A Case Study of New Brunswick Woodlot Owners Adapting to Climate Change

Prepared by staff of the New Brunswick Federation of Woodlot Owners
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Cover photo by Matthew Daigle, 2021

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Executive summary

The private woodlot owners of New Brunswick are a varied people. A 2019 survey (Woodlot Owner Survey Report)[i] found that they include all ages, all genders, all occupations and salary ranges. They also have a variety of different goals and objectives for their woodlots; including timber volume, recreation, and biodiversity to name a few. Additionally, woodlot sites can range from stony and hilly to former farmland, prone-to-flooding to susceptible-to-drought, dense tree stands to previously clear-cut. Private woodlots account for 30% of New Brunswick's forests and there are over 42,000 private woodlot owners in New Brunswick. For a small province there is a lot of diversity within this group.

To be able to explore how climate change will affect private woodlots in New Brunswick in the future we have selected and are in the process of studying four private woodlot sites that represent not only different site conditions and stand types throughout the province but also the different goals of their owners. Our case study includes a sample plot area on each woodlot consisting of a one acre control (i.e. left untreated), one acre with traditional silviculture treatments applied, and one acre that is treated using recommendations from the climate adaptive silviculture prescription tool (available for download on the NBFWO website)[ii].

The four woodlots used for the case study are each in a different eco-region of the province. They have their own unique features and site conditions, yet are still considered quite typical New Brunswick woodlots. Any woodlot owner in NB should be able to find similarities to their own woodlot with at least one of these sites.

The sample plot areas will remain in place for years to come, allowing for further study that will improve our knowledge about the effects of climate change on the Acadian Forest Region.

Introduction

The New Brunswick Federation of Woodlot Owners (NBFWO) is a not-for-profit association that promotes the economic and social interests of NB's private woodlot owners by representing their views with a united provincial voice. We coordinate educational and project opportunities on topics of interest to woodlot owners. We collaborate with Forest Products Marketing Boards and other like-minded organizations that are providing services to woodlot owners and act as a networking hub for all things woodlot related.

In the fall of 2018, the NBFWO was chosen to participate in Natural Resource Canada's Building Regional Adaptation Capacity and Expertise program (BRACE). This federal program was developed in response to the Pan-Canadian Framework on Clean Growth and Climate Change report [iii] where it was identified that building capacity is needed to translate knowledge into climate change adaptation action. The BRACE program goals are to increase the ability of communities, organizations, small and medium-size enterprises and practitioners to incorporate climate change into their planning and management and to be more climate-resilient.

As part of the NBFWO's BRACE project, and with additional funding from the Government of New Brunswick's Environmental Trust Fund, this case study was created to demonstrate a range of approaches that make practical, ecological, and economic sense to woodlot owners and that demonstrate how peers are applying climate adaptive silviculture prescriptions.

Four privately owned woodlots located throughout New Brunswick were chosen to highlight typical forest stand conditions found in the province and explore what changes to can be made to traditional forest silviculture management that will allow these woodlots to become more resilient to the changing climate conditions. Each of these woodlots will be explored in detail later in the case study, but we will begin with some information about climate change and the potential impacts to the Acadian Forest Region.

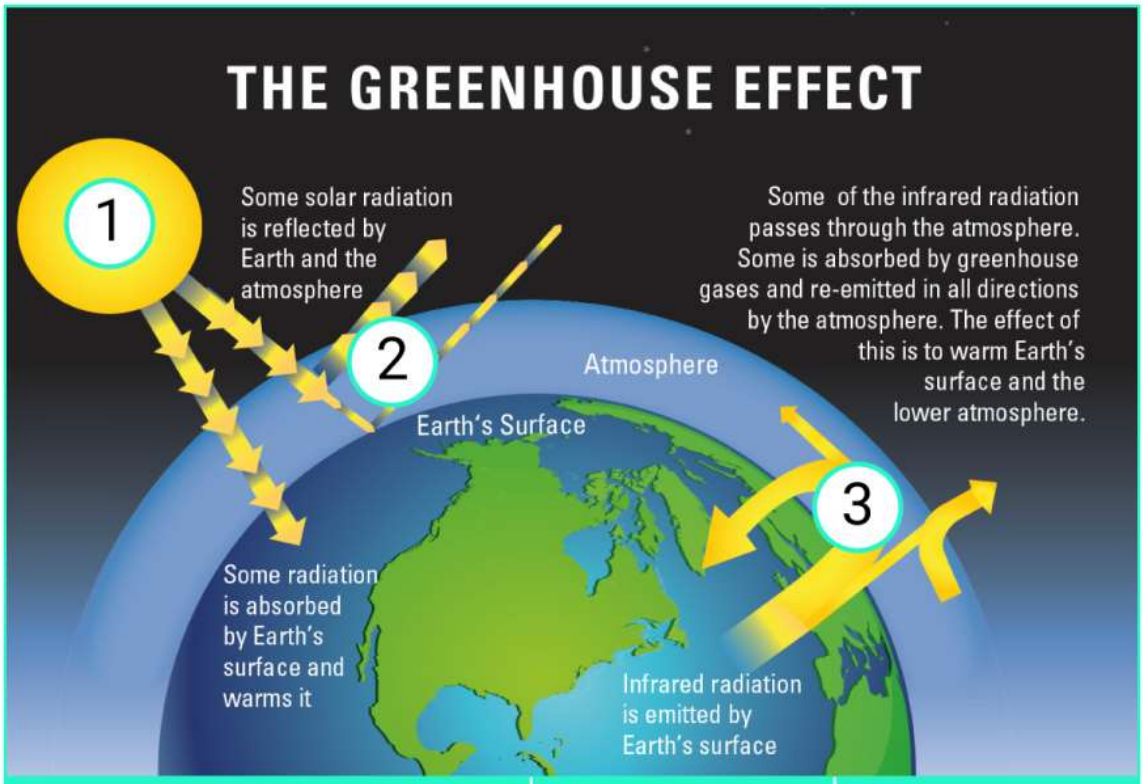
What is a Changing Climate?

"To understand climate change, we first need to understand the difference between weather and climate. Weather refers to the actual atmospheric conditions that are being experienced now. It also includes changes that are forecast over the next few days, for example, in temperature and rainfall. Climate refers to the kind of weather that's typically expected in a region. This includes describing the range of conditions that are possible.

Climate change is a long-term shift in the average weather conditions of a region, [such as] temperature, rainfall, and windiness. Climate change means that the range of conditions expected in many regions will change over the coming decades. This means that there will also be [increases in the frequency and intensity of] extreme conditions.

The climate varies naturally from year to year and decade to decade. This is caused by natural processes linking the atmosphere, ocean and land, as well as variations in heat output from the sun. In addition to changes in climate that are caused by natural climate variability, climate change [is] caused by human activity. The kind of climate change we are experiencing now is being caused primarily by human activities that [have and are releasing] greenhouse gases to the atmosphere" (Climate Change Concepts, 2022)[iv].

In Figure 1, on the next page, you can see the sun is the source of energy for Earth (1). Some of the sun's energy is reflected back to space (2), but the rest is absorbed by the atmosphere, land, and ocean and re-emitted as longwave radiation (infra-red energy). Some of this infra-red energy is absorbed and then re-emitted by greenhouse gases in the lower atmosphere, trapping heat in the lower atmosphere and reducing how much is radiated to outer space. This process is known as the greenhouse effect (3). Changes to the amount of incoming solar radiation (1), the amount of reflected sunlight (2), and the heat-trapping capacity of the atmosphere (3) cause climate warming or cooling. Factors that drive such changes are called climate drivers or climate forcing agents.



Climate Drivers	Warming Effects	Cooling Effects
1 Fluctuations in solar output change the amount of incoming solar radiation	Increases in solar radiation	Reductions in solar radiation
2 Changes in the albedo (reflectivity) of the Earth's atmosphere and surface (e.g., through changes in atmospheric aerosols, related changes in cloud, and changes in land and ice cover) affect the amount of solar radiation available for absorption	Decreases in albedo	Increases in albedo
3 Changes in atmospheric GHGs affect the emission of infrared radiation (radiant heat) to space	Increases in atmospheric GHGs trap more heat	Decreases in atmospheric GHGs allow more heat to escape

Figure 1 The greenhouse effect and key drivers of climate change.

"The greenhouse effect is a natural and necessary process. This keeps the temperature at the Earth's surface around 15 degrees C, and without the greenhouse effect, life on Earth, as we know it, would not be possible.

However, the heat trapping capacity of the atmosphere has changed because of human activities:

- Climate warming decreases the amount of snow and ice cover on Earth [which reduces] the Earth's albedo (reflectivity). Darker land and water surfaces exposed by melting snow and ice absorb more incoming solar radiation, adding more heat to the climate system and amplifying the initial warming, in turn causing further melting of snow and ice.

- The combustion of fossil fuels emits CO2 and other GHGs, considerably increasing their concentration in the lower atmosphere. Moreover, this combustion is associated with the emission of pollutants which form aerosols of various chemical compositions, which absorb solar radiation and create a net warming effect in the atmosphere. " (Canada's Change Climate Report 2019)[v]

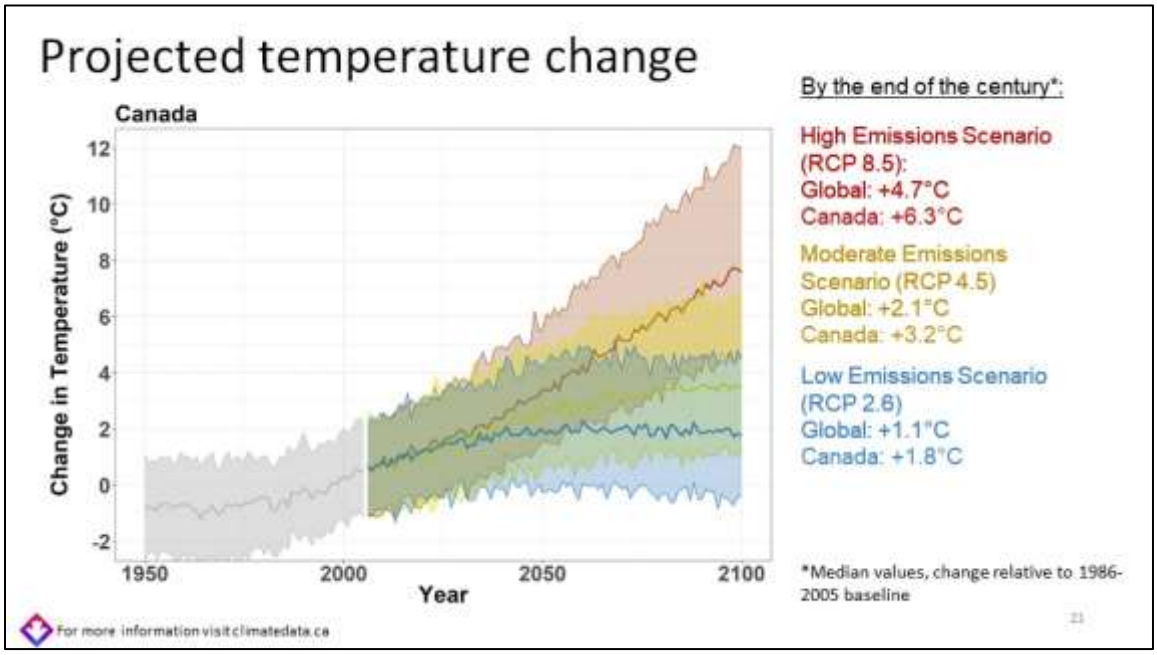


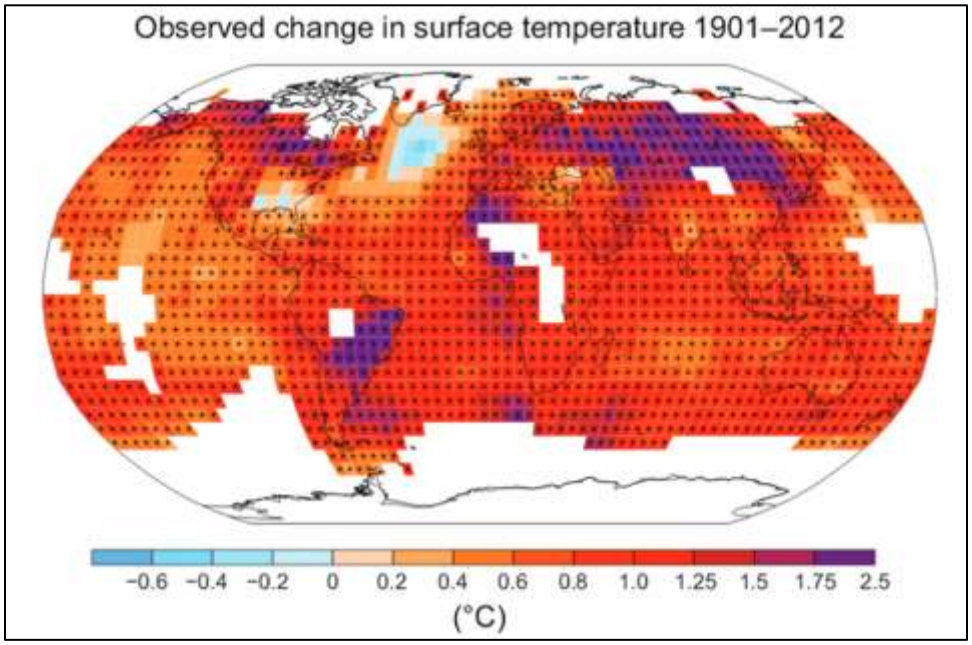
Figure 2 simulated historical and projected temperature in Canada.

*The "by the end of this century values" show the projected changes in mean annual temperature for the 2081-2100 time period relative to the 1986-2005 baseline time period.

The climate has always been changing. What is different now is the [rate of climate change and that] the additional effects from human activities (greenhouse gases, aerosols, changes in land use all combined) have become clearly discernable over the past several decades.

A report published by the IPCC (Intergovernmental Panel on Climate Change) in 2018 maintains that human activity has caused a warming of approximately 1.0°C, with a range of 0.8°C to 1.2°C over the whole globe since 1880.

But that is the average. The figure below also illustrates the fact that an average global warming value does not represent the reality in all local settings. For example, some regions (in purple) have experienced close to a 2.5 degree warming. These differences will lead to much different impacts to individual regions.



Global average temperature has increased by about **1°C** since 1880**.**

Figure 3 Global observed change in surface temperature 1901-2012.

The number of climate related events are increasing; extreme temperatures, droughts, forest fires, and tropical storms. Remember the Fort McMurray, Alberta wildfires? How about the drought followed by heavy rains that flooded British Columbia in 2021? These were destructive events that climate researchers have concluded were made more damaging due to climate change. And we can expect the numbers to grow. Between 1980 and 2018 (only 28 years) North America saw an increase of approximately 600 hydrological and climatological events (from 250 to 850).

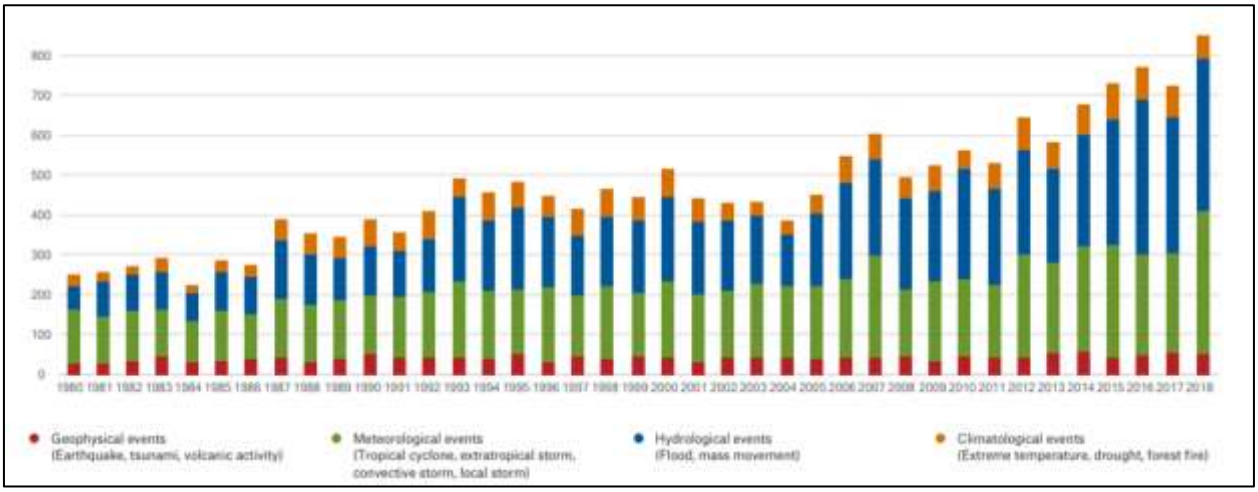


Figure 4 Number of hydrological and climatological events in North America 1980-2018.

Climate Change in New Brunswick

"The forests of the Maritime provinces of Canada (a.k.a. the Maritimes), as well as the forests of the Gaspé region of Quebec and those of the New England states, form a unique forest type known as the Acadian forest. The Maritimes, and indeed all of the Acadian Forest Region, has been historically located at the very northern limit of a temperate climate – a temperate-boreal (i.e. hemiboreal) transitional climate. Many of the temperate species found in the Maritimes are found at the northern limits of their historical ranges. Likewise, many of the boreal species found in the Maritimes are at the southern limits of their historical ranges. Unlike the more continental climates of hemiboreal forest regions/eco-zones west of the Maritimes, the historical climate of the Maritimes has been relatively moderated by the North Atlantic, where precipitation has not been a limit to growth, at the regional scale, and where summers have been cooler and winters milder, than more continental climates to the west. There is, however, considerable variability in local climates (i.e. ecoregions) within the Maritimes, due to proximity to the ocean and changes in elevation. For example, western New Brunswick has a significantly more continental climate than ecoregions closer to the coast, and the highest elevations in New Brunswick have historically had true boreal climates." (Climate Change Resilience and Carbon Storage Silvicultural Prescriptions for the Acadian Forest Region Appendix B - Supporting Information v.1.0, 2019)[vi]

"The effects of climate change are being experienced in New Brunswick and are expected to further impact the province in the future. Climate change will affect all aspects of the environment, economy and society in New Brunswick.

The environmental effects of greenhouse gas (GHG) emissions will continue to increase unless action is

taken to limit their production. However, efforts to reduce greenhouse gas emissions cannot stop climate change from occurring. Therefore, New Brunswick must also take measures to adapt to the effects of climate change.

How has climate change affected New Brunswick?

The Province is already experiencing the impacts of climate change. New Brunswick's mean annual temperature has already increased by 1.1°C in the last 30 years. Rising sea levels have also increased the risk of flooding and coastal erosion. Since December 2016, a number of extreme weather events have occurred including a snow and freezing rain storm [which destroyed] much of the electrical distribution infrastructure in the Acadian Peninsula and resulted in long duration power outages. In 2018 and 2019, the province experienced back-to-back spring flooding along the St. John River. [The 2018 flood was record setting and caused] the highest damage costs of any flood event. Additionally, in late summer of 2019, post-tropical storm Dorian brought high winds and rain to the region that resulted in extensive property, infrastructure, and shoreline damage.

How will climate change affect New Brunswick in the future?

Climate projection datasets indicate the province will become warmer, wetter, stormier, and will experience rising sea levels, which represents significant challenges and opportunities for New Brunswick's communities and resource sectors.

Warmer temperature

In New Brunswick, projections indicate an anticipated [increase in temperature between 1.6°C (under a low emissions scenario) up to 5.3°C (under a high emissions scenario) across] the province, [by the year 2100], with some areas becoming warmer than others. Projections also indicate a substantial increase in very hot days (days above 30°C) and longer growing seasons. Anticipated effects of warmer temperatures include an increase in risk to water quality, increase in pests/invasive species, more freeze-thaw events or potential for health impacts such as heat stress.

Wetter

Annual precipitation is projected to increase with a shift toward more rain days and less snowfall days. This will result in increased run-off, flooding and erosion and increased risk of damage to and failure of key infrastructures.

Stormier

High intensity precipitation events are becoming more common. Projections indicate that New Brunswick can expect more extreme and variable weather patterns. [Weather will increase damage to trees and] infrastructure such as buildings, homes and critical services like the electrical grid from high winds, ice storms and extreme storm surges.

Rising Sea Levels

Sea level rises primarily as a result of the melting of glaciers and ice caps and the rate at which

they are melting has increased due to global warming. In New Brunswick, sea level is predicted to rise by approximately 1m by 2100. Sea level rise combined with high tidal cycle and storm surge can lead to increased flood elevations and increased risk of coastal flooding [and erosion], potential loss of natural habitat and damage to infrastructure." (Climate change affecting NB 2022)[vii]

Assessing Risks and Vulnerabilities

Before you can decide on a plan for the future the number one recommendation for every woodlot owner is 'know what you have'. Take a survey or inventory of the site conditions (e.g. rocky, shallow soil, steep slope, prone to flooding, wind risks, etc.) and species that are present on your woodlot(s). Your local Forest Products Marketing Board[viii] can help you with this task.

Milder winters and warmer springs could also increase vulnerability to certain pests and diseases such as Balsam Woolly Adelgid, Spruce Budworm outbreaks.

In 2018, Community Forests International summarized the projected effects from climate change on trees and their capacity to persevere in the future[ix]. This review is highly recommended reading for anyone in New Brunswick, or the rest of the Maritimes, taking climate change into consideration when adjusting their silviculture management. The table below is a summary of the probable future for certain native tree species from that report.

Native Tree Species		Probable Future
English	Scientific (Latin) name	
American Basswood	*Tilia americana*	Decline
American Beech	*Fagus grandifolia*	Prosper
American Mountain Ash	*Sorbus americana*	Persevere
Balsam Fir	*Abies balsamea*	Decline
Balsam Poplar	*Populus balsamifera*	Persevere
Black Ash	*Fraxinus nigra*	Decline
Black Cherry	*Prunus serotina*	Prosper
Black Spruce	*Picea mariana*	Decline?
Black Willow	*Salix nigra*	Decline
Bur Oak	*Quercus macrocarpa*	Persevere
Butternut	*Juglans cinerea*	Persevere
Eastern Hemlock	*Tsuga canadensis*	Persevere
Eastern Larch	*Larix laracina*	Unclear
Eastern White Cedar	*Thuja occidentalis*	Isolated patches?
Grey Birch	*Betula populifolia*	Decline
Ironwood	*Ostrya virginiana*	Proliferate
Jack Pine	*Pinus banksiana*	Decline?
Large Toothed Aspen	*Populus granidentata*	Decline
Mountain Maple	*Acer spicatum*	Persevere
Mountain Paper Birch	*Betula cordifolia*	Prosper
Pin Cherry	*Prunus pensylvanica*	Persevere
Red Maple	*Acer rubrum*	Proliferate
Red Oak	*Quercus rubra*	Proliferate
Red Pine	*Pinus resinosa*	Decline
Red Spruce	*Picea rubens*	Isolated patches?
Serviceberry	*Amelanchier canadensis*	Persevere
Silver Maple	*Acer saccharinum*	Persevere
Striped Maple	*Acer pensylvanicum*	Persevere
Sugar Maple	*Acer saccharum*	Persevere
Trembling Aspen	*Populus tremuloides*	Unclear
White Ash	*Fraxinaus americana*	Prosper
White Birch	*Betula papyrifera*	Decline
White Elm	*Ulmus americana*	Prosper
White Pine	*Pinus strobus*	Prosper
White Spruce	*Picea glauca*	Decline
Yellow Birch	*Betula allenghaniensis*	Isolated patches?

Figure 5 Table of native tree species and their probable futures.

Case Study Overview

The objective of this case study is to build the capacity of woodlot owners to make management decisions that consider climate change, through education and implementation of best management practices. The result will be forests that are more climate resilient, and a resilient forest is an important component of a healthy ecosystem.

Whatever the goals an owner may have for their woodlot – whether it is increasing timber volume, creating wildlife habitat, or just for their own recreation, the same best management practices can be applied to woodlot management. And remember, what was considered 'best' 30 years ago, may not be what the experts agree on today.

As part of the NBFWO BRACE project, we specifically wanted to train foresters, forest technicians, and woodlot owners to use and incorporate New Brunswick-generated climate change adaptation guidelines and tools in woodlot management plans and ongoing silviculture practices. The silviculture tools created, and additional information[x] curated on the NBFWO website as part of this project, is designed for use in the Acadian Forest Region. There is a lot of great research ongoing in the Boreal forest region, but it is harder to find information that relates to closer to home. We are working to help change that.

Figure 6 the locations of the four woodlot sites (Google Earth Image Map):

- Site 1: Hazen & Karen McCrea, South Tetagouche, NB
- Site 2: Jorg & Gloria Beyeler, Sypher Cove, Grand Lake, NB
- Site 3: Conrad & Elspeth Leroux, Windsor, NB
- Site 4: McCrea Farms, Shannon, NB

The 4 woodlots used for the case study are each in a different eco-region of the province. They have their own unique features and site conditions, yet are still considered quite typical New Brunswick woodlots.

Any woodlot owner in NB should be able to find similarities to their own woodlot with at least one of these sites; whether they have a lot of balsam fir and are wondering what to do with it, or if they want to add some species diversity to a solid softwood stand, or are dealing with particularly challenging site conditions such as steep slope.

These generous owners have allowed us to set up a study area on their lands. The study area is approximately 3 acres of a relatively homogenous stand type, which is then divided into 3 approximately one acre plots;

- **Control** - Plot 1 is a control area that will be left untreated.
- **Traditional** - Plot 2 is treated with what is considered a 'traditional' silviculture treatment (for example clear cutting).
- **Climate adaptive** - Plot 3 is treated with what is considered a 'climate adaptive' silviculture treatment (for example planting climate resilient species).

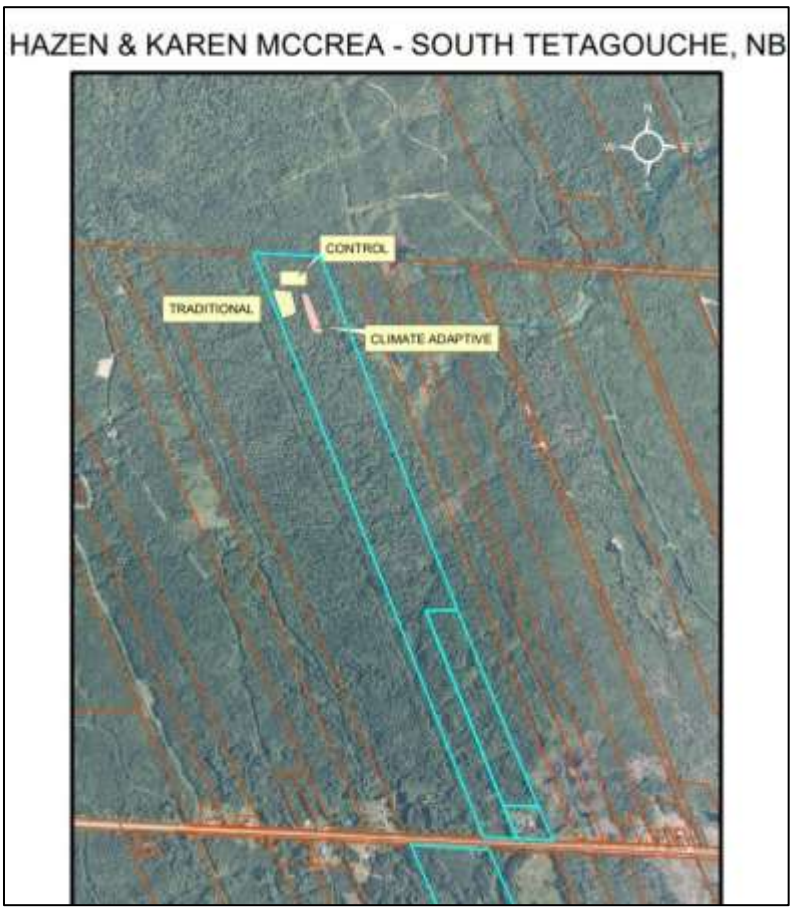
The Climate Adaptive silviculture prescription for each site was created using the Climate Adaptive Silviculture Prescription Tool[xi] created for the BRACE project. On each woodlot study area, foresters collected plot data to establish the species on site and calculate timber volumes. In the case of Site 3, the regeneration was still too young to contain merchantable timber volume so stems per hectare (stems/ha) was determined instead. Average stand age, percent crown closure, regeneration status, ground conditions and the history of the area were noted.

Site 1: Hazen & Karen McCrea

Introduction

Hazen and Karen McCrea have owned their 200+ acre woodlot on Route 180 in South Tetagouche for over 30 years. Hazen particularly values the tree plantation on their woodlot.

The main objectives for their woodlot include increasing timber production and maintaining wildlife habitat.



Site Description

Location: Route 180, South Tetagouche , NB.

GPS coordinates:
access: 47.579782; -65.934934
sites: 47.595318; -65.942213

Ground conditions:

- Moderate drainage
- Good operability
- No slope or rockiness

Site conditions:

- Softwoods are mature to over-mature
- Hardwoods are mature
- Little to no regeneration present
- Blowdowns, stem breakages, broken tops, up-rooted trees are present
- Regeneration consists of mainly red maple with occasional sugar maple, stunted and suppressed balsam fir and spruce also present
- Wildlife signs of moose and bear were observes along with small animals and many bird species

History of study site: Little to no invention has taken place, however an occasional old stump is present.

Species summary pre-treatment:

SPECIES	*CONTROL*		*TRADITIONAL TREATMENT*		*CLIMATE ADAPTIVE TREATMENT*	
	M3	**Cords**	**M3**	**Cords**	**M3**	**Cords**
Spruce	10.5	4.8	18	8.3	3	1.3
Balsam fir	16	7.1	16	7.1	16	7.1
Cedar	3	1.35	3	1.4	3	1.3
Red maple	9	5.15	5	3	13	7.3
White birch	3	1.7	0	0	6	3.4
Yellow birch	14	7.6	11	5.9	17	9.3
Ash	1	0.5	2	1	0	0
TOTAL	***56.5***	***28.2***	***55***	***26.7***	***58***	***29.7***

Owners Survey

What has the woodlot been used for in the past (e.g. timber harvesting, firewood, farmland, been left wild and free)? All of the above.

What are your short-term goals for your woodlot (next 7 years)? Improve [the growing conditions for resilient species and wildlife habitat].

What are your mid-term goals for your woodlot (7–35 years)? Improve.

What are your long-term goals for your woodlot (35+ years)? Improve.

Have you previously taken your woodlot's ability to adapt to future changing climate conditions into consideration? Yes.

Are you currently aware of what future modelling shows for NB's climate conditions? Not all of it.

Do you think your woodlot will be resilient to NB's changing climate conditions? Why? No, I'm going to lose all my [balsam] fir.

Sample Plot Area Implementation

Size of sample plots:

TREATMENT	***AREA (HECTARES)***	***AREA (ACRES)***
Control	0.4	0.99
Traditional	0.5	1.24
Climate Adaptive	0.4	0.99
TOTAL	***1.3***	***3.21***

Traditional treatment: Clear-cut the area. Remove all merchantable timber.
Goal: To salvage volume as stand is over-mature with moderate to poor health.

Climate adaptive treatment: Remove all softwoods. Retain the sugar maple and yellow birch. Scuff up the soil as much as possible during harvest to create favourable seedbeds for birch and maple regeneration. Harvesting completed with a single-grip tracked harvester to reach into the area from the sides thus not creating trails.
Goal: To encourage the establishment of long lived climate adaptive species using existing mature trees as seed source.

Species summary post-treatment:

SPECIES	***CONTROL***		***TRADITIONAL TREATMENT***		***CLIMATE ADAPTIVE TREATMENT***	
	M3	**Cords**	**M3**	**Cords**	**M3**	**Cords**
Spruce	10.5	4.8	0	0	3	1.3
Balsam fir	16	7.1	0	0	0	0
Cedar	3	1.35	0	0	0	0
Red maple	9	5.15	0	0	0	0
White birch	3	1.7	0	0	0	0
Yellow birch	14	7.6	0	0	17	9.3
Ash	1	0.5	0	0	0	0
TOTAL	***56.5***	***28.2***	***0***	***0***	***20***	***10.6***

Outcomes and Monitoring Progress

This section will be updated each time a site visit is made to measure the updated volumes and site conditions. The first anticipated update will be in fall of 2022, and then every five years afterwards.

Site 2: Jorg & Gloria Beyeler

Introduction

Jorg & Gloria Beyeler own 1100 acres (445 hectares) of land south of Minto and west of Grand Lake. It has waterfront at Sypher Cove, an old growth area along Sypher Brook, a significant moose habitat in boggy areas, and borders on the Grand Lake Meadows Protected Area.

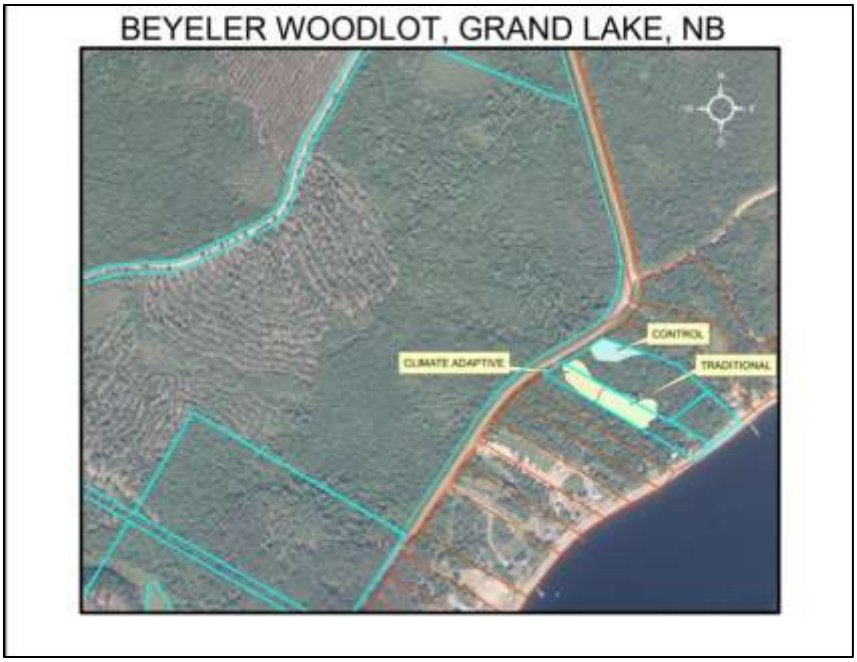
Jorg is a forester and currently owns a forestry business. They have owned part of their woodlot since 1982, with an additional purchase of land in 2001.

Their main objectives for their woodlot include decreasing the risk from Spruce budworm, increase the number and variety of climate adaptive tree species, and maintain a healthy ecosystem.

Site Description

Location: Windy Haven Lane, off Route 690 (Pondstream Road), Grand Lake, NB

GPS coordinates:
Sites & access: 45.991625; -66.057745



Ground conditions:

- Well-drained
- Little to no slope
- Good operability

Site conditions:

- On the shore of Grand Lake, potential for strong wind
- Evidence of a healthy ecosystem (rabbits, deer, bear, birds, mushrooms, ferns, shrubs, etc.)

History of study site: Little to no intervention has taken place, however some areas were pre-commercially thinned (especially in the Control area).

Species summary pre-treatment:

SPECIES	*CONTROL*		*TRADITIONAL TREATMENT*		*CLIMATE ADAPTIVE TREATMENT*	
	M3	**Cords**	**M3**	**Cords**	**M3**	**Cords**
Spruce	0	0	8	3.44	20	9.14
Balsam fir	2	1	25	11.04	29	12.88
White pine	5	0.9	77	29.62	22	8.6
Red maple	19	10.28	19	10.28	18	9.92
White birch	1	0	4	2.4	8	4.36
Oak	0	0	0	0	6	3.13
TOTAL	***27***	***12.18***	***133***	***56.78***	***103***	***48.03***

Owners Survey

What has the woodlot been used for in the past (e.g. timber harvesting, firewood, farmland, been left wild and free)? It is primarily a timber production property with approximately 92% productive forest land with the special features as explained above. The property has been managed extensively over the past 37 years with most of the property under active management.

What are your short-term goals for your woodlot (next 7 years)?

1. Reduce risks to the current threat by the Spruce Budworm by harvesting mature stands that have pre-dominantly Balsam Fir.

2. Complete an upgrading of the road network for the property.

3. Actively introduce and increase the range of red oak and bur oak species on the property by planting acorns and seedlings over the next few years.

4. Complete all the necessary follow-up activities and treatments from the recent 6 years of various types of harvest treatments.

5. Re-establish the trail network that may have been impacted by the harvest treatments over the past six years.

What are your mid-term goals for your woodlot (7–35 years)?

1. Create a succession plan to ensure the continuous management of the property within our family as I mature into older age.

2. Achieve a diversification of revenue sources from the woodlot; along with our other properties to reduce the dependence of harvesting timber to generate income.

3. Gradually shift the age class structure and also create a higher percentage of age class diversity within stands during this period.

4. Increase the percentage of ecosystem types and stands that become un-even aged and partially harvested on an approximate 15 years entry cycle.

5. Increase the woodlot's potential to become resilient to the changing climate by adapting our management practices during this period.

What are your long-term goals for your woodlot (35+ years)?

1. Achieving and maintaining a long-term sustainable harvest level using multiple harvest treatments that diversify the harvest entry regimes and also maintaining a consistent forest growth and health across all productive forest areas.

2. Consistently increase the financial value of the woodlot into the future.

3. Maintain ecosystem biodiversity by achieving a reasonable balance of healthy forest conditions on the productive forest areas as well as maintaining some old growth ecosystems all of which would benefit wildlife flora and fauna as natural habitats.

Have you previously taken your woodlot's ability to adapt to future changing climate conditions into consideration?

Yes, I am well aware of the need to create future climate change resiliency on this this woodlot and on all my woodlot properties. This includes aspects of climate change such as temperature warming, changes in weather volatility; wind events, greater threats from hurricanes, severe rain events, drought periods, changing frost conditions and a gradual reduction in winter cold temperatures. All these factors ultimately affect species range changes, insect and disease threats, wildfire risks, surface water movement and run off, ground water table changes as examples.

That's a long way of saying yes, I have been making gradually adjustments to property and forest management procedures to hopefully create more resiliency on my properties by adaptive management.

Are you currently aware of what future modelling shows for NB's climate conditions?

Yes, but haven't really updated my knowledge in the last few years.

Do you think your woodlot will be resilient to NB's changing climate conditions? Why?

Well, I definitely hope so, but the uncertainty regarding the rapidly changing climate conditions will create risks that are hard to predict. The main aspects of changes to our management practices involve focusing on species that will be more resilient in a warmer climate, changing the forest structure diversity with longer rotations and greater species diversity, improving surface water management on woodlot road networks, and protecting stand treatments from severe wind events as much as possible.

Sample Plot Area Implementation

Size of sample plots:

TREATMENT	*AREA (HECTARES)*	*AREA (ACRES)*
Control	0.3	0.74
Traditional	0.6	1.48
Climate Adaptive	0.4	0.99
TOTAL	***1.3***	***3.21***

Traditional treatment: Shelter-wood cut to retain good quality white pine. Remove all balsam fir, spruce and poor quality hardwoods. Work was completed using a single-grip harvester and porter system.
Goal: To salvage fir and spruce volume before lost to maturity and encourage white pine regeneration.

Climate adaptive treatment: Remove all balsam fir, spruce and poor quality hardwoods. Retain white pine where present. Plant red oak seedlings in openings, and protect from browse with protective sleeve. Work was completed using a single-grip harvester and porter system.
Goal: To increase diversity of climate adaptive species through planting of red oak seedlings and acorns.

Species summary post-treatment:

SPECIES	*CONTROL*		*TRADITIONAL TREATMENT*		*CLIMATE ADAPTIVE TREATMENT*	
	M3	**Cords**	**M3**	**Cords**	**M3**	**Cords**
Spruce	0	0	0	0	0	0
Balsam fir	2	1	0	0	0	0
White pine	5	0.9	77	29.62	22	8.6
Red maple	19	10.28	12	6.42	12	6.3
White birch	1	0	4	2.4	8	4.36
Oak	0	0	0	0	6	3.13
TOTAL	***27***	***12.18***	***93***	***38.44***	***48***	***22.39***

Outcomes and Monitoring Progress

This section will be updated each time a site visit is made to measure the updated volumes and site conditions. The first anticipated update will be in fall of 2022, and then every five years afterwards.

Site 3: Conrad & Elspeth Leroux

Introduction

Conrad and Elspeth Leroux own 487 acres of land off of Route 580 in Carleton County. They first bought a section of the woodlot in 1978. Conrad is retired and enjoys the peacefulness of his woodlot. He wants to improve the growing conditions to increase the health, diversity and resilience of his woodlot so it produces productive trees of the highest quality.

Site Description

Location: Route 580, Windsor Settlement, Carleton County

GPS coordinates:
access: 46.405942; -67.409535
sites: 46.405932; -67.420517

Ground conditions:

- Well-drained
- South-east slope
- Good operability

Site conditions:

- Softwood height: 2-3 metres
- Hardwood height: 5-6 metres
- Predominantly hardwood area on slight rocky slope with southern exposure.
- A few mature softwoods, mostly younger sugar maple, red maple, poplar and cherry
- Fast growth due to soil fertility
- Occasional ledge outcrops under shallow soil
- Occasional areas of poor drainage
- Regeneration too young to provide timber volume (M3 or cords), so stems per hectare (stems/ha) were determined.

History of study site: Formerly cleared farmland (before the 1970's). One part of the woodlot was used as a Christmas tree plantation, and after they stopped selling Christmas trees, the remaining plantation was left to grow on its own. Another section had a Red pine plantation that was harvested in 2018/19. The area where the case study site is located was clear cut about 20 years ago.

Species summary pre-treatment:

SPECIES	***CONTROL***	***TRADITIONAL TREATMENT***	***CLIMATE ADAPTIVE TREATMENT***
	stems /ha	**stems/ha**	**stems /ha**
Spruce	125	125	125
Balsam fir	1312	1312	1312
Cedar	62.5	62.5	62.5
Sugar maple	3000	3000	3000
Red maple	3313	3313	3313
Yellow birch	188	188	188
White birch	3250	3250	3250
Beech	2500	2500	2500
Trembling aspen	3032	3032	3032
Largetooth aspen	3032	3032	3032
Ash	750	750	750
Ironwood	750	750	750
Pin cherry	1625	1625	1625
TOTAL	***22939.5***	***22939.5***	***22939.5***

Owners Survey

What has the woodlot been used for in the past (e.g. timber harvesting, firewood, farmland, been left wild and free)?

Prior to the 1970's, about half was cleared land used for farming. After our acquisition, part was operated as a Christmas tree plantation. This was eventually stopped due to market conditions and time constraints. The remaining trees were left to grow. Those and the Red Pine plantation were harvested in 2018/19 and the ground was scarified in 2020. Other former fields have almost all reverted to commercial and non-commercial forest species of varying ages. During our tenure, much of the wooded areas have been cut. Some clear-cut, some selective thinning cuts, with help from CVWPA (Carleton Victoria Wood Producers Association).

What are your short-term goals for your woodlot (next 7 years)?

- Replant the 2018/19 clear-cut area of Balsam Fir and Red Pine (with spruce and white pine).
- To include a component of White Pine in a manner which will facilitate control of inevitable weevil attack
- Pre-commercial thinning of hardwood regeneration in areas (that were previously) clear cut on Lot 58.
- Attempt to establish suitable hardwood replacement for the expected loss of all ash trees due to emerald ash borer.
- Presently attempting establishment of Red Oak by seeding of acorns on a trial basis.
- Monitor beech regeneration for feasibility of encouraging strains resistant to the bark disease which infects the majority of beech trees.
- Considering my age, arrange for the orderly transfer of ownership of the woodlot, hopefully within the family.

What are your mid-term goals for your woodlot (7–35 years)?

I would hope that the next owners are family members who will manage for a well-stocked forest of various age groups and diverse species native to the Acadian Forest or suitable for expected climate changes.

What are your long-term goals for your woodlot (35+ years)?

Basically, that the woodlot be fully stocked, tending more to climax species and aiming for a future harvest of greater value due to larger trees of higher quality. It is very difficult to predict what will be in demand for future markets and what future strains will occur from disease and climate change. The wisest approach will probably be to avoid reliance on one or a few products. Monoculture is very risky.

Have you previously taken your woodlot's ability to adapt to future changing climate conditions into consideration?

No. Only in the last year, or so. The Federation's seminar in Fredericton last year on this topic was an eye-opener for me. I now realize that this is important.

Do you think your woodlot will be resilient to NB's changing climate conditions? Why?

There will always be trees of some kind in the woodlot. Will they be healthy? Will they be of commercial value? Will the species mix change? Will we continue to lose species due to imported diseases? Who can say for sure? But I do believe that we should plan and act based on best available information and forecasts.

Sample Plot Area Implementation

Size of sample plots:

TREATMENT	*AREA (HECTARES)*	*AREA (ACRES)*
Control	0.4	0.99
Traditional	0.6	1.48
Climate Adaptive	0.7	1.73
TOTAL	***1.7***	***4.2***

Traditional treatment: Pre-commercially thin favouring traditional softwood species retaining hardwoods where no softwoods are present.
Goal: Timber volume.

Climate adaptive treatment: Pre-commercially thin favouring climate adaptive species such as sugar maple, and favouring hardwoods over softwoods. (i.e. White birch over balsam fir as in next rotation fir will regenerate in the shade and once again dominate whereas white birch will not be able to re-establish under the canopy of existing trees.
Goal: To create favourable growing conditions for the climate adaptive species and minimize balsam fir content.

Species summary post-treatment:

SPECIES	*CONTROL*	*TRADITIONAL TREATMENT*	*CLIMATE ADAPTIVE TREATMENT*
	stems /ha	**stems/ha**	**stems /ha**
Spruce	125	0	0
Balsam fir	1312	688	0
Cedar	62.5	0	0
Sugar maple	3000	250	375
Red maple	3313	188	438
Yellow birch	188	0	0
White birch	3250	1125	188
Beech	2500	0	188
Trembling aspen	3032	32	875
Largetooth aspen	3032	32	438
Ash	750	63	0
Ironwood	750	0	0
Pin cherry	1625	0	0
TOTAL	***22939.5***	***2378***	***2502***

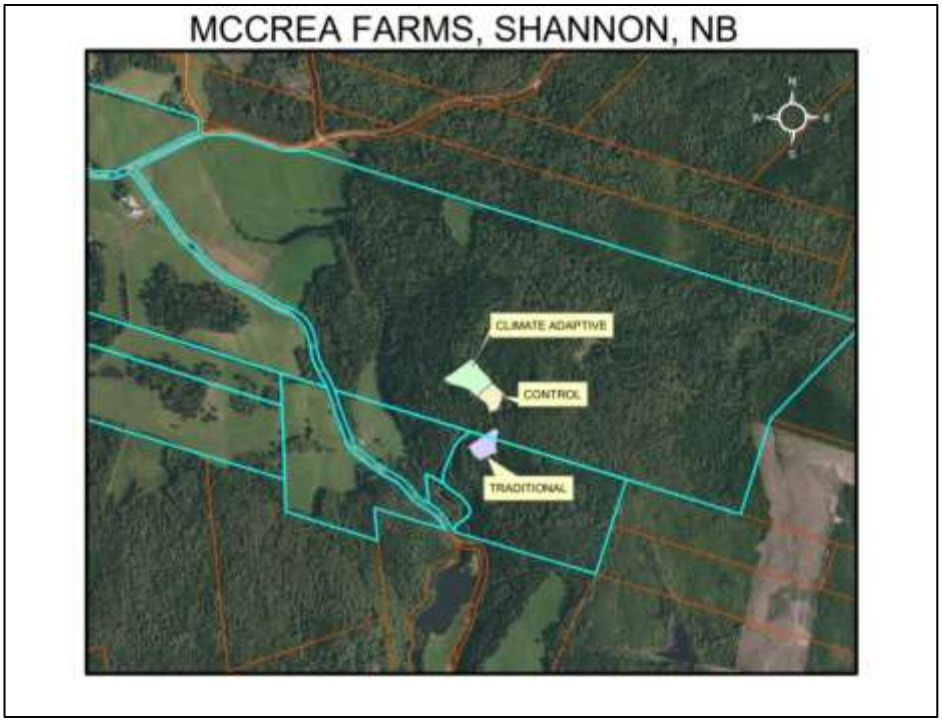
Outcomes and Monitoring Progress

This section will be updated each time a site visit is made to measure the updated volumes and site conditions. The first anticipated update will be in fall of 2022, and then every five years afterwards.

Site 4: McCrea Farms

Introduction

McCrea Farms, owned by Jim McCrea and his daughter and son-in-law, Nancy and Bruce Colpitts, has belonged to the family for 80 years. The PID the case study is located on consists of 300 acres, but their total woodlot is over 5000 acres. They use the woodlot for timber harvesting, firewood, farmland, and tourism trails.



Site Description

Location: 2670 Route 705, Shannon, NB

GPS coordinates:
access: 45.705986; -65.973931
sites: 45.699119; -65.968262

Ground conditions:

- Mossy
- Heavily shaded
- Occasional rockiness

Site conditions:

- stand age = 42 years
- 75% crown closure
- Spruce regeneration is scattered amongst the abundant balsam fir regeneration

History of study site: The land was farmed in the past but has been managed for a mixture of values: farming, recreation, hunting, tourism trails, maple syrup, firewood and timber. The area the case study site is located was pre-commercially thinned in early 1990's.

Species summary pre-treatment:

SPECIES	*CONTROL*		*TRADITIONAL TREATMENT*		*CLIMATE ADAPTIVE TREATMENT*	
	M3	**Cords**	**M3**	**Cords**	**M3**	**Cords**
Spruce	0.69	3.22	0.86	4.03	1.46	6.85
Balsam fir	45.26	20.57	56.57	25.71	96.17	43.71
Cedar	1.37	0.59	1.71	0.74	2.91	1.26
Hemlock	1.14	0.55	1.43	0.69	2.43	1.17
Red maple	6.63	3.66	8.29	4.57	14.09	7.77
White birch	10.52	5.72	13.14	7.14	22.34	12.14
TOTAL	***65.61***	***34.31***	***82.00***	***42.88***	***139.40***	***72.90***

Owners Survey

What has the woodlot been used for in the past (e.g. timber harvesting, firewood, farmland, been left wild and free)?

Timber harvesting, firewood, farmland and tourism trails.

What are your short-term goals for your woodlot (next 7 years)? / What are your mid-term goals for your woodlot (7–35 years)?

Capture fir mortality and generate revenue while keeping other goals and objectives, like wildlife and tourism, in mind.

What are your long-term goals for your woodlot (35+ years)?

Maintain a sustainable source of income.

Have you previously taken your woodlot's ability to adapt to future changing climate conditions into consideration?

Partially. We have been trying to capture fir mortality for over 5 years.

Are you currently aware of what future modelling shows for NB's climate conditions?

Aware of some of the impacts; decrease in fir, maybe better for some hardwood.

Do you think your woodlot will be resilient to NB's changing climate conditions? Why?

Not without some different practices. I think with time and consideration of different harvesting and silviculture we could put ourselves in a better position. There is a lot of land to keep up with the fir that is dying so we will not be successful everywhere, but will prioritize the woodlot, taking into account all of our objectives.

Sample Plot Area Implementation

Size of sample plots:

TREATMENT	*AREA (HECTARES)*	*AREA (ACRES)*
Control	0.4	0.99
Traditional	0.5	1.24
Climate Adaptive	0.85	2.1
TOTAL	***1.75***	***4.32***

Traditional treatment: Remove all balsam fir retaining spruce where possible.
Goal: To provide improved growing conditions to allow the spruce to develop into higher quality products such as sawlogs.

Climate adaptive treatment: remove all balsam fir, retaining spruce where possible, keeping in mind possibility of wind creating blowdowns. (Note: the original recommendation was to remove the spruce as well due to risk of strong winds blowing over the shallow-rooted spruce trees once the balsam fir is removed, however, the owner decided to keep them for now). In early fall 2022, the area will be dragged to disturb mineral soil to create favourable seedbeds for spruce regeneration. To create species diversity, fill planting with white pine (observed in the area), maples, or seeding with acorns or other species will follow.
Goal: To restore diversity to the site and minimize the balsam fir content.

Species summary post-treatment: *post-summary volumes will be collected in spring 2022 after snow melt.

SPECIES	***CONTROL***		***TRADITIONAL TREATMENT***		***CLIMATE ADAPTIVE TREATMENT***	
	M3	**Cords**	**M3**	**Cords**	**M3**	**Cords**
Spruce	0.69	3.22				
Balsam fir	45.26	20.57				
Cedar	1.37	0.59				
Hemlock	1.14	0.55				
Red maple	6.63	3.66				
White birch	10.52	5.72				
TOTAL	***65.61***	***34.31***				

Outcomes and Monitoring Progress

This section will be updated each time a site visit is made to measure the updated volumes and site conditions. The first anticipated update will be in fall of 2022, and then every five years afterwards.

Conclusions (for now, 2022)

This is not your typical case study. The woodlot sites chosen will continue to grow and change over the years, and this document will be updated to reflect those changes.

The climate is changing, and we need to consider this in our silviculture planning and decision-making for the future. There is climate information available from many sources to help you understand how the climate has already changed and how it's projected to change in the future. Start using this information now and know you will likely need to adjust course over time as you learn more, the information available improves, and your goals and situation evolve.

We know that there are a range of possible climate futures. There isn't a "most likely" emissions scenario or climate projection, and you will need to select the most relevant climate information for your particular woodlot, risk tolerance and planning horizon.

You know your woodlot best. Climate information is another piece of information that you can layer into your pre-existing knowledge for decision-making. We know enough to be able to use climate information to adapt to the future changing climate conditions in New Brunswick.

If you have questions, remember that you are not alone. Contact your local Forest Products Marketing Board for additional information and keep your silviculture management plan up to date.

As mentioned previously, we will continue to monitor the case study sample plot areas on the four private woodlot sites for the foreseeable future in order to provide updates to the data (volumes, conditions, etc.). The plan is to revisit the sites every five years. All of the information presented in this case study is available on the NBFWO website (nbwoodlotowners.ca), with a page dedicated to each of the case study sites. All updates to site data will be able to be found there as well.

We look forward to watching the sites evolve and reporting back on the progress made, the unexpected happenings that are bound to occur, and on the efficiency of the Climate Adaptive Silviculture Prescription Tool.

Please stay tuned.

Table of Figures

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