# THE HISTORY OF DEFORESTATION IN SOUTHWESTERN ONTARIO AND METHODS USED IN AFFORESTATION OF OLD AGRICULTURAL FIELDS

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# ABSTRACT

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The forests of southwestern Ontario were logged in the 1700's for use by the British and French navies as ship masts, spars and hulls. Early settlers cleared the forests to make way for agriculture and settlements. The large-scale deforestation had devastating results to the land and people. Erosion, flooding, drought, loss of wildlife and fish habitat, the inability to grow crops and deserted farms resulted. Eventually, it was recognized that planting trees was the only way that the damage could be restored. As a result, legislation was passed to encourage tree planting but it took time and the willingness of municipalities, landowners, government and concerned agricultural groups for trees to be planted on a larger scale.

This thesis is a literature review describing the history of land clearing in southwestern Ontario and explores the use of afforestation methods to regenerate old agricultural fields. A great deal has been learned about the best practices for success in afforestation. Understanding soil type, matching tree species to soil, species requirements, planting methods, competition control and tending are all important factors. After over two hundred years when deforestation started restoration of the land still continues in southwestern Ontario as is exemplified by popular tree planting programs in effect today such as the 50 Million tree program.

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# 1.0 INTRODUCTION

Southwestern Ontario has a long history of changing land use and forestry practices. To understand the present distribution and types of forests, agricultural use, population growth and attitudes towards natural environments it is very helpful to look to the past. The first settlers who came to southwestern Ontario saw the forests as something to be conquered and cleared to make way for agriculture as did the governments of that time (Bowley 2015; Dunkin 2008). The result of large-scale deforestation was devastating to the environment and ultimately to the farmers and those living in settlements and towns. The soils were so depleted on sandy submarginal farmland that deserts developed with blowing and shifting sands. Rivers and creeks either flooded or ran dry, wells became contaminated. Crops failed and farmers moved off their homesteads (Zavitz 1908; OMNR 1982). It took many years, changing governments and concerned groups such as the Ontario Fruit Growers Association and individuals such as Edmund Zavitz, to make a difference and foster change (Dunkin 2008). Eventually, government programs to re-establish forests began and over time Agreement Forests were planted and woodlots were sustainably managed. Landowners with marginal agricultural land were assisted to plant and manage their forests.

The agricultural and forested landscape of southwestern Ontario can be better understood today when looking at past clearing and forest establishment practices and patterns. Much has been learned regarding afforestation on a variety of soil types using different species. Achieving diversity over time for a healthy forest environment is often the goal of the forest owner and forest practitioner.

## OBJECTIVE

The forests of southwestern Ontario have been cleared and high graded over a long period of time. This led to many detrimental effects which prompted the development of a number of different programs and practices to try to restore forests and regenerate marginal farmland. This paper presents a literature review describing the

history of land clearing in southwestern Ontario and explores the use of afforestation identifying which management strategies are most effective to successfully regenerate old fields.

# 2.0 LITERATURE REVIEW

## 2.1 THE LAND

The historical forests of southern Ontario were established on various soil types deposited from the Laurentide Ice Sheet of the Wisconsinan Glaciation period. Areas of sand, gravel, deep clays, and loams exist throughout the area (Dyke 2004).

Before European settlement the Indigenous people living there used the forests as a source of food and shelter. There is evidence that they cleared small areas for cultivation of crops and used fire to improve the habitat for forage, medicines and hunting (Burden et al. 1986).

By our standards, the historical forests were vast, with large trees and a diversity of plants and wildlife. A variety of tree species existed depending on the soil type and ecosite, and as a result of Indigenous land use. A variety and abundance of Carolinian tree species existed in the most southern areas near Lake Erie (Elliot 1998).

Considering the long development of much of the forest many areas would have been dominated by climax species, that is, species of trees at the end of their successional phase, consisting of sugar maple, beech, and hemlock, with pines and oaks more prominent in areas that were subject to fire on drier sites (OMNR 2019).

### 2.1.1 EUROPEAN SETTLEMENT

With the arrival of Europeans came changes to the forest. In the 1600's various European explorers and fur traders moved through the southern forests but in the 1700's settlement occurred along with logging. The first main logging efforts were to supply the British and French navies with ship masts, spars and hulls from 1776 to 1836. During the Napoleonic wars, large red and white pine were cut and squared for export to the United Kingdom. Changes to the British trade policy in the 1850s, and a treaty between Canada and the United States increased the export of pine sawlogs to the U.S (Elliot 1998).

By the 1800's the early setters of southern Ontario were focused on land clearing for farms and to produce crops. At that time, the government's priority was on settlement and agricultural development, which would be accomplished through deforestation and conversion of the land to a farming economy (Elliot 1998). Little regard was given to trees that were seen as obstacles for removal to allow for cultivation and as another cash crop. Forests were cut and or burned to clear areas for agriculture. Potash was sometimes produced from the ashes and sold for use in the manufacture of soap, glass, tanned leather, gunpowder, and bleached cotton textiles. Fuelwood and construction materials were used for farms and exported as well (OMNR 1982).

The clearing of forests in southern Ontario advanced quickly. From 1840 to 1887, over sixty per cent of the Trent River watershed was cleared for cultivation and about eighty per cent of forest cover had been removed from townships along Lake Ontario and further inland by about 1891 (Bowley 2015). The early European settlers believed that the land was something to be controlled and that forests should be removed to reinvent the pastoral environment they left behind in Europe (Dunkin 2008).

(Figure 1) shows an area which was cleared of forest and burned to create agricultural land. The stumps would need to be removed to plant crops. Many of these areas were later shown to be unsuitable for agriculture. This particular area was later purchased by Simcoe County in 1922 to become part of the Municipal Forest now known as the Hendrie Forest.

Figure 1 - Early farmers cleared and burned forests to create agricultural land. (Zavitz 1908).

## 2.2 RESULTS OF LAND CLEARING

The removal of forests over the landscape had devastating results. Some of the worst effects were seen where entire watersheds were harvested. Trees slow winter snow melt and replenish ground water. Without trees the snow melted quickly and the soil without tree roots was unable to absorb the melt or rainwater. Large amounts of water ran along ground surfaces causing soil erosion, formation of large gullies and ran into rivers causing flooding along entire river systems. Shallow wells became contaminated with erosion and runoff. Since groundwater retention was affected, there was a loss of soil moisture and reduced stream baseflows and summer droughts. The loss of trees also contributed to droughts by reducing rainfall and increasing temperatures (Bowley 2015; OMNR 1982).

Several watersheds were adversely affected by overharvesting including the Trent Water system, Ganaraska watershed, Grand River watershed and the Thames watershed (Bowley 2015).

For example, the Grand River Watershed with its tributaries is the largest watershed in southern Ontario. It covers 6,800 square kilometers and starts in the highlands of Dufferin Country where Luther Marsh is a headwater source and runs 310 kms southwest into Lake Erie (GRCA n.d.). Settlers harvested the cedar which was prominent around Luther Marsh and along the banks of the Grand River for use as cedar fencing in the 1880's. As the forests continued to be cleared along the river for cultivation, snow melted quickly in the spring and didn't have a chance to percolate into the ground. Since the marsh area was devoid of trees it couldn't hold water and discharged it gradually. In the spring, water flowed down stream overflowing the banks causing flooding over most of the 300 km distance to Lake Erie. The river was used as a source of water and for transportation to the towns built along the waterway. Flooding in spring and summer droughts when the rivers dried up became a growing problem. Sewage disposal in the river and effluent from later factories caused pollution (Bowley 2015).

In 1912 the Grand River Improvement Association tried to control annual flow along the river by erecting a series of dams and reservoirs. This was a start to remedy the problem but flooding, drought, and pollution continued for some time until much later in 1934 when the Grand River Conservation Commission was formed which later in 1948 became the Grand River Conservation Authority (GRCA n.d.).

### 2.2.1 AGRICULTURAL FIELD EROSION

In 1903 Judson Clarke, Ontario's first chief forester and Edmund Zavitz, then forester working at the Agricultural College in Guelph, travelled southern Ontario, and recorded the desert like conditions that resulted from deforestation. Large areas were recorded and photographed in Norfolk and Simcoe Counties as well as the Oak Ridges Moraine and Prince Edward County. These were areas where forests had been harvested, crops grown, or cattle grazed until the fertile soil was depleted leaving the lands susceptible to wind erosion exposing infertile dried sands (Bacher 2011). It was clear that soil type contributed to the extent of erosion that occurred after deforestation and agricultural use. Where there were large areas of sand, erosion was at its worst and greatest.

As a result of his tour of the growing devastation, Zavitz produced a "Report on the Reforestation of Waste Lands in Southern Ontario" in 1908 which was delivered to the Ontario Legislature where he reported that there were 10,000 acres (4,040 hectares)

in Norfolk County of "sand lands unfit for agriculture" which he said, "must be placed under forest management" (Figure 2) (Zavitz 1908). In addition, he estimated that there were 25,500 ha of land in Lambton, Simcoe, Northumberland and Durham Counties that should be protected from ground fires to allow for natural regeneration as well as areas requiring planting (Zavitz 1908). The estimates of area at that time needing attention run as high as 150,000 ha (OMNR 1982).

Figure 2 - Sand blown out from under pine stumps. 'Wasteland' in Walsingham Township, Norfolk County (Zavitz 1908).

An example of the results of deforestation which Zavitz observed occurred in Norfolk County (Figure 3), where a large sand plain exists north of Lake Erie where white pine was the predominant species. Settlement by Loyalists originally occurred on the north shores of Lake Erie and spread east and north towards Brantford avoiding the large sand plain (Figure 4) (Niewojt 2007).

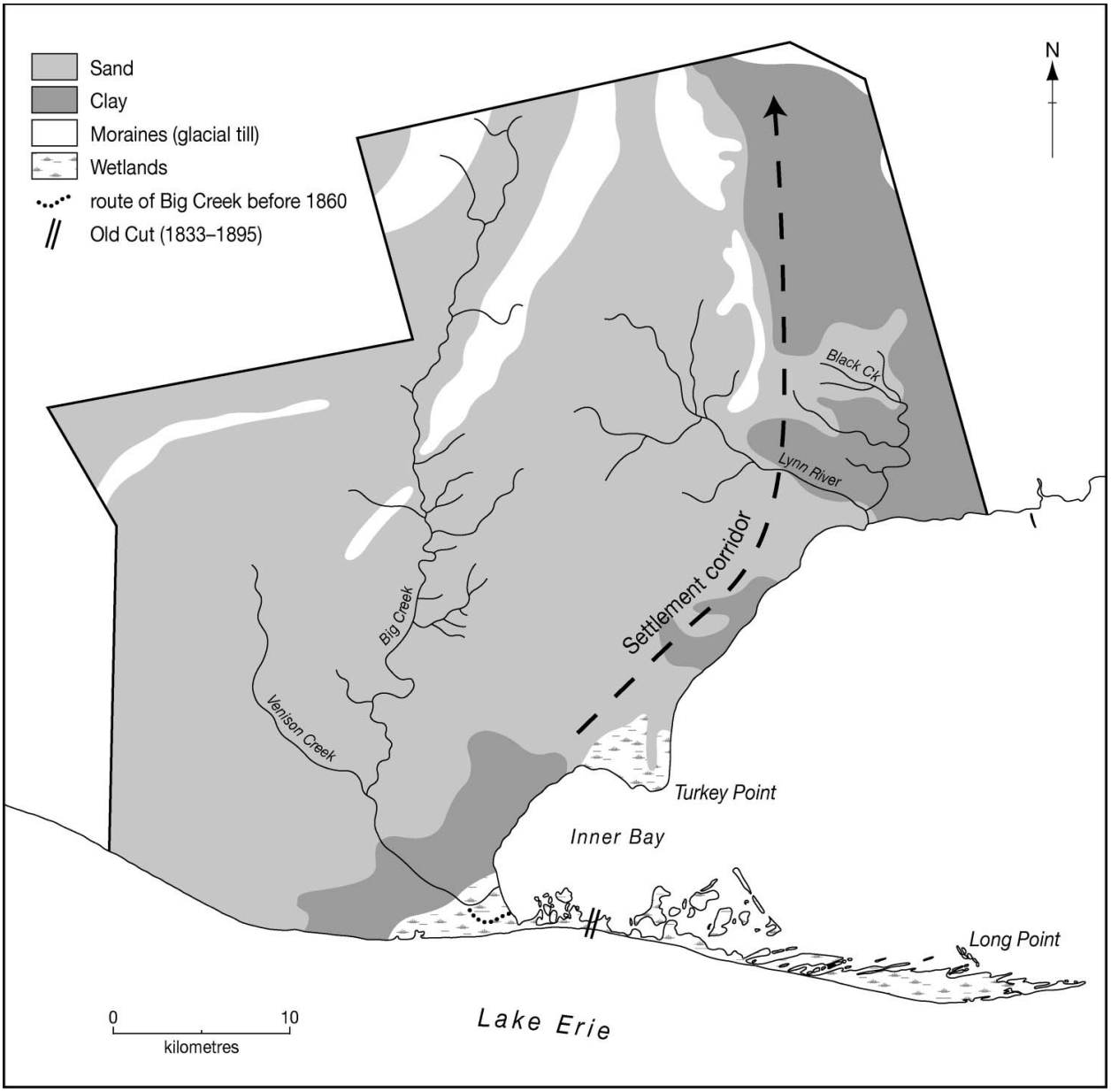


Figure 3 - Location of Norfolk County, Ontario (Niewojt 2007).

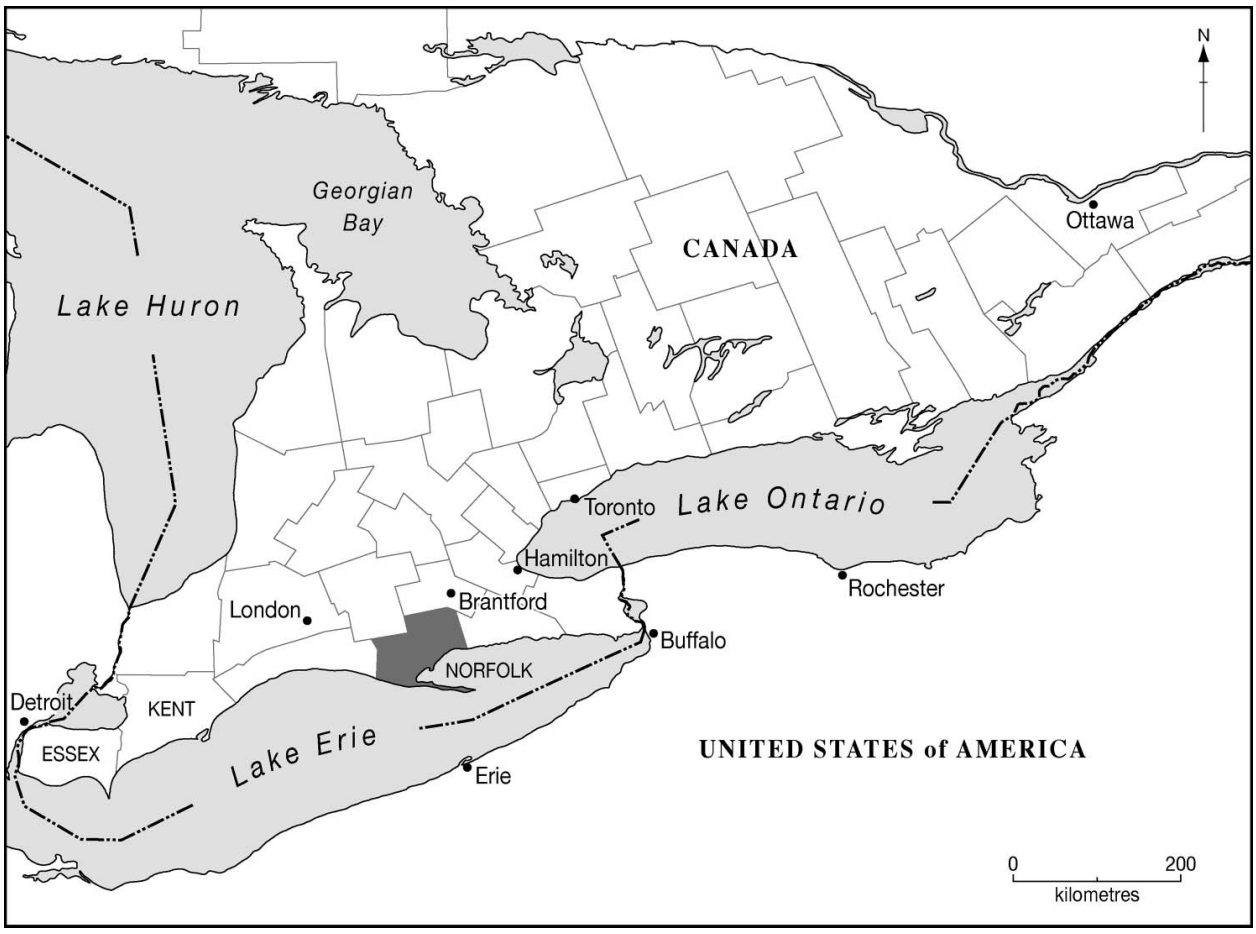


Figure 4 - The soil types and major watercourses of Norfolk County. The first settlers farmed to the west of Turkey Point marsh. Later settlement established a populated corridor that continued east along the lake and north onto the heavier clay soil (Niewojt 2007).

The forest resource on the sand plain eventually became an important source of timber. White pine was in high demand by the late 1820's as a valued building material in the American construction market. When the Erie Canal was completed in 1825 exports increased via the Great Lakes as the population and urban development increased in the U.S. (Niewojt 2007). The settlers of the area harvested timber in the winter and worked their farms in the summer, giving them extra income to manage their new homesteads (Bowley 2015).

After the forests were removed, farmers on the sand plain grew crops and did well until the soil was depleted of nutrients and crop yields declined. They next grazed cattle until there was no longer enough vegetation to feed them and then tried to graze sheep for wool. In the end, the soil was so depleted that there was very little vegetation left to hold down the sands. Many farmers moved off the land to find other ways to

make a living and others tried to farm on small areas (Niewojt 2007; Dunkin 2008; Zavitz 1908). With large areas devoid of forests strong winds swept across the countryside blowing sand. In some areas fencerows and farm buildings would become partially buried and sand drifted across roads. In the winter blowing and drifting snow made travel difficult. (Figure 5) shows a farm in Norfolk County in 1908 with drifting sand encroaching on deserted farm buildings and cart. An example of what was once a thriving farm desolated due to poor land management practices. This was a pattern repeated across southern Ontario where forests were cleared on sandy sites that eventually became impoverished through farming and eventually deserted (figure 6) and (Figure 7).

Figure 5 - An abandoned farm in Charlotteville Township, Norfolk County. The remnant of the wagon is being gradually covered by sand (Zavitz, 1908).

Figure 6 - An abandoned farm in South Walsingham Township, Norfolk County (Zavitz 1908).

Figure 7 - Sand drifts covering fence lines (OMNRF archives in OMNRF 2019).

In his 1908 report, Zavitz pointed out the benefits of establishing forests on the wastelands he had seen in southern Ontario,

> "The policy of putting these lands under forest management has many arguments in its favour. It will pay as a financial investment; assist in insuring a wood supply; protect the headwaters of streams; provide breeding ground for wild game, provide object lessons in forestry, and prevent citizens from developing under conditions which can end only in failure" (Zavitz, 1908).

## 2.3 REFORESTATION BEGINS

The vision that Zavitz had in his 1908 Report on the Reforestation of Waste Lands in Southern Ontario, of tree nurseries and forest management demonstration areas came into being with the purchase and development of the first forest station near St. Williams in 1908 by the Ontario Department of Lands and Forests. At that time, he taught at the Ontario Agricultural College in Guelph and had worked at the small provincial nursery there. This nursery was moved to St. Williams in 1908 (Bacher, 2011).

The St. Williams nursery offered landowners free trees to plant on their private lands on poor sites such as sand and gravel and marginal farmland. Government assistance in the form of education was advised at that time (Bowley 2015).

After the success of St. Williams Nursery other forest stations were established in key areas of poor farmland that required reclamation. These included Norfolk Forest station #2 in 1924, Midhurst Forest Station in 1922 (Figure 8), Orono Forest Station in 1922, Howard G. Ferguson Forest Station in 1946, Fort William Forest Station in 1946 (ODLF 1960).

Figure 8 - Midhurst Forest Station 1925. Plantation of two-year-old red pine (Zavitz 1925).

In 1871 the government passed *An Act to Encourage the Planting of Trees Upon the Highways in the Province.* This Act gave Municipalities the authority to plant roadside trees to help stop wind erosion. The program was minimally successful. By 1879 other groups such as the Ontario Fruit Growers Association were also showing great concern over the lack of tree planting and was one of the groups most persistent pressuring government (Dunkin, 2008). In 1883 this Act was replaced by the *Tree Planting Act* which provided landowners with a small payment as an incentive to plant trees. Unfortunately, the approach of landowners doing their own work at that time was not very successful in planting large areas (OMNRF 2019). It is interesting to note however, that gradually over time from 1905 to 1919, 3,440,000 trees were distributed from nurseries mostly to private landowners (Armson 2001).

In 1911 the *Counties Reforestation Act* was passed recognizing that it was important to give Counties and Townships the ability to purchase land for the purpose of

planting trees on the large wastelands. Even though loans of $25,000 were offered, no interest was expressed in the program (Armson 2001).

### 2.3.1 AGREEMENT FORESTS

In 1921 with the interest of Premier E.C. Drury and Zavitz as Provincial Forester the *Reforestation Act* was passed, which enabled the province to enter into agreements for reforesting, developing, and managing lands held by the counties (the Agreement Forest Program). In this way, the government paid for and did all the work to establish forests on land that the Counties owned and were covered by an Agreement. In 1922 the first Agreement Forest was established in Simcoe County, close to Drury's home near Barrie. It was called the Hendrie Forest and started with 1000 acres (405 ha) (OMNR 1982).

Over the years the Agreement Forest program grew and expanded its ownership criteria and ability to sell timber. In total there were 56 Agreement Forests in southern Ontario covering 128,853 ha of plantations and natural forest by 1998. At that time, the province turned over the control and management of the lands to the owners. These forests are now referred to as Community Forests (OMNRF 2019; Borczon 1982). It is interesting to note that through the efforts of many foresters and interested groups from the time the wastelands of Simcoe County were identified, reforested and managed, that in 2022 Simcoe County was named the Forest Capital of Canada.

### 2.3.2 WOODLANDS IMPROVEMENT ACT AGREEMENTS, 1966

Under the *Woodlands Improvement Act*, an individual landowner was able to enter into an agreement with the Ontario government, whereby their property was assessed, a management or planting plan was prepared, site preparation, planting work and competition control was done for the landowner and the landowner paid for trees at a subsidized cost. In return, the landowner agreed to protect the plantation for a 15-year period. Advice would be provided after that time on management of the plantation. Woodlot improvement assessment and improvement work would also be provided in existing woodlots. The minimum area required to enter into an agreement was five acres. This program was very productive and successful as it offered private landowners real assistance to regenerate submarginal agricultural lands and improve woodlots through advice and tree marking to produce high quality trees. The program ended in 1993 and at that time more than 137,000 ha were under management and 213 million seedlings had been planted (OMNR 2001; OMNRF 2019).

### 2.3.3 THE 50 MILLION TREE PROGRAM – 2007

In 2007 the Ontario government started the 50 Million Tree Program whereby a commitment was made to plant 50 million trees on 25,000 ha of private and public land. Forests Ontario, a non-for-profit organization was engaged as the lead delivery agent for the program and covers up to 90 percent of the costs for tree planting on one hectare of land or greater. The landowner signs a 15-year management agreement in return. The program now includes a minimum requirement to plant 500 trees. In total as of 2021 over 36 million trees have been planted on 17,000 ha. (MacDonald et al. 2020; Forests Ontario 2022; OMNRF 2019). This program is similar to the Woodlot Improvement program, with the landowner engaging in a 15-year agreement and a planting plan is provided to the landowner along with assistance to plant the trees by service providers.

## 3.0 AFFORESTATION OF OLD AGRICULTURAL FIELDS

Through the efforts of many dedicated foresters and forestry technicians since the time of Edmund Zavitz, much has been learned about the practices used to successfully regenerate old agricultural fields. Following are some considerations to take into account when embarking on the task of creating a new forest.

There are several points to consider when approaching the project of establishing a new forest on an old agricultural field. These include management objectives, size of site, soil type, site characteristics, matching species to the soil and site conditions, type of planting stock, site preparation, planting method, herbicide needs and if choosing to plant hardwoods what special requirements are needed (OMNRF 2019; Trees Ontario 2012).

In addition to these points are considerations of cost and available labour which will vary depending on location. In some cases, subsidies to assist in costs may be available.

## 3.1 MANAGEMENT OBJECTIVES

There may be several management objectives being considered when creating a plan to reforest an old field and these will be influenced by the area being reforested and the site and soil conditions. Some objectives may include, the production of forest products, creating or improving wildlife habitat, protecting streams and watersheds, protecting a site from wind and water erosion, recreation, improving aesthetics, increased habitat connectivity and ecological site restoration (OMNRF 2019; Boothroyd-Roberts et al. 2012).

The site and soil conditions will influence the species that can be planted, and this will influence the objectives as will the size of the area under management (OMNR 1995; White et al. 2005).

## 3.2 SIZE OF SITE

On larger sites, the more common objectives such as timber production, wildlife habitat and erosion control are more suitable since planting and herbicide application machinery may be used and are more cost effective. On small areas the opportunity for ecological restoration may be incorporated since it is more costly and requires intensive work and several different species (Trees Ontario 2012; OMNRF 2019).

## 3.3 SOIL TYPE AND SITE CHARACTERISTICS

The type of soil that is present determines the options of species that can be planted and therefore has the greatest effect on the decisions of objectives and management. The site characteristics including the topography, steepness of slopes, and the amount of grass and other vegetation or shrubs present are all considerations that may constrain the decisions being made in the afforestation plan (von Althen 1977; OMNRF 2019).

Since most of the old fields in southern Ontario are privately owned, other important factors for the private landowner to consider when establishing a new forest

include: availability of labour to get the establishment work done, location and proximity to markets to sell forest products, proximity to a nursery to supply planting stock, the type of forest products that will be produced such as fuelwood or lumber, and financial considerations or the costs and time involved in establishing and tending the plantation (OMNRF 2019; OMNR 1995).

## 3.4 MATCHING SPECIES TO SOIL TYPE

Choosing a species of tree that is best suited to a particular soil type is a very important step in establishing a new forest. Knowing the different soils, moisture and drainage on the planting site is the first step in determining the choices of tree species that will do best (Groninger et al. 2003).

Typical species used in afforestation are conifers since they tolerate light and tend to do better on soils that are more impoverished with reduced fertility and topsoil loss such as found on old agricultural fields. Typical species include white pine, red pine, white spruce, and eastern white cedar (Trees Ontario 2012; OMNR 1995).

White pine does well on coarse and medium soils which are gravelly, loamy, sandy, and silty. It will tolerate a wider range of moisture regimes than other pines from moist to moderately dry. It shouldn't, however, be planted on dry sites or sites that are prone to drying. It is susceptible to blister rust and white pine weevil and if planted in areas prone to these, control measures will need to be taken. White pine is also susceptible to frost damage as it begins its growth early in the spring (OMNRF 2019; Ostry et al. 2010; White et al. 2005; OMNR 1995).

Red pine does well on coarse, and medium soils which are gravelly, sandy, loamy, and silty. It does best on deep, well drained, sandy soils. It doesn't do well on poorly drained, poorly aerated, or calcareous soils (soils derived from limestone). Competition from grasses, raspberry and shrubs may reduce its survival and growth so tending for competition is important. Red pine doesn't have any serious pests or disease problems (OMNRF 2019; White et al. 2005; OMNR 1995).

White spruce does well on coarse to very fine soil textures of varying natural drainage, however it doesn't do well on deep well drained sands. It exhibits slow initial growth after planting and larger stock is recommended as it is also prone to frost damage (OMNRF 2019; White et al. 2005).

Eastern white cedar does well on coarse to very fine textured soils with drainage from good to poor on coarser sites. It is often chosen for sites that have fresh mineral soils with a high calcium content (OMNRF 2019).

It is important to understand that on sandy impoverished sites it is best to establish a conifer species to create the soil and light conditions to allow shade tolerant hardwood species to later naturally seed in under the conifer if the goal is to attain a mixed species forest (Trees Ontario 2012). It may be too difficult and costly to establish hardwood on these old fields. The establishment of hardwoods is possible on more fertile moist sites, but these have to be chosen carefully (von Althen 1991).

## 3.5 PLANTING METHODS

Trees are planted on old agricultural fields either by hand or by machine. Hand planting is done on sites where accessibility is more difficult or on steep slopes, rocky ground or variable drainage and on areas that are small where machinery would not have enough space to maneuver. The wedge method is a typical way that hand planting is done on old fields. An experienced planter can plant up to 1000 trees per day (OMNRF 2019).

Tree planting machines (Figure 9) are suited to larger areas that are easy to access and are flat to gently rolling with limited rockiness. There are a number of different planting machine models that are used; however, the typical planting machine is towed behind a tractor, has a round “vertical cutting blade (a coulter) that cuts into the sod, a scalper that removes the sod and other vegetation to expose the mineral soil, and a trencher that opens a slit that receives the planting stock. Rubber tired packing wheels pass on either side of the slit to pack the soil around the tree” (OMNRF 2019).

One person sits on the tree planting machine and controls the spacing between the trees with the rows and carries out the planting. The tractor driver controls the distance between the rows and a third person monitors the quality and spacing of the trees and prepares and supplies the stock for planting. Planting machine crews can plant up to 8000 trees per day (OMNRF 2019).

Figure 9 - An example of a planting machine towed behind a small farm tractor (OMNRF 2019)

Figure 9. An example of a planting machine towed behind a small farm tractor (OMNRF 2019).

## 3.6 COMPETITION CONTROL

It is important to control competition of herbaceous and woody plants when establishing a plantation of trees on old fields. “A weed is a plant growing where it is not wanted, competing with more desirable plants for water, nutrients, sunlight and space. Weeds compete with trees by quickly developing root systems in the top several inches of soil, which reduce water and nutrient availability to tree roots” (Zeleznik et al. 2004). Continued effort and monitoring after planting are needed to keep the plantation free of competition and invasive species for the success of the established trees (J. Nickelson et al. 2015).

There are several methods used to control the competition of herbaceous and woody plants on old fields. These include mechanical and chemical site preparation treatments before planting and tending treatments after planting as well as the use of cover crops. Often there may be a combination of treatments depending on the site, severity of competition and the tree species used. In southern Ontario, there often is a variety of farm equipment available to use for site preparation, tending and chemical treatments. The goal is to reduce the competition to allow the trees to reach a height where they start to close their canopy, shade the ground weeds and become free to grow (Trees Ontario 2012; Groninger et al. 2004; OMNR 2019).

Site preparation may include mowing, band spraying herbicide in a narrow band, full boom spraying, disking, ploughing and furrowing. Some of these methods may also be combined. The competing plants may be only partially removed or completely removed depending on the goals of treatment. The choice of method will also be very dependent on the site conditions, equipment availability, and access (OMNR 2019; Zelenik 2004).

Cover crops are used to prevent the invasion of unwanted competing vegetation. They are used especially where a cultivated field is being converted to a forest where mineral soil is exposed and will dry out. Often a mix of white Dutch clover and barley is used as well as ryegrass or wildflowers. Mowing can be done to cut and maintain the cover crop. Sometimes herbicide treatments are also used such as band spraying to tend the plantation (OMNR 2019; Zelenik 2004).

## 3.7 CONSIDERATIONS FOR PLANTING HARDWOOD

Hardwood species have specific site requirements to be successful in plantations and demand intensive tending to produce successful growth. They require more soil nutrients and moisture than conifers and are highly susceptible to competition from herbaceous plant species and to rodent damage (von Althen 1991).

Important factors to include for a successful hardwood plantation are firstly, the selection of the planting site. High value hardwoods require deep, fertile, moist but well drained soils. Secondly, competition control. This includes site preparation such as ploughing and disking the entire area to minimize competition at the beginning of establishment. Tending is very important for the first two to three years after planting until the canopy has closed and the ground is shaded providing competition control (von Alton, 1991). Protection of the trees from rodents where necessary. In some areas

rodents such as mice and voles can cause damage to young hardwood trees by gnawing at the bark and girdling the trees. Where there are heavy grasses rodents can hide from predators, therefore reducing the cover helps reduce the number of rodents. Poison baits and trapping have been used to reduce the number of rodents where populations are high (von Althen 1991, OMNRF 2019; Pedlar et al. 2006).

## 3.8 EXAMPLE AFFORESTATION PLANS

The following subsections 3.8.1 and 3.8.2 contain examples of afforestation plans for two old field sites.

### 3.8.1 Site #1

A stony site with gently rolling topography, which has a well drained moderate to deep medium textured loam. Accessibility is year-round. The field is in grass and in the past was grazed by cattle. The area of the site is 2 hectares or 5 acres.

The objective is to establish a forested site to rehabilitate the site, create habitat for wildlife, reduce wind, connect forested blocks, recreation and to create some sawlogs in the future which will open the stand to allow hardwood to naturally seed from a nearby hardwood woodlot to create a more mixed and diverse forest.

Hand planting is recommended for the site due to the stones throughout. Spacing will be 2.4 m between rows and 1.8 m within rows. A spacing of 1.5 m by 1.5 m may be considered for white pine to encourage the trees to gain height more quickly thereby reducing leader diameter and weevil infestation (OMNRF 2019; OMNR 1995). Bareroot white pine, eastern white cedar, European larch, red pine and Norway spruce are being recommended for planting. White pine will be planted over most of the site. Norway spruce will be used as a windbreak. The other species will be planted in groups to add diversity to the site.

After planting, the herbicide simazine mixed with iron oxide for colour to provide visibility will be sprayed in spots around the trees using a backpack sprayer after planting in the spring before weed emergence. After the second growing season glyphosate will be applied in the fall using a backpack sprayer after the trees have hardened off at the end of the growing season (OMNRF 2019; OMNR 1995).

White pine will be susceptible to white pine weevil and blister rust and should be monitored carefully. For white pine weevil an insecticide can, be considered for use in the spring. Also, the infested leaders can be clipped and destroyed in June or July and corrective clipping can be done to encourage a new leader to form. To reduce blister rust, the infected branches should be pruned to prevent cankers from forming on the main stem. It is also helpful to control competition to reduce the moisture under the trees and allow air flow through the plantation (OMNRF 2019; Trees Ontario 2012).

### 3.8.2 Site #2

A relatively flat site, not rocky, which has a well drained deep medium textured sandy loam which is not calcareous. Accessibility is year-round. The field is in grass and other herbaceous plants and was grazed by cattle in the past. The area of the site is 4 hectares or 10 acres.

The objective is to establish a forested site to rehabilitate the site, create habitat for wildlife, connect forested blocks, recreation and create red pine small poles from thinning's and sawlogs in the future

Machine planting to red pine with white spruce as a windbreak on the western windward side is recommended. Spacing will be 2.4 between the rows and 2.1 between the trees within the rows. Bareroot red pine and white spruce planting stock will be used (OMNRF 2019; OMNR 1995).

The plantation will be band spayed with simazine in the spring after planting to control competition before the weeds emerge. The site will be monitored in the summer to determine when the next application of herbicide should be applied. The herbicide glyphosate will be applied after the second growing season in the fall if required. The plantation will continue to be monitored for the need to control competition (OMNRF 2019; OMNR 1995; Zelenik 2004).

Future thinning's of the red pine to maintain growth and vigour will be scheduled at the appropriate times.

## 4.0 MATERIALS AND METHODS

To understand and report on the history of forest clearing in southwestern Ontario and the subsequent detrimental effects, a review of information recorded from

1908 is included. The subsequent initiatives and programs undertaken to try to rehabilitate the land after deforestation required a literature review of historical information and writings that describe the years of progress towards re-establishing forests. A search of scientific journals and silviculture guides that discuss what has been learned over the years by foresters, forest technicians, and scientists to successfully establish forests on old agricultural fields was done. The Lakehead University Library was a significant source of information with key word searches including “afforestation”, “history of forestry”, “competition in afforestation”, “old field planting”, “private land tree planting”, “site preparation”. Google Scholar was also used to search key words and known authors such as E.J. Zavitz and K. Armson. Personal library was also useful for information related to silviculture and historical information. The literature searched spanned many years to include relevant historical and more recent publications from 1908 to 2022.

# 5.0 DISCUSSION

The first settlers that came to southern Ontario viewed the forest as something to be conquered with the wish to control their environment (Dunkin 2008; OMNR 1982). To the early settlers re-creating their pastoral homes as farmers and using the forest for economic gain made sense. The advance of deforestation across southern Ontario to create farms is repeated in the literature and evident in the photos taken by Edmund Zavitz in 1908. With the advance of settlements and farming however, little attention was paid to the natural environment, the protection of waterways and more vulnerable soils and shallow sites. The literature points to the large areas of deforestation which include entire watersheds and the resulting flooding and droughts (Dunkin 2008; Bowley 2015; Armson 2001). With land clearing and farming taking place on more sandy soils, Zavitz recorded the blow sands and desert like conditions which remained after the soil was depleted and settlers left their farms.

Even though there were those who had concerns regarding the detrimental results of deforestation, it is clear it took many years for political, municipal and landowner support to start making positive changes by planting trees. (Bacher 2011; Borczon 1982; Armson 2001). The most significant change occurred in 1922 with the establishment of the first Agreement Forest (Borczon 1982; Armson 2001). Since that time, other government programs such as the Woodlands Improvement Act in 1966 and the 50 Million Tree program in 2007 have made significant progress to help the private landowner re-establish forests and improve the management of woodlots. (OMNRF 2019; Elliot 1998; Armson 2001).

Through the years of effort by foresters, forest technicians and scientists much has been learned about afforestation and management of plantations. It is clear that the large-scale land disturbances that occurred in southern Ontario take a long time to recover from. The literature on afforestation points out that it is very important that careful site rehabilitation through the understanding of soils and matching tree species to soils be done for a successful plantation (OMNRF 2019; Trees Ontario 2012; von Althen 1991). Consideration of objectives in afforestation plans and the restoration of sites to diverse species for a variety of habitats will provide sustainable forests for the future.

The need to continue restoring forest cover and sustainably manage existing forests in southwestern Ontario is apparent. With increased urbanization and the need to combat global warming the planting and managing of trees takes on additional urgency and importance.

# 6.0 CONCLUSION

The original forests of southern Ontario were cleared by settlers for agriculture, used as lumber and fuel for their homesteads and towns, and exported to Europe and the United States as squared timber and lumber. The results of the large-scale deforestation caused erosion, flooding, drought, loss of habitat for fish and wildlife and the loss of rich diverse natural environments.

The once productive farms originally established on fertile forest soils were abandoned as the soils were depleted especially on sandy sites. The resulting blow sands and unproductive soils were left unattended, and erosion by wind and water increased.

It took many years for a successful response from government, municipalities and landowners to abate the detrimental effects of deforestation. Through the vision, tenacity and dedication of foresters like Edmund Zavitz, restoration of many "wastelands" was possible through the establishment of trees which grew into the forests we see today. With ongoing urbanization in southern Ontario, it is important that the protection of established forests continue in a sustainable way and that we increase forest cover whenever possible. These forests will protect water systems and fish habitat, provide habitat for wildlife, purify air and water, provide forestry jobs and carbon sequestration to help combat global warming.

Much has been learned about afforestation practices to successfully establish forest cover and create diversity over time. Understanding the history of past deforestation will help guide practitioners and landowners in rehabilitating sites and create new forests again. With the assistance of knowledgeable forest managers and available literature, guides and extension notes, forest cover and well managed woodlots can continue to grow.

With the present demand for the ongoing tree planting programs, we see today, it is clear that private landowners and community forest owners see value and need to continue with the efforts started by foresters such as Edmund Zavitz so many years ago.

# 7.0 LITERATURE CITED


Armson, K.A., W. R. Grinnell, F. C. Robinson. 2001. Chapter 1. History of reforestation in Ontario pp. 3-22 in Wagner, R.G., S.J. Colombo, (eds.), Regenerating the Canadian Forest: Principles and Practice for Ontario. Queen's Printer, Fitzhenry and Whiteside, Toronto. 650 pp.

Bacher, J.C. 2011. Two Billion Trees and Counting - The Legacy of Edmund Zavitz. Dundurn, Toronto, ON 274 pp.

Boothroyd, K., D. Gagnon, B. Truax. 2013. Can hybrid poplar plantations accelerate the restoration of forest understory attributes on abandoned fields? Forest Ecology and Management 287:77-89.

Bowley, P. 2015. Farm forestry in agricultural southern Ontario.ca. 1850-1940: Evolving strategies in the management and conservation of forests, soils and water on private lands. Scientia Canadensis 38(1):22–49.

Burden, E.T., J.H. McAndrews, G. Norris. 1986. Palynology of Indian and European forest clearance and farming in lake sediment cores from Awenda Provincial Park, Ontario. Canadian Journal of Earth Sciences 23(1):43-54

Dunkin, J. 2008. A forest for the trees: Deforestation and conservation efforts in Northumberland County, Ontario 1870–1925. The International Journal of Regional and Local Studies 4(1):47-70.

Dyke, A. S., 2004. An outline of North American deglaciation with emphasis on central and northern Canada. Developments in Quaternary Sciences 2:373-424.

Elliot, K. 1998. The forests of southern Ontario. Forestry Chronicle 74(6):850-854.

Forests Ontario. 2022. 50 Million Tree Program. https://forestsontario.ca/en/program/50-million-tree-program. March 24, 2022.

[GRCA] Grand River Conservation Authority. n.d. Grand River Conservation Authority History. https://www.grandriver.ca/en/who-we-are/GRCA-history.asp. March 10, 2022.

Groninger, J.W., S.G. Baer, D. A. Babassana, D.H. Allen. 2004. Planted green ash (Fraxinus pennsylvanica Marsh.) and herbaceous vegetation responses to initial competition control during the first 3 years of afforestation. Forest Ecology and Management 189:161-170.

MacDonald, H., D. McKenney, K. McLaven, S. Perry. 2020. Realizing expectations from planting trees on private land in Ontario, Canada. Landscape Online 78:1-9.

Nickelson, J.B., E.J. Holzmueller, J.W. Groninger, D.B. Lesmeister. 2015. Previous land use and invasive species impacts on long-term afforestation success. Forests 6:3123-3135.

Niewójt, L. 2007. From waste land to Canada's tobacco production heartland: Landscape change in Norfolk County, Ontario. Landscape Research 32(3): 355-377.

[ODLF] Ontario Department of Lands and Forests. 1960. Fifty Years of Reforestation in Ontario. L.K. Cameron, Toronto. 33 pp.

[OMNRF] Ontario Ministry of Natural Resources and Forestry. 2019. Afforestation Guide for Southern Ontario. Queen's Printer for Ontario, Toronto. 320 pp.

[OMNR] Ontario Ministry of Natural Resources. 2001. Critical Review of Historical and Current Tree Planting Programs on Private Lands in Ontario. Ont. Min. Nat. Res. Toronto. 32 pp.

[OMNR] Ontario Ministry of Natural Resources. 1982. Evergreen Challenge The Agreement Forest Story. Queen's Printer for Ontario, Toronto. 60 pp.

[OMNR] Ontario Ministry of Natural Resources. 1995. Extension Note Planning for Tree Planting. Queens Printer for Ontario, Toronto. 4 pp.

Ostry, M.E., G. Laflamme, S.A. Katovich. 2010. Silvicultural approaches for management of eastern white pine to minimize impacts of damaging agents. Forest Pathology 40:332-346.

Pedlar, J.H., D.W. McKenney, S. Fraleigh. 2006. Planting black walnut in southern Ontario: midrotation assessment of growth, yield, and silvicultural treatments Can. J. For. Res. 36:495–504.

Trees Ontario, 2012. A Discussion Paper for Alternative Approaches to Afforestation in Ontario. Toronto, Ontario. 65 pp.

von Althen, F.W.1991. Afforestation of former farmland with high-value hardwoods. Forestry Chronicle 67(3):209-212.

von Althen, F.W. 1977. Hardwood planting in Ontario. Forestry Chronicle 53(4):209-214.

White, T.J.R., S.W.J. Dominy, D.J. Allen. 2005. Review of best practices for tree planting on marginal agriculture lands in Ontario. Natural Resources Canada, Canadian Forestry Service. Sault Ste. Marie, ON. 98 pp. (Cited in Trees Ontario, 2012).

Zavitz, E.J. 1908. Report on the Reforestation of Waste Lands in Southern Ontario. Ontario Department of Agriculture, Toronto, ON. 25 pp.

Zeleznik, J., R. Zollinger. 2004. Weed Control in Tree Plantings, NDSU Extension Service North Dakota State University, Fargo, North Dakota, W-1097. 19 pp.