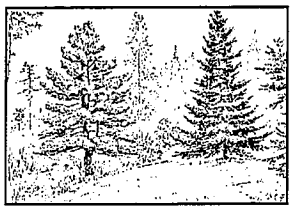


# Plan Context



## 2.1 Economic & Social Context

Carlton County's history, economy, and quality of life have always been intertwined with the natural resources of the landscape. The Anishinaabeg (Ojibway), who drove the Dakota from the region in the late 1700s, lived a semi-nomadic life tightly focused on the changes of the seasons and the unfolding resources of the land. Fish, berries, wild rice, hunting, and maple syrup took their turns as the central economic activity of the Anishinaabeg during the year.

The first white settlers were farmers and loggers and these two activities became the mainstay of the county. White pine was the king tree and many mills sprung up to convert massive trees into the raw material that built Midwestern towns. The County also had tie, post, and lath mills as well as many charcoal kilns in Mahtowa.

Then came the historical point of reference for the county when the fire of 1918 swept through killing 453 people, destroying 4,089 homes, and burning 250,000 acres in four counties. The vast cutover lands had burned quickly in the face of drought, low humidity, and high winds.

By the 1930s the white pine logging era ended just as the growth in farming in the county reached its peak. However, in the 1940s began the comeback for forested lands which up to the point had been devastated by unmanaged logging or eliminated by agriculture. Northwest Paper (then Potlatch) established the first of its plantations. Tax forfeited lands were sold to become tree farms. And new industries such as Wood Conversion (ConWed), Diamond Match, and Northwest Paper (now SAPPI) became economic mainstays feeding on the now abundant aspen forest.

Up through the 1970s the County continued to aggressively sell tax forfeited lands – over 131,000 acres were sold and another 49,000 conveyed to the State. Then, as these lands became valued as forest and recreational areas, the County began managing its lands in earnest.

Through this era the county had steady growth in population. Between 1990 and 2000 the county grew from 29,259 to 31,671 people. It is projected to grow at a rate nearly equal to the state average and reach 34,750 by the year 2010.

The recently adopted comprehensive plan relates how natural resources have underpinned the county's economy through today although now tourism plays a much larger role than in the past:

> "Historically, the County has relied on agriculture and the wood products industry for economic stability. Although agriculture is still a part of the economy in the County, it is no longer a prominent industry. The wood products industry has remained stable and continues to provide a strong employment base through Potlatch Incorporated (mill now owned by SAPPI), Diamond Brands, and private

logging companies that supply timber. The County also has a strong manufacturing base, which could continue to be a stable industry for the future.

"New industries have also emerged as the economy has changed. Tourism and recreation have become a strong force in the economy of Carlton County. Trails for biking, hiking, and snowmobiling have been promoted in the County and are used by a variety of local and visiting recreationists. Carlton County offers other opportunities for tourism, such as the Black Bear Casino, which attract many people throughout the year."[3]

As to the future, the comprehensive plan sets forth the following vision statement: "Carlton County is an area in which its residents enjoy a high quality of life. Continued planning, cooperation with other units of government, and citizen participation will ensure that residents of all ages and background will sustain this high quality of life for many years to come."

Among the comprehensive plan's concepts, goals, and objectives are many that relate to the appropriate management of public and private forested lands. Among the statements are ones seek sustainable use of natural resources; maintenance of high water quality in Carlton County's lakes, wetlands, and waterways; protection of native wildlife, plants, and biotic communities; sustainable management of forests; encouragement of a variety of land use types within the County to enhance the quality of life and environment of the area, and facilitate cost effective and efficient provision of public services; maintenance of rural character; and provision of recreation facilities to meet public needs while maintaining user safety and protecting the environment.

## 2.2 Ecological Context

### Biophysical Regions

In 1998 the County retained the services of Natural Resource Services, Limited (NRSL) to identify "biophysical regions" within the county. Using field research and selected climate and geomorphic properties, NRSL divided Carlton County into five biophysical regions. These regions loosely conform to the "subsections" defined under the Ecological Classification System described later in this subchapter.

[3] "Carlton County Community-Based Comprehensive Plan", April 2001, prepared by ARDC.

Map 1: biophysical regions

The five biophysical regions are:[4]

- Wawina Hibbing Plain: Extensive plains with low gradient and low local relief form the major portion of this region. Slow moving water in streams and substantial areas of prolonged water-saturated land. Extensive bogs and peatlands. Local dry uplands among the low marshes and bogs. Low areas suitable for lowland hardwoods and conifers. Upland areas suitable for quality pulpwood and bolts.

- Brookston Upland: Local elevation highs, local low rolling hills and large peat bogs create a region with significant variation in local relief and highly contrasting land. Soil is predominantly glacial drift containing a variety of sandy, silty, and clayey deposits. Area near Brookston is bedrock controlled. Large peat bogs are found in region. Site quality for timber is medium to high for most uplands.

- Cloquet Island Lake Plain: An extensive dry plain with shallow depressions and scattered hills. Bogs and marshes developed in the depressions. Lakes and streams are major features of this region. Seasonal water levels in lakes and streams are modified from event extremes due to high storage capacity in watershed. Site quality for trees is medium to high for most uplands but overall site quality is average to slightly below average as compared to rest of area.

- Duluth Upland: An irregular bedrock controlled ridge and valley terrain; in St. Louis River valley local relief is steep and dramatic. Region is defined by extensive areas of clayey soils. Stream headwaters have low storage capacity. Site quality ranges from low to high for this region. Substantial portion of region has high susceptibility to windthrow due to clayey conditions, perched water tables in root zone, or shallow soils over bedrock.

- Nemadji Plain: Former glacial lakes deposited thick layers of silt and clay in this region. Subsequent erosion has created a basin with a series of "flats" bordered by steep slopes leading to another "flat" and ultimately stream channels. The slopes are generally highly unstable. Site quality is medium to high for most uplands in region. Mid and lower slope positions will tend to be more productive. Wind damage will be substantial due to wet areas and perched water tables.

A small area in the extreme northwest corner of the county was not labeled or described.

Part of the effort to identify biophysical regions involved generating extensive amounts of information from forest plots. This information needs to be entered into a digital database tied to the County's forest inventory so that it can become the basis for classifying stands as to ecological potential, ongoing research, and monitoring.

**Ecological Classification System**

A second approach to identifying the ecological character of the landscape uses the National Hierarchical Framework of Ecological Units adopted by the US Forest

[4] Information drawn from "Biophysical Regions for Carlton County, Minnesota", 1998, Natural Resource Services, Limited, Donald H. Prettyman.

Service[5] and the Minnesota DNR. This Ecological Classification System (ECS) provides a nested series of increasingly smaller and more detailed levels of description of the landscape.

**Provinces**

Minnesota is divided into three major ecological **provinces** each representing distinctive ecological features and processes.[6]

- Laurentian Mixed Forest Province: Minnesota's true forested lands, at the time of settlement this region consisted of extensive conifer, conifer-hardwood mix, or hardwood forest. The topography is variable with landforms ranging from lake plains and outwash plains to ground and end moraines. Extensive peatlands occupy much of this area. Carlton County lies within this province.

- Eastern Deciduous Forest Province: This is the transition zone between the prairie to the south and west and the true forest to the north and east. It is a species-rich area with many species at the edges of their ranges. Variability in soils, moisture, and landform creates opportunities for a wide variety of forest types including maple-basswood hardwoods and fire-dependent pine/oak.

- Prairie Grassland Province: Slicing across western Minnesota is the tall grass prairie, little of which remains in its original condition today. Mainly various forms of prairie, some portions of this province which experienced lower levels of fire saw the formation of a dry oak savanna.

**Sections**

The ecological classification system divides provinces into **sections**. These are defined mostly by the origin of glacial deposits, regional elevation, floristic regions, and regional climate. Minnesota has ten sections four of which converge in Carlton County.

Most of the county lies in the Western Superior Uplands which is generally described as being comprised of the ground moraines of the Superior glacial lobe and the end moraines in east central Minnesota. The dominant landforms are gently rolling till plains and drumlin fields. Mille Lacs Lake is the dominant water feature. The drainage network is young and undeveloped with extensive areas of wetlands. The original vegetation was a mosaic of forest types including maple-basswood in the south and a mix of conifer, hardwood, and mixed conifer-hardwood forests to the north.[7]

[5] McNab, W. H. and P.E. Avers, 1994, Ecological Subregions of the United States: Section Descriptions, US Forest Service publication WO-WSA-5, Washington, D.C.

[6] The descriptions for these provinces comes from the MDNR's web site [www.dnr.state.mn.us/ecological_services/ecs/laurentian]; 2002.

[7] The descriptions for these sections comes from the MDNR's web site [www.dnr.state.mn.us/ecological_services/ecs/laurentian]; 2002.

The east central portion of the county is in the Southern Superior Uplands which is generally described as "a glacial lake bed. It consists of a relatively narrow band of lacustrine [lake origin] clays located along the south and west shore of Lake Superior. Topography is level to gently rolling, except along rivers and streams. Water has cut significantly deep valleys throughout the region and red clayey sediments are deposited into Lake Superior. Pre-settlement vegetation consisted of forests dominated by white spruce, white pine, and aspen-birch."

Small portions of the county lie in the Northern Minnesota Drift and Lake Plain and the Northern Superior Uplands sections.

**Subsections**

As shown in Map 2, the 10 sections are divided into 26 **subsections** of which five cover Carlton County. The **biophysical regions** described earlier are generally comparable to subsections although the two have slightly different geographic boundaries.

- Northern Superior Uplands Section

  North Shore Highlands: This subsection occupies the area adjacent to Lake Superior and consists of gently rolling to steep terrain. Rock outcrops are common and soils are typically shallow. Lake Superior dominates the region and acts to moderate climate throughout the year. Pre-settlement vegetation was forest consisting of white pine, red pine, jack pine, balsam fir, white spruce, and aspen-birch.

- Northern Minnesota Drift and Lake Plains Section

  St. Louis Moraines: Rolling to steep slopes characterize much of this subsection. End moraines are the dominant landform. Mississippi River divides the subsection; smaller rivers such as the Prairie (fed by the Tamarack) feed into it. Pre-settlement vegetation included white pine-red pine along the eastern edge; aspen-birch also grew on the moraines but were more common in the associated outwash plains; conifer swamp and bogs were scattered throughout the subsection.

  Tamarack Lowlands: This subsection conforms with the boundaries of Glacial Lake Upham and the Aurora till plain. Topography is level to gently rolling. Soils tend to be peat over both fine-textured and sandy lake deposits. Pre-settlement vegetation in the lowlands was black spruce, tamarack, white cedar, and hardwoods such as black ash; sedge meadows were also common; upland fringes supported aspen-birch and upland conifer.

- Western Superior Uplands Section

  Mille Lacs Uplands: As this subsection occupies nearly all of the Western Superior Upland, the descriptions are the same.

- Southern Superior Uplands Section

  Glacial Lake Superior Plain: As this subsection occupies all the South Superior Upland in Carlton County, the descriptions are the same.

Map 2: subsections

Map 3: LTAs

### LandType Associations

The final ecological class to be mapped in this narrative is the **Land Type Association (LTA)** (Map 3). This geographic level is proving to be well suited to forest management planning. The Minnesota DNR is using LTA-level analysis as the basis for its emerging forest management efforts. LTAs are generally defined by glacial landforms, bedrock types, topographic roughness, lake and stream distributions and types, wetland patterns, and soil parent material.

#### North Shore Highlands[8]

Lb03. Highland Moraine: Rolling to hummocky land; wetlands occupy 29% and lakes 3% of area. Most soils are fine sandy loams.
Lb20. Brookston Moraine: Complex of hummocky moraines and rolling till plains. Wetlands cover half of area. Soil parent material is coarse loamy with many stones. Acid peatlands occupy 36% of area.
Lb21. Brimson Sand Plain: Level to rolling outwash plain. Wetlands occupy 41% of area. Parent soil material is sandy.

#### St. Louis Moraines Subsection

Nb10. Sandy Lake Moraine: Complex of rolling to steep moraines and till plains separated by outwash. Sand and/or gravel common at depth of 4-10 feet. Outwash soils are sandy; uplands are loamy soils.
Nb11. Wright Till Plain: Dominated by rolling uplands and peatlands; wetlands occupy 46% of area.
Nb12. Hill City Till Plain: Nearly level to gently rolling plain. Wetlands occupy a third of area. Parent soil material is loamy till with few stones; thin layer of wind blown silt covers much of area.
Nb13. Rice Lake Moraine Complex: Complex of rolling moraines and till plains. Wetlands occupy 32% and lakes 6% of area. Most upland soils are loam or clay loam.
Nb19. Automba Drumlin Plain: Dominated by rolling plains with drumlins. Wetlands cover 45% of area. Mineral soils have loam surfaces and sandy loam subsoil; thin layer of wind blown silt covers most of area; hardpans are common.

#### Mille Lacs Uplands Subsection

Kb01. Bruno Moraine: Hummocky end moraine with over a third covered by wetlands. Variety of soils; hardpan commonly exists in the subsoil.
Kb07. Solana Till Plain: Characterized by hilly terrain with steep slopes. Wetlands occupy 40% of the area. Most of uplands have sandy loam soils; hardpans are common in the subsoil.
Kb12. Kettle River Drumlin Plain: Characterized by a rolling till plain with drumlins (long cigar-shaped ridges). Most soil is silt loam or loam over sandy loam; hardpans are common.
Kb13. Willow River Sand Plain: Rolling outwash plains and channels. Most soils have sandy textures. Wetlands occupy a quarter of area. Hardpans are generally absent.
Kb14. Nickerson Moraine: Terrain is rolling to steep in the moraines and rolling to level in the outwash channels. Wide variety of soils. Wetlands occupy

[8] LTA descriptions prepared by Dan Hanson, ECS Specialist, Mn DNR Division of Forestry for Minnesota County Biological Survey, 2002.

29% of area and lakes 3%.

**Glacial Lake Superior Plain Subsection**

Ja01. Douglas Lake-Modified Till Plain: Encompasses the deep-water portion of the Glacial Lake Duluth basin. Deeply eroded by post glacial streams. Nearly all soils have clay texture; hardpans are usually absent.

Ja09. Duesler Lake Plain: Encompasses the shallow-water portion of the Glacial Lake Duluth basin. Variety of soils; wetlands occupy 20% of area.

Ja10. Nemadji Lake Plain: Shallowest portion of the Glacial Lake Duluth basin; is transition between lake sediment and glacial till.

**Tamarack Lowlands**

Nd01. Moose-Willow Peatlands: Flat landscape dominated by peatlands with scattered islands of uplands. Wetlands occupy 67% of area. Upland islands have sand, silty clay, or silt loam features.

The next and most detailed level of description is what is called in this plan the Native Plant Community. Section 3.3 presents this narrative. The comparable term under the Biophysical Region approach is a Biophysical Land Unit; these have not yet been described and delineated for Carlton County.

## 2.3 Forest Dynamics

Relative to the human lifespan, the overarching forest landscape seems unchanging except at the local, easily viewed scale. Yet, along a longer range time scale, the landscape has been and remains in constant change.

As the glaciers melted and retreated 10-12,000 years ago, tundra vegetation dominated the slowly warming landscape.[9] This was followed by a spruce forest which, in turn, was quickly succeeded by a red pine or jack pine forest. Then, about 7000 years ago an oak savannah replaced the pine as a period of warmer, drier climatic conditions dominated the continent. Roughly 4000 years ago, cooler, wetter conditions re-established themselves and, as a result, oak declined, white pine increased, and the region's extensive bogs began forming.

That forest landscape remained in place through historic times. It was modified through deliberate and unintentional human-induced disturbances, most often fire. Later, logging, conversion to agriculture, drainage, deliberate conversion to different forest types, and, in some areas, reversion from agriculture to forest have all wrought significant changes to the forested landscape.

Thus, the forest that exists today is an ever-changing landscape governed by the physical properties of the underlying soils and terrain, the dominant climatic conditions, and the critical processes of forest dynamics. And, of course, all these have or can be altered through human intervention (e.g., drainage, pollution, introduction of exotic species, land use conversion, land management).

In section 2.1 and later in 3.2 the underlying potential of the land as expressed in native plant communities is defined. The following discussion focuses on understanding key forest dynamics as they become important to forest management.

[9] This summary is based on one found in Minnesota Biological Survey. 1998. Carlton County biological survey 1992-1995. Biological Report No. 59. Minnesota Department of Natural Resources.

## Forest Succession

It is deemed important to the health and vitality of the forest, and as a consequence, all that is supported ecologically and economically by it, that the County's forested lands possess the full range of development or growth stages. Forests change or "succeed" from one stage of development to another over time; the agent of change can be natural, such as fire, or human, such as logging and deliberate fire. The basis for a concern to pattern the current forest after the historical forest is the "assumption that native species have evolved under these natural disturbance regimes and will be better able to cope with human-induced disturbances such as logging if these are designed to imitate the key characteristics of natural disturbances."[10]

The basic pattern of forest succession involves four major phases:[11]

Establishment: or stand initiation, is the phase "characterized by establishment of new individuals, release of surviving seedlings and saplings, and vegetative reproduction of injured plants from below ground structures. It is marked by relatively rapid changes in species dominance, environment, structure, and levels of competition and high mortality among small individuals."

Thinning: is "characterized by the closing together of tree canopies" which "results in steep declines in understory establishment and growth, increases in mortality of many understory plants, and the onset of mortality in the tree layer" due to competition for light and water.

Transition: is "marked by a variety of gradual changes in population, stand structure, and vegetation processes that can last from less than 100 to over 1,000 years depending on the forest type and disturbance history. The original cohort of trees slowly breaks up, tree establishment and release of suppressed understory trees increases, and a new cohort of trees gradually grows into the canopy gaps."

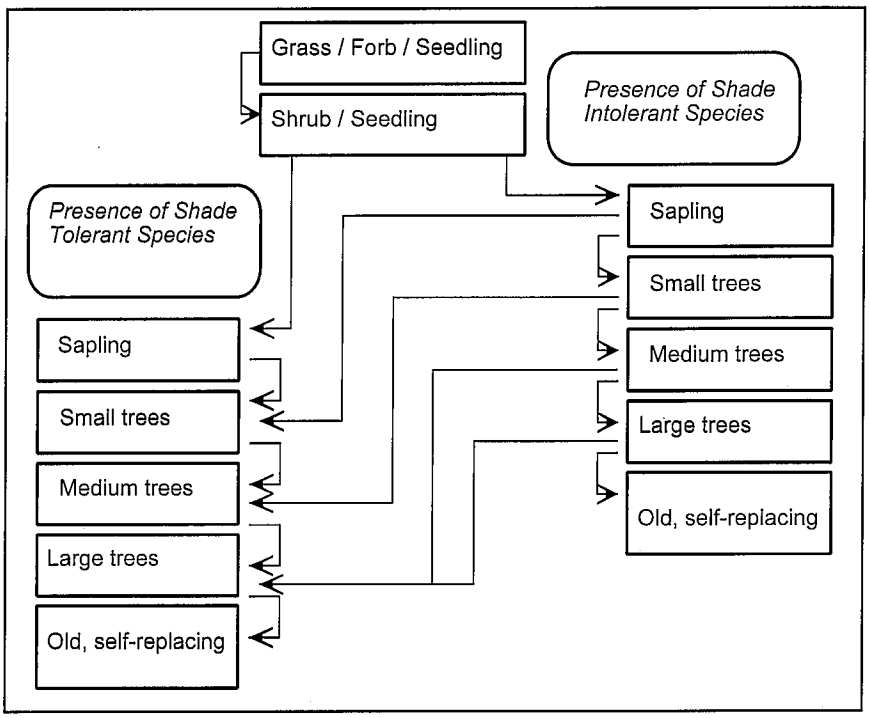
Mature/Shifting Mosaic: is "characterized by a shifting pattern of relatively small patchy disturbances (death of individual canopy trees or groups of trees forming gaps of various sizes and shapes) which provide resources for new establishment of trees in the understory and increased height growth of individuals in lower and mid-canopy positions." It is dominated by shade tolerant plants, except on fire-dependent ecological systems which support mature even-aged forests which are partially (e.g., oak) or fully shade intolerant (e.g., pine). Fire-dependent forests had stand altering fire events that would reset the successional regime. The mature/shifting mosaic phase is uncommon in current landscapes where logging and natural disturbances have occurred more frequently than the average life span of the dominant tree species.

The term **Vegetation Growth Stage** (VGS) is used to describe the current condition of a forest and its potential for change through succession. It combines successional and developmental stages that occur after disturbance, where successional stage refers to changes in species composition over time and developmental stage refers to stand structure over time. The primary growth stages are: grass / forb /seedling; shrub / seedling (seedlings and shrubs now dominate the site); sapling (dense stands

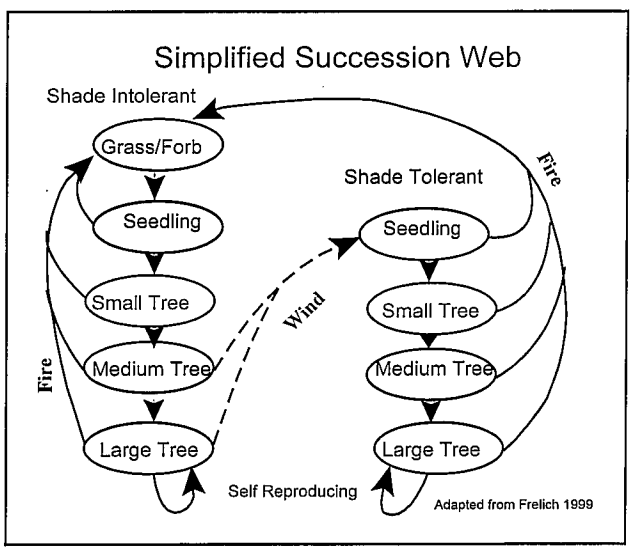
[10] Hunter, Malcolm, Jr. "Principles of Ecological Forestry", in *Maintaining Biodiversity in Forest Ecosystems*, edited by Malcolm Hunter, Jr., Cambridge University Press, 1999.

[11] Spies, Thomas, "Forest Stand Structure, Composition, and Function", in *Creating a Forestry for the 21st Century*, edited by Kathryn A. Kohm and Jerry F. Franklin, Island Press, 1997.

of trees less than 2" in diameter); small trees (trees are thinning out in number as size increases to 2-5" in diameter); medium trees (dominant trees are 5-9" in diameter while an understory is developing); large trees (dominant trees are 9-12" in diameter and understory is developed); old, self-replacing (dominant trees exceed 12" in diameter and capable of replacing themselves within the current forest structure). The stages are split between shade intolerant species (e.g., aspen, birch, tamarack) and shade tolerant ones (e.g., maple, basswood, balsam fir). Sites dominated by shade intolerant species at one stage may succeed to a shade tolerant stand as the under-story trees come to dominate the site. The accompanying figure summarizes the stages and potential direction of change.




The linear description of succession above does not take into account the impact of disturbance. As shown in the figure on the next page, in a natural state, that is absent intervention by humans, fire and wind play the major roles in altering the forest land-scape. Any stand can be affected by fire at any time and, in effect, have its successional cycle reset. Stands at the small tree stage or beyond are susceptible to wind damage, which resets succession back to the seedling or sapling stage and favors shade tolerant species if are present on the site.




It is important to remember that VGS refers to "time before disturbance", that is, the time that has elapsed since the stand was sufficiently disturbed through wind or fire to reset the stand's successional phase (modern era disturbances include timber harvesting and clearing for agriculture).

Precisely speaking, the term refers to the age of the *forest*. However, in practical terms, for most forests, the age of the forest and the age of the dominant trees will be the same. A key exception is older hardwood forests in their multi-aged self-sustaining mature stage at which time the forest age can be considerably older than that of the dominant trees.

In the absence of human intervention, these forces of forest succession create a patchwork of forest across the landscape that reflects how each forest community has adapted over time to the particular disturbance regimes characteristic of the regional landscape. As noted above, fire and windthrow have been the dominant types of disturbance in these forests. The capacity and timing of fire and wind to alter stands range from very short (50-80) years on dry outwash-dominated landscapes to over 1000 years in northern hardwood systems.

Knowing the timing and intensity of stand altering events, statistical models can be devised to estimate the relative proportions of cover types and age classes (i.e., the vegetation growth stages) that would typically occupy the landscape under steady state conditions. These proportions are similar to the "balanced age class acres" that are the general target for regulated forests. It differs however, in that the model accounts for different successional stages, allows age classes to differ in their relative proportion, and allows for the presence of age classes beyond the timber rotation age.

By running the model at the extreme high and low estimates for the fire and wind rotations, the range of proportions in each cover type or age class can be calculated. These calculated **ranges of natural variability** (RNV) can be compared to the existing acreages in each ecological type and ownership category.

In general, the region's history of logging, agricultural conversion of land, and fire suppression, the comparisons between the current forest and the RNV generally show an overabundance of age classes in the 60-80 year age class depending on the cover type, sometimes a poor representation and some times an excess in the youngest age classes, and almost always a poor representation in the older age classes. Understanding the RNV for a given forest landscape provides meaningful guidance for managing forests in a sustainable manner that emulates the forest conditions that occur under natural disturbance regimes.