Climate Change Resilience and Carbon Storage Silvicultural Prescriptions for the Acadian Forest Region

Definition of Terms v.1.0

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COMMUNITY FORESTS INTERNATIONAL

Definition of Terms

The following section offers definitions and explanations of some of the terminology used in the C&C Decision Tree and in this supporting document.

Stand

A stand is a distinct patch of forest. The stand is the basic management unit of silviculture. A stand is described and classified by its composition and structure; as well as the ecological character of the site the stand is growing on.

Silviculture

The science and technology of establishing and maintaining forest stands that have value to people. Silviculture includes both individual treatments and systems. Individual silvicultural treatments are actions intended to manipulate stand composition and/or structure towards a more desirable condition. A silvicultural system is a complete plan for the maintenance of stand composition and structure in the long term- into the next generation of trees.

Silvicultural Treatment

A specific action intended to manipulate stand composition, structure and dynamics. The majority of silvicultural treatments seek to manipulate the composition and structure of the vegetation, but some treatments attempt to alter the character of the site though site preparation.

Reserve

A "reserve" is a tree that is selected for retention following the final harvest and regeneration of a stand. Reserve trees are a defining characteristic of two-age silvicultural systems. Reserves can also be used in irregular silvicultural systems, which are known as "irregular systems with reserves". Reserve trees can be retained for many reasons including serving as "full-cycle" trees that are allowed to grow old and die in the stand, never to be harvested.

Full-Cycle Tree

A tree in a managed stand that is never harvested, that is allowed to grow old and die.

Development Stages

A stand that is dominated by a cohort of trees (i.e. "single-cohort-dominated stands", "single-cohort stands", "double-cohort stands") originates from a single event (i.e. major disturbance) that allows them to grow and develop. Single-cohort-dominated stands grow through a series of sequential development stages. This tool uses the following names for these development stages:

1. Stand initiation
2. Stem exclusion
3. Understory re-initiation
4. "Old growth"

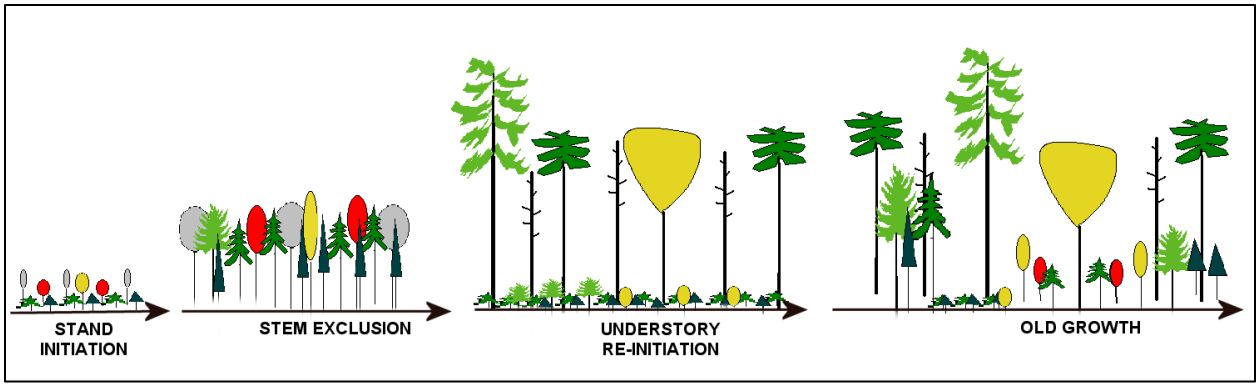

Figure 4. Stand development stages.

The Stand Initiation Stage

Following a major, stand-replacing disturbance where the majority of the canopy is removed/killed, the regeneration layer in a stand and the forest floor are fully exposed to light. This creates opportunity for both the release of already established regeneration as well as new regeneration in full sunlight. The total sum of all the tree regeneration that is released and/or established during this stage becomes a single cohort.

The Stem Exclusion Stage

Eventually a regenerating cohort forms a closed canopy and the trees effectively dominating the canopy preventing full sunlight from reaching the forest floor. A stand initiation stage that reaches a closed canopy state signifies the beginning of the "stem exclusion stage". During the stem exclusion stage trees compete for growing spaces and trees in each canopy layer become differentiated into different crown classes (i.e. dominant; co-dominant; intermediate; over-topped), and tree species with very different shade-tolerances and growth rates may produce multiple canopy layers. As the stem exclusion stage progresses, trees per unit area (i.e. trees/ha) gradually decline, density and volume increase, and the mean stand diameter (MSD) increases. New regeneration may establish during the stem exclusion stage, but it does not grow into the canopy as there is too little sunlight in the understory for trees to fully develop. Tree death during the stem exclusion stage does not result in effective canopy gaps. The space produced by tree death during the stem exclusion stage is quickly occupied by other developing trees in the canopy.

The Understory Re-Initiation Stage

As a stem exclusion reaches an advanced stage, the death of large old trees produces canopy gaps that cannot be filled by surrounding trees in the canopy. These canopy gaps allow sunlight into the understory, encouraging younger trees to grow up into the canopy. An understory re-initiation stage has a canopy that remains dominated by a single cohort, with scattered gaps of younger trees that are free to grow into the upper canopy.

The "Old Growth" Stage

Eventually the gradual understory re-initiation stage leads to a highly variable, irregular, multi-aged canopy, which is not dominated by a single cohort. When the canopy-gap replacement in an old stand

has advanced to the point that the original single cohort is no longer dominant, the stand has entered the "old growth" stage of development. This development stage is gap-driven, where individual trees reach their maximum ages and sizes and die. The stand becomes full of dead standing and fallen trees. The canopy is multi-aged and irregular in its structure. The understory is full of multi-aged trees and multiple canopy layers. There are many different names for this late development stage in forest stands, such as "the shifting-gap stage/phase", "the shifting mosaic", etc. The term "old growth stand" or "old growth forest" may refer to working definitions that are not specific to this stage of stand development.

Age Structure

The structural complexity of a stand is fundamentally determined by its age structure. The age structure of a stand is a function of its disturbance/treatment history.

Stands that have recently originated from a single stand-replacing event (i.e. "major disturbance") start out dominated by a single effective age of trees (i.e. "single cohort"). Stands that are dominated by a single cohort of trees go through a consistent and predictable sequence of development stages and stand dynamics. Stands that are dominated by a single cohort have relatively uniform canopies.

Stands that are dominated by a single cohort eventually reach old development stages where the death of old dominant trees creates canopy gaps. In the absence of a major disturbance, single-cohort-dominated stands eventually transition to multi-aged, gap-driven stands (i.e. "old growth development stage", "shifting-gap stage", etc.). Stands that are maintained by constant minor disturbances become an intimate mix of different effective ages (i.e. "multi-cohort stands" or "uneven-aged stands").

Even-aged Stand

A stand that is ***exclusively*** dominated by a single cohort of trees. The term single-cohort stand is synonymous with "even-aged stand" in silviculture. See "single-cohort stand" for more information.

Two-Aged Stand

A stand with a canopy that is dominated by single cohort, with scattered much older trees that came from the previous stand. The term double-cohort stand is synonymous with "two-aged stand" in silviculture. See "double-cohort stand" for more information.

Uneven-aged Stands

A stand that is an intimate mix of three or more distinctly different-aged trees (i.e. multiple cohorts). The term multi-cohort stand is synonymous with "uneven-aged stand" in silviculture. See "multi-cohort stand" for more information.

Effective Age

Effective age is the age of a cohort, not the actual biological age of the trees in a cohort. For example, when we say "this stand is 60-years old", we mean that this stand originated from a major disturbance that occurred 60-years ago. Natural advance regeneration can develop for decades, or even centuries, in the shade of a forest canopy, sitting and waiting for the light of a canopy removal. As a result, established advance regeneration can be a wide range of ages when it is eventually released and

receives enough sunlight to grow into the canopy. For example, a shade-tolerant seedling could sit and wait for a century for enough light to fully develop. The effective age of this tree would be traced to the event that allowed it to freely grow, despite the fact that it has a central core of a century of ineffective growth.

Cohort

In silviculture, a cohort is a group of trees that originated from a single releasing disturbance. Trees that belong to a cohort can come from any source or mechanism. A cohort of trees has a single effective age, which is traced to the disturbance that established and/or released the regeneration. Silviculturalists manage cohorts; they manage the effective age of trees, not the actual biological/chronological age of trees. In silviculture, the term "age class" is synonymous with "cohort". However, the term "age class" can lead to misunderstanding and misinterpretation, as it can mean something very different when managing forests at the landscape level.

Single-Cohort Stand

A single-cohort stand is a stand that is ***exclusively*** dominated by a single age-group (i.e. cohort) of trees. A single-cohort stand originates from a major stand-replacing disturbance where no canopy trees survive.

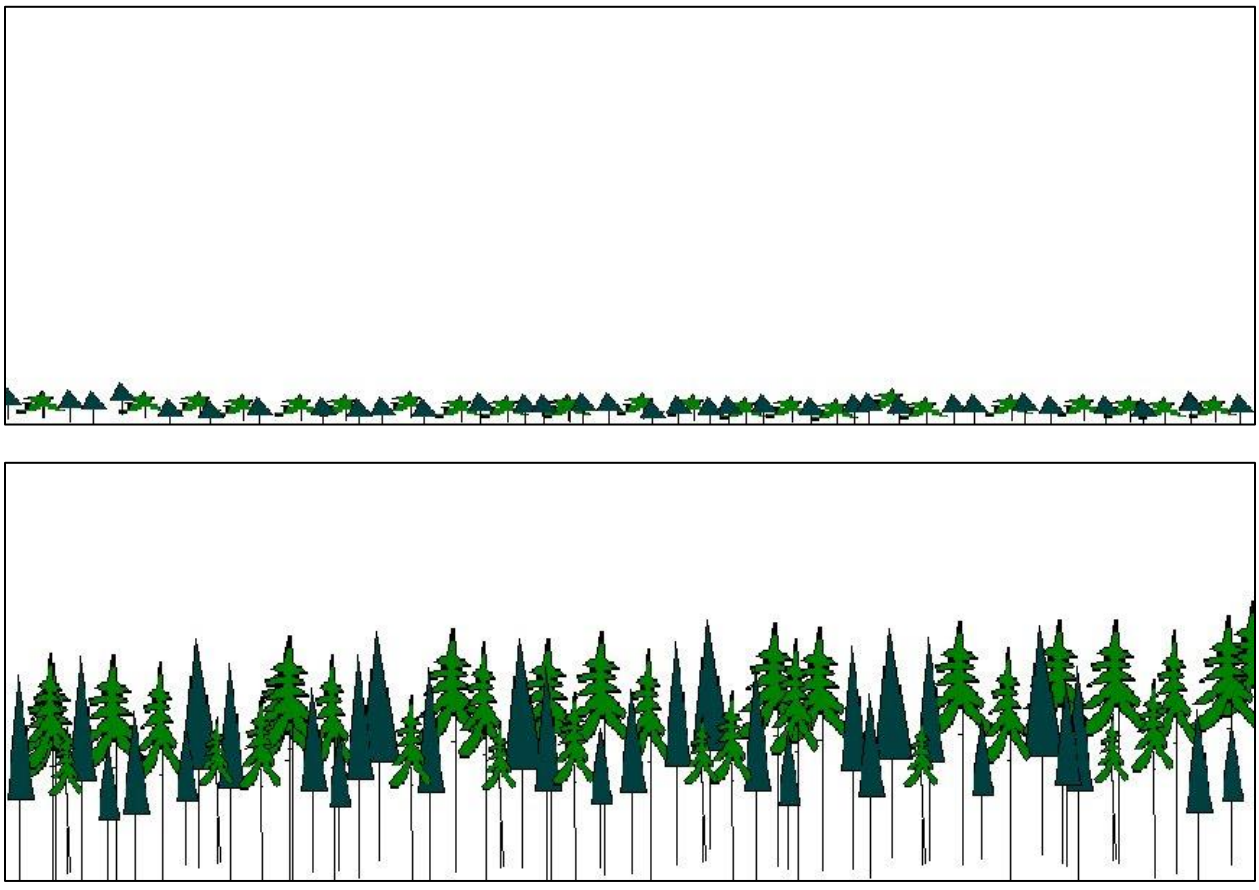

Figure 1. Single-cohort (even-aged) stands.

The term single-cohort stand is synonymous with “even-aged stand” in silviculture.

Double-Cohort Stand

A double-cohort stand has a canopy that is dominated by a single cohort of trees, with scattered much older trees. Like a single-cohort stand, double-cohort stands originate from a single, major, stand-replacing disturbance. Unlike, single-cohort stands, double-cohort stands occur when scattered canopy trees survive the major disturbance.

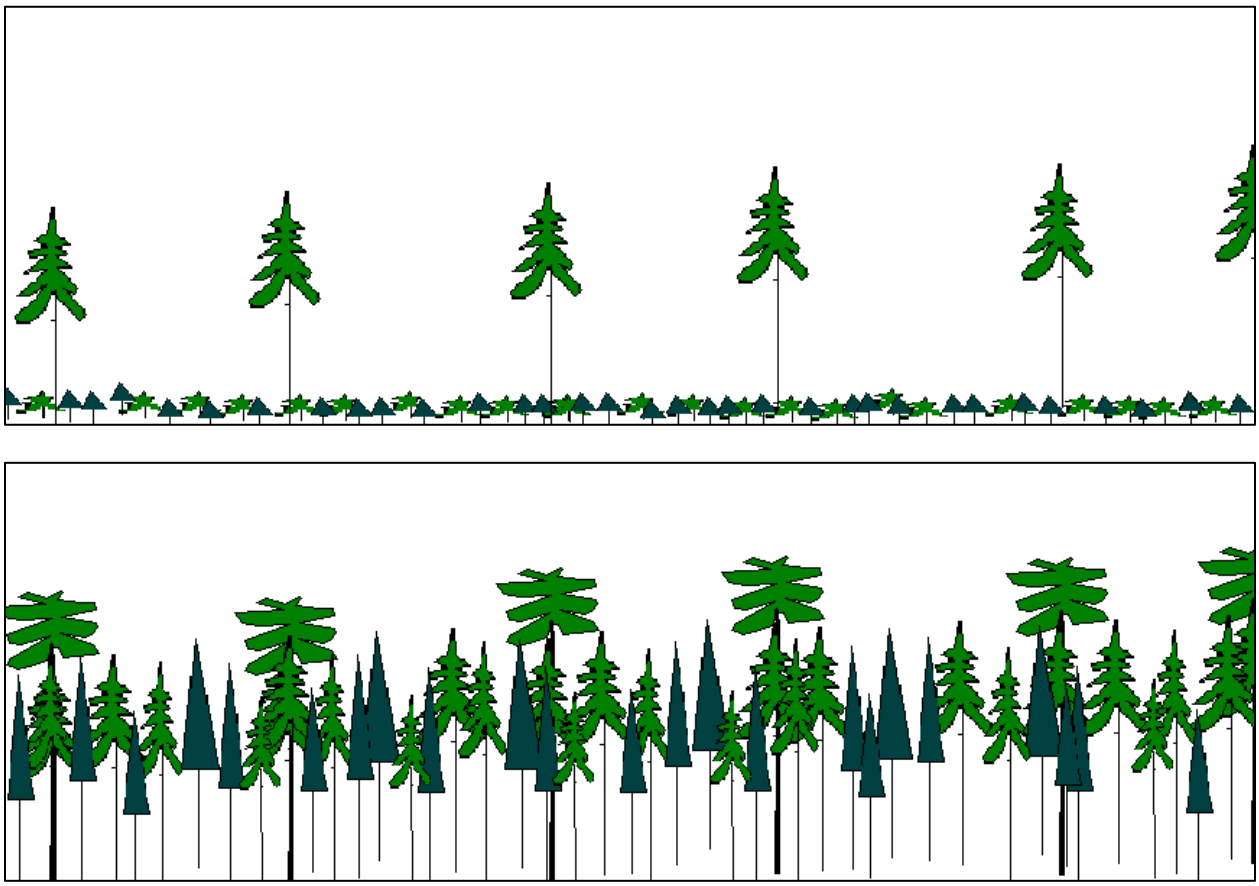

Figure 2. Double-cohort (two-aged stands).

The term double-cohort stand is synonymous with “two-aged stand” in silviculture.

Multi-Cohort Stand

A multi-cohort stand is a mix of multiple (i.e. three or more) distinct age-groups of trees (i.e. multiple cohorts). Multi-cohort stands are maintained by frequent, minor disturbances that produce canopy gaps allowing younger cohorts to grow up into the canopy.

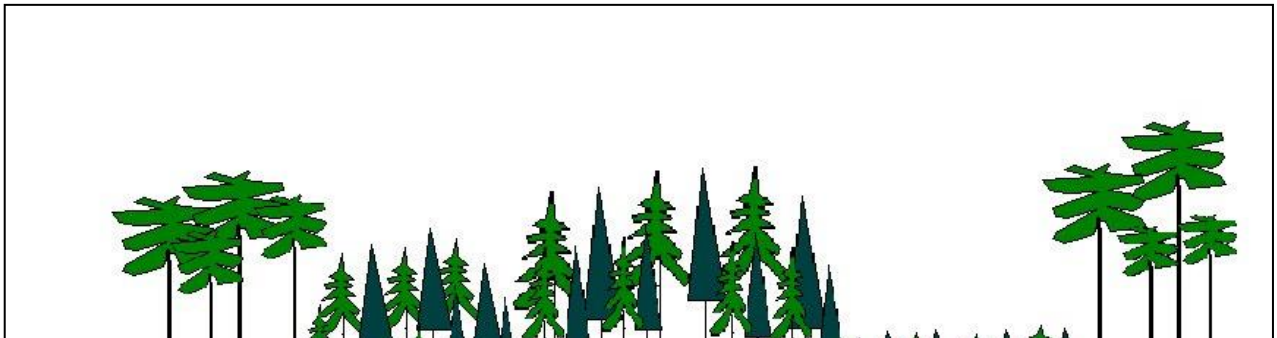

Figure 3. A multi-cohort (uneven-aged) stand.

The term multi-cohort stand is synonymous with "uneven-aged stand" in silviculture.

Silvicultural Systems

A silvicultural system is a complete plan for the maintenance of stand composition and structure in the long term – into the next generation of trees. In the Germanic tradition, silvicultural systems are primarily classified by the age structure they seek to maintain (i.e. even-age systems, two-age systems, uneven-age systems, etc.).

Even-age Silvicultural System

An even-age silvicultural system is a long-term plan for a stand that maintains the ***exclusive*** dominance of a single cohort of trees. In an even-age system the entire canopy is removed during final harvest, a new single cohort of trees is established and then grown to maturity, where it is harvested and regenerated into another cycle (i.e. rotation) of the system.

Two-Age Silvicultural System

A two-age silvicultural system is a long-term plan for a stand that maintains the dominance of a single cohort of trees but retains scattered canopy trees (i.e. "reserves") when the stand is regenerated. In a two-age system the majority of the canopy is removed during final harvest, with scattered canopy trees retained. Following final harvest, a new single cohort of trees is established and then is grown to maturity, where it is harvested and regenerated into another cycle (i.e. rotation) of the system.

Uneven-age Silvicultural System

An uneven-age silvicultural system is a long-term plan for a stand that maintains an intimate mix of multiple cohorts of trees (i.e. three or more distinct cohorts in the canopy). Uneven-age systems are maintained through frequent partial cutting that harvests mature cohorts, producing canopy gaps- allowing younger cohorts to grow into the canopy. An uneven-age system is governed by continuous partial cutting- known as "selection cutting/harvesting". The time interval in between "selection cuts" is called the "cutting cycle". Uneven-age silvicultural systems are reliant on the continuous regeneration and ingrowth of desirable/acceptable growing stock. An uneven-aged stand is never "mature", as it is a mix of different-aged cohorts. At each cutting cycle in an uneven-age system, mature trees are harvested, new regeneration is encouraged/established/released, young trees are encouraged to grow into the canopy, and immature trees can be tended. All phases of silviculture are constantly at work in an uneven-age silvicultural system. Uneven-age silvicultural systems are also called "selection systems" as they rely on the selection regeneration method.

Irregular Silvicultural Systems

Irregular silvicultural systems exist in a continuum between systems that maintain the dominance of a single cohort (i.e. even-age/two-age systems), and systems that maintain an intimate mix of three or more cohorts (i.e. uneven-age systems).

In an irregular silvicultural system, the canopy of a stand is very gradually regenerated (over decades), producing a very gradual establishment of regeneration. Eventually the canopy is removed, resulting in an "irregular stand" that is structurally complex because of the prolonged and gradual regeneration period. This highly variable regeneration can either occur naturally in old stands, or can be established through long, drawn out harvesting of the canopy. Once the final harvest of the canopy is complete, an irregular stand is treated like it is dominated by a single cohort and is grown for another cycle-eventually leading to another extended final harvest and regeneration period at the end of the cycle. During the final harvest and regeneration period of an irregular system, the treatments are very similar to the partial cutting associated with uneven-age systems, but unlike uneven-age systems, there is no attempt to maintain multiple cohorts in the stand through continuous harvest and regeneration.

Reserves can be retained at the end of the final harvest and regeneration period in an irregular system, which are known as an "irregular system with reserves". Due to all of the partial sunlight produced by the extended final harvest period, the shelterwood regeneration method is most commonly associated with irregular silvicultural systems, and are known as "irregular shelterwood systems" and "irregular shelterwood systems with reserves".

Selection Systems

Uneven-age silvicultural systems are classically referred to as "selection systems" because of their use of the "selection regeneration method" and "selection cutting" or "selection harvesting". There are two very different approaches to uneven-age systems:

1. Single tree selection systems
2. Group selection systems

Single Tree Selection Systems

Single tree selection systems (i.e. "individual tree selection systems") are a classical approach to uneven-aged stand management where the largest canopy gaps produced are the size of a large mature tree - hence the moniker "single tree" selection. Single tree selection systems have an artificial stand structure, where a stand is a uniform mix of all sizes and effective ages of trees. This stand structure requires continuous intensive intervention where the stand is artificially maintained at a low density (typically regulated by basal area) and desirable "crop trees" of all ages and sizes are maintained uniformly throughout the stand. True stem exclusion is artificially prevented in a single tree selection system, so that small, young desirable crop trees can gradually develop and grow into the canopy. At least partial shade is permanently maintained in a single tree selection system, which gives a competitive advantage to the most shade-tolerant species on a given site. Single tree selection systems, when successful, maintain a constant stable stand structure, but they require constant intervention/treatment, and therefore very frequent cutting cycles. A single tree selection cut/harvest

as part of a single tree selection system seeks to: harvest scattered large mature trees, tend immature trees, maintain an artificial stand density, and encourage the regeneration of desirable trees. A single tree selection cut combines a final harvest, regeneration and tending treatment all in one.

Group Selection Systems

Group selection systems (i.e. "patch selection systems") are a classical approach to uneven-aged stand management where canopy gaps are produced by cutting "groups" or "patches" of trees. The size of the "group" or patch cut made can be modified in an almost infinite number of ways, to both harvest mature trees, as well as encourage, establish and release desirable regeneration. Age structure in a group selection system is maintained by means of area control and the length of the cutting cycle. For example, a group selection system might be maintained by regenerating 10% of the stand area, every 15 years. At a minimum, group selection systems require a continuous cycle of group selection cuts/harvests. Immature cohorts in a group selection system can be tended at any time. Unlike single tree selection systems, there is no requirement to regulate stand density and tend immature trees in a group selection system. The patch cuts in a group selection system can take any form or shape, including being cut in strips, sometimes referred to as a "strip selection system".

Partnerships

In 2018, with support from the New Brunswick Environmental Trust Fund, Community Forests International contracted Gareth Davies to develop climate-adaptive silviculture prescriptions for the Acadian Forest Region and build a decision tree tool for forest professionals. In 2019, with a first draft of this supporting document and the prescriptions decision key both complete, and with funding from Natural Resources Canada, Community Forests International partnered with the New Brunswick Federation of Woodlot Owners to continue refining these materials and to deliver capacity building activities to forestry professionals.

Suggested Citation

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