfront sampling will need to be more intensive to determine minimum requirements for future pre- and post-treatment assessments. Ultimately, the goal is to determine measures of success and average costs for each treatment/stand type combination studied. This will allow for estimation of recommended treatment rates that may also be scalable depending on stand conditions.

Treatment area size will be restricted to approximately 5 ha to allow for sufficient replicates (6-12) with available funding (a minimum of 3 ha required). Based on site assessment, there may be more than one treatment option identified within a proposed research location, and opportunities to compare manual and mechanical treatments under the same site conditions are desirable. Each treatment area will require a 1 ha control that will be surveyed but not treated.

Site Criteria: To be eligible for an RT trial, a candidate site must meet the following criteria:

Uniform 5 ha area (target maximum), with a required minimum of 3 ha	Uniform based on ecosite and VT or Forest Group, but the area does not need to be contiguous. If not contiguous, the minimum area for each section is 1 ha.
Treatment Cohort Density	More than 5,000 stems/ha
Treatment Cohort Average Height	Softwood: minimum 7 m; Hardwood: minimum 9 m
Forest Group	SH, MW, TH, IH, OF, SP (Neily et al. 2023)
Mature Overstory Cohort Cover	Less than 30%
Treatment Cohort Age	Less than 40 years
Eligible Ecosites	AC6, AC7, AC10, AC11, AC13, AC14 (Neily et al. 2023) Edaphic sites (AC6 and AC7) may have restrictions on acceptable crop tree (species) selection.
Crop Trees	Softwood: rS, wS, bS, eH, bF, wP, rP, jP, eL* Hardwood: sM, rM, yB, rO, wA, wB, tA, ltA, I*

***rS = red spruce, wS = white spruce, bS = black spruce, eH = eastern hemlock, bF = balsam fir, wP = white pine, rP = red pine, jP = jack pine, eL = eastern larch, sM = sugar maple, rM = red maple, yB = yellow birch, rO = red oak, wA = white ash, wB = white birch, tA = trembling aspen, ltA = large-tooth aspen, I = Ironwood.**

Post-treatment stand conditions must meet the following criteria:

Treatment Cohort Density	1200 – 3000 stems/ha
Cohort Crop Tree Stocking	Minimum 500 crop trees/ha*
% Residual LIT Species	Must remain the same or (ideally) increase post-treatment
Treatment Cohort Residual Tree Quality	Must remain the same or (ideally) increase post-treatment (i.e., no decreases in the percentage of acceptable softwood and hardwood trees found in prism sweeps).

***Can include any tree from the crop tree species list. A crop tree may be retained due to its potential to produce a future sawlog, but also for biodiversity, climate adaptation, and carbon sequestration purposes. Sites where LIT species stocking is low may classify any healthy LIT tree as a crop tree regardless of form.**

Non-representative areas (e.g., a mature patch with > 30% crown closure, an under-size patch, or a wet area) within a proposed treatment area should be delineated and removed from the proposed treatment area – preferably as part of an initial desktop assessment. If needed, map adjustments can also happen after site inspection and/or pre-treatment plot assessment. If a pre-treatment plot lands in an inclusion that is not representative of the site, the plot should not be assessed in these conditions. If the area is small (< 0.1 ha), then the plot should be offset to the nearest area with target conditions. If the inclusion is large (≥ 0.1 ha), then the plot should be dropped and the area mapped and removed from the treatment area.

Plot Measurements: Required plot measurements are listed below.

Pre-treatment: Minimum 4 plots/ha (additional plots required if perceived site variability is high)

Regeneration survey with 1.78 m radius plot	Count of established crop tree regeneration (minimum 30 cm height) by species. Four (4) subplots per plot are required located 7 m from plot center at cardinal directions.
Prism sweep with 1 BAF or 2 BAF prism (or angle gauge)	**Species and diameter class (to 1 cm):** Depending on tree size, choose the appropriate prism to get between 10 and 20 trees per sweep (record BAF used). **Heights (to 0.1 m):** Representative heights of SW and HW (all trees) and representative heights of LIT species if they are suppressed in the understory.
Crown assessment* **(adapted from OMNR 2004; Pelletier et al. 2016)**	**For prism sweep trees only:** Acceptable crown conditions (Yes/No). Acceptable means: - LCR 1/3 (33%) or more - No excessive damage or die-back (>30% for shade intermediate-tolerant species, >10% for shade intolerant species)
Bole assessment* **(adapted from OMNR 2004; Pelletier et al. 2016)**	**For prism sweep trees only:** Acceptable bole conditions (Yes/No). Acceptable means: - No forks in bottom 5m (or lower 50% of tree if tree is <10m tall); no major wounds, rot, fruiting bodies, or excessive sweep/crook; lean <15^{o} from vertical
FEC assessment	VT (or Forest Group), ST, and ecosite.
Biodiversity features (if found)	e.g., EGS, wildlife features, hydrology features, geology features, etc.
Photographs	Four photos, one in each cardinal direction to include ground and above-ground features.

*** Note also if tree is part of a multiple-stem clump.**

Post-treatment: Minimum 4 plots/ha (additional plots required if perceived site variability is high)

Regeneration survey with 3.99 m radius plot	Count of established crop tree regeneration (minimum 30 cm height) by species. Four (4) subplots per plot are required located 7 m from plot center at cardinal directions.
Prism sweep with 1 or 2 BAF prism (or angle gauge)	**Species and diameter class (to 1 cm):** Depending on tree size, choose the appropriate prism to get between 10 and 20 trees per sweep (record BAF used). **Heights (to 0.1 m):** Representative heights of SW and HW (all trees) and representative heights of LIT species if they are suppressed in the understory.
Crown assessment* **(adapted from OMNR 2004; Pelletier et al. 2016)**	**For prism sweep trees only:** Acceptable crown conditions (Yes/No). Acceptable means: - LCR 1/3 (33%) or more - No excessive damage or die-back (>30% for shade intermediate-tolerant species, >10% for shade intolerant species)
Bole assessment* **(adapted from OMNR 2004; Pelletier et al. 2016)**	**For prism sweep trees only:** Acceptable bole conditions (Yes/No). Acceptable means: - No forks in bottom 5m (or lower 50% of tree if tree is <10m tall); no major wounds, rot, fruiting bodies, or excessive sweep/crook; lean <15^{o} from vertical
Biodiversity features (if found)	e.g., EGS, wildlife features, hydrology features, geology features, etc.
Photographs	Four photos, one in each cardinal direction to include ground and above-ground features.

*** Note also if tree is part of a multiple-stem clump.**

Additional treatment specifications and operational requirements can be found in Appendix 1.

Between Plot Assessment:

- GPS coordinates for FEC unit transitions and /or inclusions (with required notes)
- GPS coordinates for biodiversity features (with required notes)

Discussion

Accurate stand mapping is fundamental to ecosystem-based forest management because it allows for more focused prescriptions and better prediction of treatment responses. It also provides valuable information on biodiversity features that can be directly incorporated into silviculture and/or harvest planning. For this research project, accurate stand mapping will also allow for more rigorous assessment of treatment success by VT/ecosite unit, as well as pre- and post-treatment sampling requirements for different stand conditions.

The initial cohort minimum density criterion of 5,000 stems/ha equates to an average spacing of 1.4m x 1.4m, too dense for desirable crown development and tree growth.[1] The residual target density of 1,200 to 3,000 stems/ha equates to a range of 2.9 x 2.9m to 1.8m x 1.8m spacing and is in keeping with current post-treatment PCT specifications (1,500 to 3,500 stems/ha) for sapling size natural stands (Association for Sustainable Forestry). In addition, having a <30% mature, overstory crown closure criterion ensures that the treatment is broadly applied across a site and not just a patchy understory thinning and/or crop tree release treatment.[2]

The pre-treatment regen plot area (radius 1.78 m = 1/1,000 ha) is smaller than the post-treatment plot radius (3.99 m = 1/200 ha) to account for expected differences in tree density before and after treatment. This is in keeping with Association for Sustainable Forestry silviculture assessment procedures (ASF 2015). Prism sweeps are also being conducted to capture information on species mix and stand structure which is related to biodiversity assessments.

Live crown ratio (LCR) is being assessed to relate results to potential increases in softwood wind-firmness in residual stands (Brüchert and Gardiner 2006), and for the potential to respond to release (OMNR 2004; Pelletier et al. 2016; McGrath et al. 2021). RT has the potential to increase wind-firmness in older softwood stands by allowing for development of more tapered trees that are better adapted to wind exposure because they sway with a smaller amplitude and frequency, thus helping to prevent

[1] 5000 stem/ha of trees > 1 m height is also the threshold value used by NBDNRED for PCT and plantation cleaning treatments (NBDNRED 2023).

[2] As a rule of thumb, 30% crown closure roughly equates to a mature, overstory basal area of 12 m^2/ha under hardwood cover, 15 m^2/ha under mixedwood cover, and 18m^2/ha under softwood cover (using a 2BAF prism).

root system weakness. Crown and bole conditions are being assessed to promote long-term tree vigour and quality. If trees are part of a clump (e.g., red maple stump sprouts), this is also recorded both pre- and post-treatment.

Acknowledgments

We thank Western Woodlot Services Cooperative (WWSC) staff Andrew Oliver and Bronson Joudrey for their field testing and feedback on these specifications.

Literature

ASF (Association for Sustainable Forestry). 2015. Silviculture assessments procedure manual.

Brüchert, F. and B. Gardiner. 2006. The effect of wind exposure on the tree aerial architecture and biomechanics of Sitka spruce (*Picea sitchensis*, Pinaceae). *Am. J. Bot. 93 (10)*: 1512-1521.

Keys, K., A. Kekacs, and R. Dickie. 2023. *Family Forest Network restoration silviculture project: Research outline*. Technical Note #S1. Prepared for Nova Scotia Department of Natural Resources and Renewables.

Lahey, W. 2018. *An independent review of forest practices in Nova Scotia: Executive summary, conclusions, and recommendations*.

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

NBDNRED (New Brunswick Department of Natural Resources and Energy Development). 2023. *New Brunswick private woodlot silviculture program 2023-2024*. Province of New Brunswick.

Neily, P., S. Basquill, E. Quigley, K. Keys, S. Maston, and B. Stewart. 2023. *Forest ecosystem classification for Nova Scotia (2022): Field Guide*. Biodiversity Tech Report 2023-002. Nova Scotia Department of Natural Resources and Renewables.

OMNR. 2004. *Ontario tree marking guide, Version 1.1.* Ontario Ministry of Natural Resources.

Pelletier, G., D. Landry, and M. Girouard. 2016. *A tree classification system for New Brunswick*. Version 2.0. Northern Hardwoods Research Institute. Edmundston, New Brunswick.

Appendix 1. Additional treatment specifications and operational requirements.

Treatment Specifications:

- If the target crop tree is already free-to-grow (FTG), then no surrounding trees or woody shrubs need to be cut. This enhances biodiversity and reduces treatment costs. However, if the target crop tree is not FTG, then competing trees and woody shrubs must be cut to meet FTG specifications.

  For this project, FTG is defined as:

  > *For crop trees ≥ 4 m in height, competing trees and woody shrubs are less than one/third (33%) of the crop tree height on at least three sides.*
  >
  > *For crop trees < 4 m in height, competing trees and woody shrubs are less than one/quarter (25%) of the crop tree height on all four sides.*
  >
  > *Competing trees and woody shrubs are defined as those whose crowns are touching the crop tree crown, or whose crowns are within the area covered by the crop tree crown (either above or below).*

- The maximum stump height of cut trees and woody shrubs is 30 cm.

- Crop tree preference will be determined on a site-by-site basis and communicated to the contractor.

- Requirements for treating red maple clumps (and other clumps if present) will be determined on a site-x-site basis and communicated to the contractor.

Operational Requirements:

- No cutting or machine traffic is allowed in the designated control area, only foot traffic.

- As part of treatment funding, contractors are required to keep track of and report on hours actively working on the RT treatment.

- As this is a pre-commercial thinning treatment, it is expected that most cut stems will be left on site. However, contractors are allowed to remove some commercial size stems or other products from treated areas if they wish, but only if this removal does not negatively impact the treated area and the time taken for this activity is not included in reported treatment hours.

- Contractors have a maximum of 2 months to complete the RT treatment at a given site.