Red Oak Research and Demonstration Area in Phelps Township, North Bay, Ontario-2004 to 2005

Dave Deugo
Andrée Morneault
Dianne Othmer
Megan Smith
Al Stinson
Murray Woods
Ian Kovacs
Ian Aho
Bill Parker
Rob Baker
Marinus Verwey
Guylaine Thauvette
Don Willis
Jeff Dech

Dave Deugo, Andrée Morneault, Dianne Othmer, Megan Smith, Al Stinson, and Murray Woods are with Southern Science and Information, Ontario Ministry of Natural Resources, PO Box 7000, Peterborough, ON KM 8M5. Ian Kovacs is with Nipissing Forest Resource Inc., PO Sox 179, Callender, ON POH 1H0. Ian Aho and Bill Parker are with the Ontario Forest Research Institute, Ontario Ministry of Natural Resources, 1235 Queen Street E, Sault Ste Marie, ON PGA 2E5. Rob Baker, Marinus Verwey, and Guylaine Thauvette are with the North Bay District, Ontario Ministry of Natural Resources, 3301 Trout lake Road, North Bay. Don Willis is with Jiffy Products (NB) Ltd. & Preforma, North Bay, ON PIS 8L2. Jeff Dech is with Nipissing University, 100 College Drive, Box 5002, North Bay FIB 8L7.

In: Riley, L . E.; Dumroese, R. K.; Landis, T. D., tech. coords. 2006. National Proceedings: Forest and Conservation Nursery Associations-2005. Proc. RMRS-P-43. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 160 p. Available at: http:/ /www.rngr.net/nurseries/publications/proceedings

Keywords: red oak, *Quercus rubra,* wildlife management, shelterwood

Introduction

In July 2004, a large stand of red oak *(Quercus rubra)* was harvested in Phelps Township, North Bay District, North Bay, Ontario using the uniform shelterwood system. Most of the stand was harvested to retain 40 percent crown closure, while a very small portion was harvested to retain 70 percent crown closure. During tree marking, an active Northern Goshawk *(Accipiter gentilis)* nest was identified and the appropriate Area of Concern (AOC) prescription was applied. Within the modified cut portion of the AOC, the group selection silvicultural system was used with two different size group openings: the traditional 0.1 ha (0.25 ac) with a diameter of 36 m (118 ft), and a smaller opening (0.05 ha 10.12 ac]) with a diameter equal to 24 m (79 ft) (stand height). The stand is growing on deep loamy-sands and best described as having a "dry" moisture regime classification. A number of studies initiated by Nipissing Forest Resource Inc., Callender, ON, in cooperation with the Ontario Ministry of Natural Resources, Southern Science and Information Section, Peterborough, ON have been established within this harvested red oak stand: (1) group selection, (2) acorn sowing, (3) planting—spacing and pattern, (4) uniform shelterwood, (5) planting stock size and fertilizer at time of planting, (6) tending treatments, and (7) regeneration ecology.

Overall Assessments and Treatments

Soil pits will be dug near each plot to assess soil type, soil texture, and moisture regime. Hobo® weather stations (Onset Computer, Bourne, MA) were established in group openings, 70 percent shelterwood and 40 percent shelterwood areas, to quantify and monitor the effect of the overstory treatments on air and soil temperature and soil moisture. Fisheye lens photography was done in each group opening before and after harvest. In addition, each plot will be photographed at regular intervals (every 2 to 5 years) to quantify the effect of overstory treatments on crown closure. Photo locations will be established for a future chronosequence of each plot.

Technology Transfer

Signage

A sign will be designed and established at the main intersection for members of the public and other interested individuals.

Field Tours

This site will be used as part of all the regular technology transfer field tours conducted by the Forestry Research partnership—Canadian Ecology Centre (teacher's tours, Lakehead University tours, forestry tours, and so on).

Reports

A one-page summary of the studies, with map showing plot locations, will be provided to the Forestry Research Partnership to be included with field tour guide books. An establishment report will be prepared that provides a more detailed discussion of the objectives and methods for each study on the site and detailed maps of plot locations. Status reports will be prepared at the end of each year with updates on treatments and results. A one-page document will be prepared outlining potential treatments for inclusion into the Forest Management Plan Annual Work Schedule. A photo library will be maintained and available to all partners.

The Studies

Group Selection Study

This research focuses on the effect of the size of opening and location within opening on: 1) survival, growth, and condition of planted red oak seedlings; and 2) stocking, density, and condition of natural regeneration of red oak and other tree species.

Research Questions—What group opening size promotes the highest density and best growth of red oak natural regeneration? Are the density and growth of red oak natural regeneration affected by location within the group opening (north, south, east, or west side)? Are the height and diameter growth of planted red oak affected by location within the group opening (north, south, east, or west side)?

Methods—An active Northern Goshawk nest and its associated Area of Concern (AOC) provided an opportunity to test the group selection system for red oak in this stand. The AOC prescription asks for a 50-m (164-ft) radius no-cut buffer, and an additional 100-m (328-ft) radius modified cut buffer, within which 70 percent crown closure must be maintained. After consultation with Brian Naylor, habitat biologist with the Southern Science and Information Section, we marked out four 36-m (118-ft) diameter group openings and four 24-m (79-ft) diameter group openings during the summer 2004 within the 100-m (328-ft) modified cut buffer. The openings were cut in mid-late September 2004. The cumulative effect of openings was 0.5 ha (0.12 ac) within the 6.28-ha (15.52-ac) modified cut buffer, thus an 8 percent opening of the overstory. Subsequent to the cut, one of the large group openings was chosen for the sowing study and is therefore no longer available for the group selection study.

Approaches Used to Answer Research Questions— What group opening size promotes the highest density and best growth of red oak natural regeneration? In group openings, 2- by 2-m (6.6- by 6.6-ft) stocking plots (STARS plots) were established and will be used to assess the stocking, density, and height of red oak regeneration and other tree species. The plots will also be used to assess the cover and height of competing vegetation.

Are the density and growth of red oak natural regeneration affected by location within the group opening (north, south, east, or west side)? STARS clusters have been randomly allocated in north, south, east, and west directions at different distances from the centre of the opening.

Are the height and diameter growth of planted red oak affected by its position within the group opening (north side, south side, east side, west side)? Red oak seedlings (1+0Jiffy-pots™) were planted at a spacing of 3 by 3 m (10 by 10 ft) in a north/south grid pattern within three of the large openings (100 seedlings) and all four of the small openings (50 seedlings) in early June 2005. During the summer 2005, they will be pinned, numbered, and mapped. We will assess the survival, height and diameter growth, and condition of all pinned red oak seedlings within the group openings.

Red Oak Sowing Study

Acorn sowing focuses on the effect of: 1) frozen storage on acorn germination and early growth of red oak seedlings; and 2) silvicultural system (group selection versus uniform shelterwood) on survival, early growth, and condition of red oak seedlings originating from acorns.

Research Questions—What effect does frozen storage have on the germination rates of acorns sown in the field? Is there a difference between germination rates and early establishment of acorns sown in a group opening compared to a uniform shelterwood at 40 percent crown closure?

Methods—This project was initiated in October of 2004 to investigate the use of sowing red oak acorns to regenerate

red oak. We also wanted to see if acorns collected in one year could be stored and used for regeneration over the next 1 or 2 years to bridge the gap between acorn corps. Fall 2004 was a good seed year for red oak in Phelps Township. Therefore, acorns were collected from mid-September until early October. Fourteen pounds (6.4 kg) of acorns were sent to the Angus Seed Plant to be frozen for storage. Another group of acorns were sown immediately.

We also wanted to investigate the role of overstory crown closure in acorn germination and survival and growth of the resulting red oak regeneration. Crown closure might create different microclimates (soil temperature, soil moisture, and so on) or different deer use (browse).

Acorns were planted in clusters of five acorns, aligned in an "X" fashion (spaced 30 cm 112 in] apart) at a depth of approximately 5 cm (0.8 in). Each cluster was spaced 3 m (10 ft) apart along a line (figure 1). The centre of each cluster was flagged with an assessment pin. Fall 2004 acorns were flagged in pink and spring 2005 acorns were flagged in blue. In fall 2004, acorns were pushed into the ground with a piece of dowling, and in spring 2005, acorns were planted to the same depth using a tree-planting tool called Pottiputki.

Approaches Used to Answer Research Questions— What effect does frozen storage have on the germination rates of acorns sown in the field? Fresh acorns were sown in fall 2004 and acorns stored overwinter in frozen storage

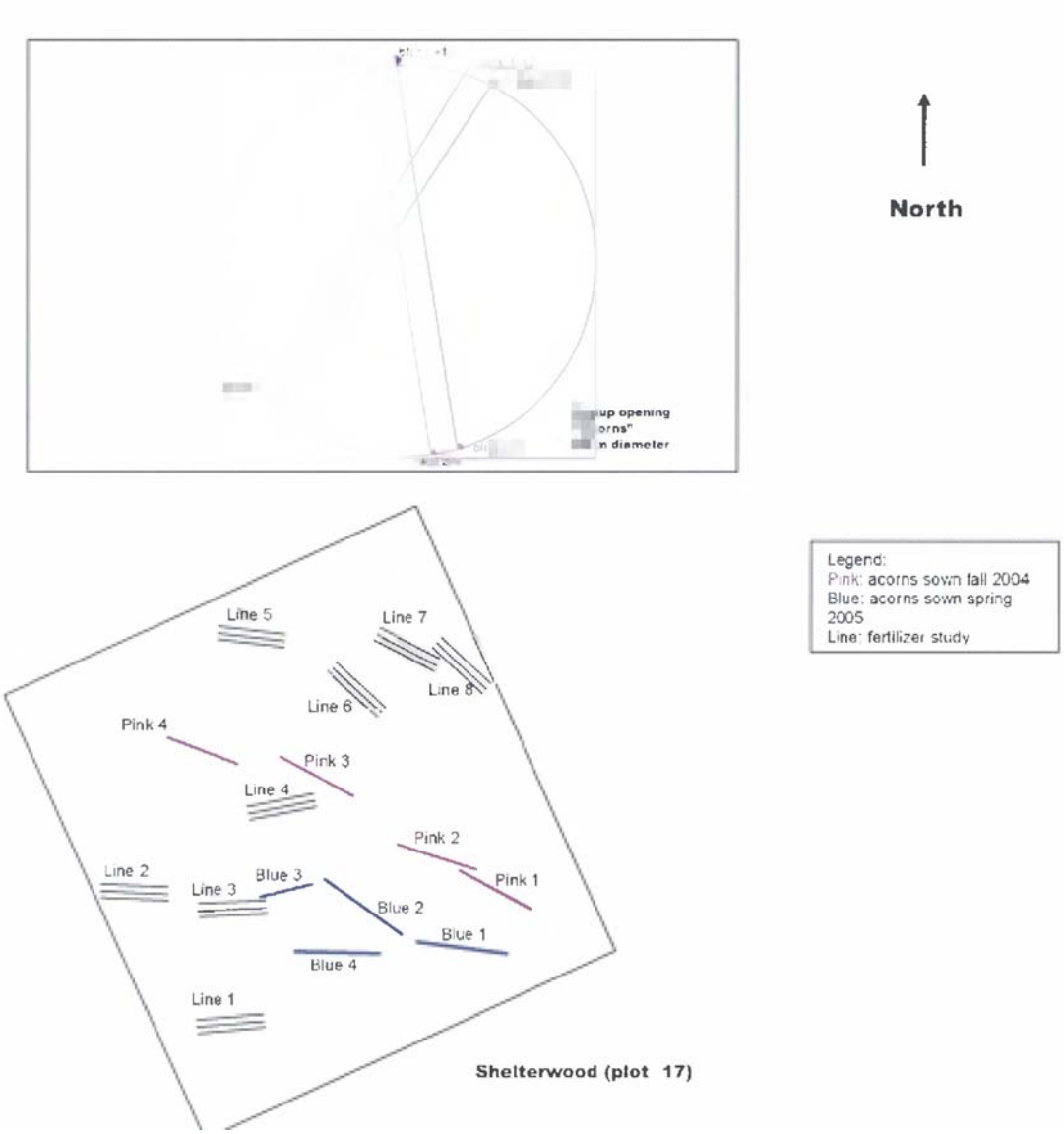

Figure 1—Red oak sowing study. Pink strips were sown in fall 2004 and blue strips were sown in spring 2005 after a winter in frozen storage (-2 ºC [28ºF]). Acorns were sown in groups of live spaced 3 m (10 ft) apart along strip. (Note: Acorns sown in fall 2005 are not shown on this map.)

were sown in spring 2005. Sowing plots were examined periodically over summer 2005 to evaluate their germination, growth, and condition. The ability of acorns to germinate after 1 and 2 years of frozen storage will be tested in future sowings in fall 2005 and fall 2006.

Is there a difference between germination rates and early establishment of acorns sown in a group opening compared to *a* uniform shelterwood at 40 percent crown closure? Fresh and frozen-storage acorns were sown under two different overstory treatments: 36-m 118-ft) group selection opening and a uniform shelterwood treated stand (40 percent crown closure). The group opening (plot 4A, figure 2) contained two33-m (108-ft) lines (lines 1 and 2) which were established across the group opening in fall 2004, and two more lines (lines 3 and 4) established 2 m (6.6 ft) west of lines 1 and 2 in spring 2005. A total of 12 acorn clusters were established along each transect line.

In the uniform shelterwood site, eight 30-m (98-ft) lines were established across the area that underwent the first cut of a uniform shelterwood treatment; four lines in fall 2004 and four lines in spring 2005. The lines were established along pre-existing skid trails. A cluster of five acorns was established every 3 m (10 ft) along the line (figure 1). The centre of each cluster was flagged with an assessment pin.

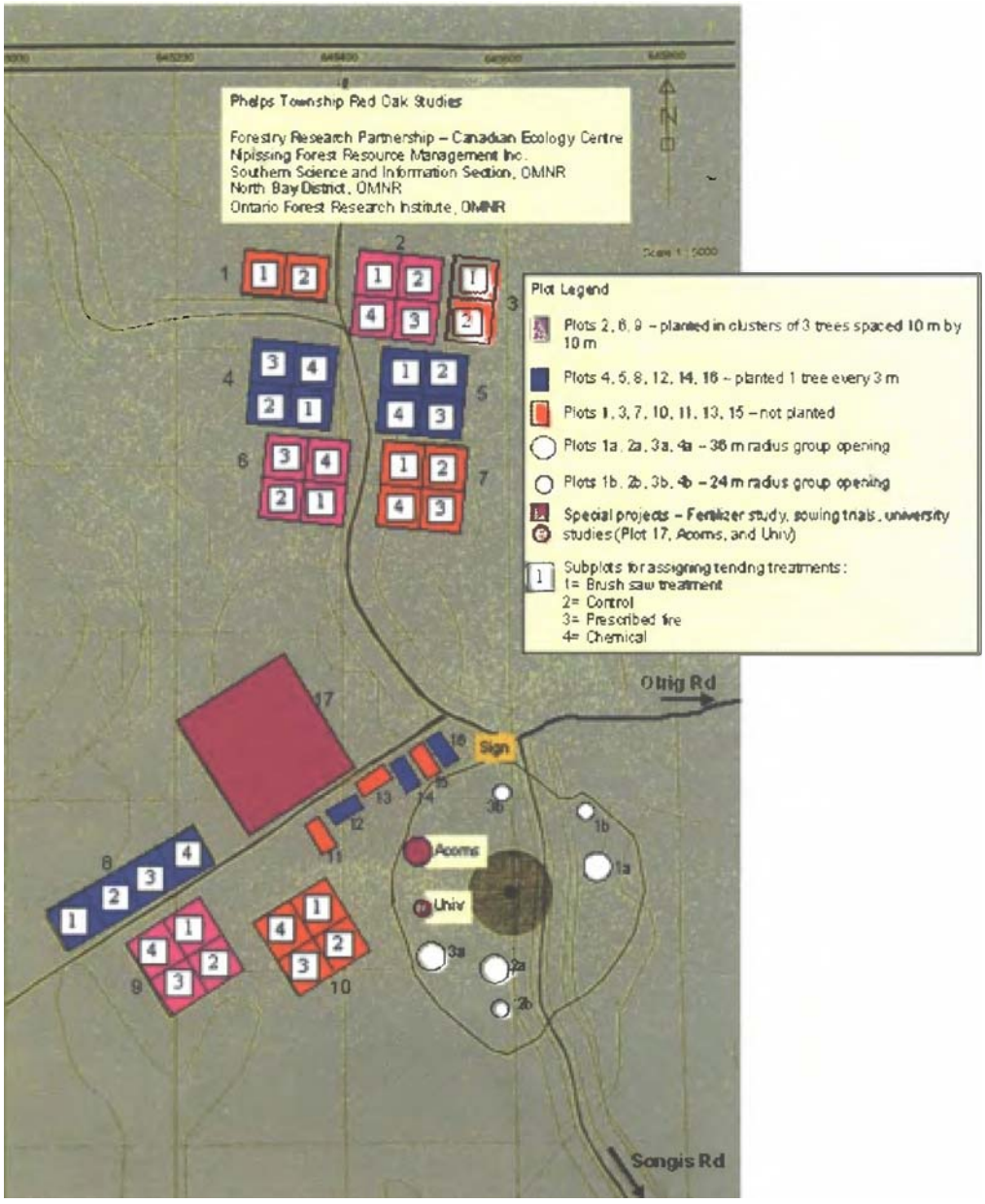

Figure 2—Map of red oak study area in Phelps Township.

Fall 2004 acorns are flagged in pink and spring 2005 acorns are flagged in blue. Each acorn was planted in the soil at a depth of approximately 5 cm (2 in). In fall 2004, acorns were pushed into the ground with a piece of dowling, and in spring 2005, acorns were planted to the same depth using a tree-planting tool called Pottiputki. A total of eleven 5-acorn clusters were established along each transect.

Planting—Spacing and Pattern

This study focuses on the effect of planting spacing and pattern on: 1) survival, early growth, and condition of planted red oak; and 2) stocking and density of red oak regeneration.

Research Questions—How does stocking and density of red oak regeneration differ when trees are planted at 3- by 3-m (10- by 10-ft) spacing compared to three seedlings planted in a cluster at 10- by 10-m (33- by 33-ft) spacing? Is tending facilitated when trees are planted in a cluster at 10 by 10 m (33 by 33 ft) as opposed to the traditional 3- by 3-m (10- by 10-ft) spacing?

Methods—Red oak seedlings in the Nipissing Forest are normally planted at 3- by 3-m (10- by 10-ft) spacing, These red oak seedlings are expensive to produce (1+0 container stock in Jiffy-pots' cost approximately Canadian $4501 1,000) and tending costs can be high if all seedlings (1,100 trees/ha 1445 trees/ac]) are released. One alternative is to describe the desired future stand condition and to only establish and tend the number of future trees that are desired, keeping in mind that seedling mortality can be high in the initial 5 years of establishment. On this site, we are aiming for a minimum 30 percent stocking to red oak (to minimize future pest problems), and approximately 100 oak stems/ha (40 stems/ac) at maturity. We estimated that only 30 percent of seedlings that are planted will eventually become crop trees, so we decided to establish three trees at each planting spot (in a triangular formation, each planted seedling roughly 30 cm [12 in] apart) in a 10- by 10-m (33- by 33-ft) grid across the site. So, instead of 1,100 spots, only 100 spots/ha (40 spots/ac) need to be tended and maintained. In both cases, the trees are planted and therefore their distribution is regular across the site. In contrast, natural regeneration tends to be more patchy and irregular.

Approaches Used to Answer Research Questions—How does stocking and density of red oak regeneration differ when trees are planted at 3- by 3-m (10- by 10-ft) spacing compared to three seedlings planted in a cluster at 10- by 10-m (33- by 33-ft) spacing compared to no planting? Nine 1-ha (2.5-ac) plots were established in the shelterwood area (40 percent crown closure): three were planted at the traditional 3- by 3-m (10- by 10-ft) spacing; three were planted using three seedlings in a cluster at a 10- by 10-m (33- by 33-ft); and three were left for natural regeneration. STARS clusters will be established in each 1-ha (2.5-ac) plot and will be used to assess the stocking, density, and height of red oak regeneration and other tree species. The plots will also be used to assess the cover and height ofcompeting vegetation. Finally, 100 seedlings were pinned in each of the planted plots and will be used to calculate survival.

Is tending facilitated when trees are planted in a cluster 10 by 10 m (33- by 33 ft) as opposed to the traditional 3- by 3-m (10- by 10-ft) spacing? Larger plots are likely required in order to successfully answer this question. However, we will use these plots to identify potential problems, constraints, and options that may lead to a larger, more operational-scale proposal.

Uniform Shelterwood

This study will focus on the effect of two intensities of shelterwood cutting (40 and 70 percent crown closure) on: 1) survival, early growth, and condition of planted red oak; 2) percent cover and height of competing vegetation; and 3) stocking, density, and condition of natural red oak regeneration.

Research Questions—Do survival, growth, and condition of planted red oak differ when it is planted under a uniform shelterwood with 70 percent crown closure compared to 40 percent crown closure? Which crown closure promotes the highest density and best growth of red oak natural regeneration?

Methods—Red oak seedlings were planted at the traditional 3- by 3-m (10- by 10-ft) spacing under two different post-cut conditions on 6 June, 2005. These conditions were uniform shelterwood with 40 percent crown closure (within three 1-ha [2.5-ac plots, flagged blue) and uniform shelterwood with 70 percent crown closure (within three 20-by 40-m [66- by 131-ft] plots, flagged blue).

Approaches Used to Answer Research Questions—Do survival, growth and condition of planted red oak differ when it is planted under a uniform shelterwood with 70 percent crown closure compared to 40 percent crown closure? Planted red oak seedlings were pinned and numbered in each plot and will be monitored and assessed annually.

Which crown closure promotes the highest stocking and density and best growth of red oak natural regeneration? STARS plots (2- by 2-m [6.5- by 6.5-ft I stocking plots) will be established in the centre of each plot within which the density, height, and percent cover of natural red oak regeneration and other tree species will be monitored.

Planting Stock Size and Fertilizer at Time of Planting

In this research, we will study the effect of two concentrations of fertilizer on the survival and early growth of large and small red oak planting stock.

Research Question—What are the effects of two different concentrations of fertilizer on the survival and early growth of large and small red oak planting stock?

Methods—Prior to planting on 27 May, 2005, Andree Morneault, Megan Smith (Southern Science and Information, Ontario Ministry of Natural Resources), Ian Kovacs (Nipissing Forest Resource Management Inc,), and Don Willis (Jiffy Products (NB) Ltd. and Preforma) visited Webb's Nursery in Bonfield, ON to examine the red oak nursery

stock. Upon examining the seedlings, we asked the nusery to sort them by size: large and small. Only large seedlings were planted into the research areas and the leftover large and the small seedlings were planted into the operational planting areas.

During our visit to Webb's Nursery, we were concerned about the vigour and potential survival of the small seedlings. Therefore, we decided to compare large versus small seedling stock to see if the larger stock ***has an*** advantage (relating to survival and growth) over the smaller stock. Don Willis provided us with a tacking agent and fertilizer to further compare the survival and growth of red oak seedlings that were given a fertilizer upon planting as opposed to no fertilizer.

The tacking agent used was called CAST (calcium activated seed tacker) Powder, which is an effervescent formulation of a natural biopolymer that forms a firm gel upon contract with calcium ions. This agent was mixed with the fertilizer in order to hold, or "tack," the fertilizer onto the red oak Jiffy-pots"' containers. The fertilizer was a $20N:8P_20_5:20K_20$ Plantex® High Nitrate Forestry Seedling Special. Two fertilizer rates were tested: 1) light fertilizer rate at 4 mg N/seedling or 20 mg total fertilizer/seedling; and 2) heavy fertilizer rate at 10.5 mg N/seedling or 52.5 mg total fertilizer/seedling.

Approaches Used to Answer Research Questions—Each treatment was applied to 25 seedlings and replicated four times. The treatments were as follows: 1) large seedlings with no fertilizer, light fertilizer, or heavy fertilizer; and 2) small seedlings with no fertilizer, light fertilizer, or heavy fertilizer.

Seedlings were planted on 6 June, 2005. Immediately before planting they were dipped in their respective fertilizer concentrations, Seedlings were dipped so that the entire Jiffy-pot"' was covered in the solution. Seedlings were planted in lines along skid trails (3 lines side by side) in the uniform shelterwood area which was harvested to 50 percent crown closure. Initial measurements, including height, diameter, crown width, and overall health, were taken on 8 and 9 June, 2005. Subsequent growth and survival measurements will be performed each fall, beginning in 2005.

Tending Treatments

The tending treatments will look at the effect of: 1)tending technique (mechanical, chemical, prescribed fire, or untreated control) on the control of competing vegetation and growth response of red oak; and 2) overstory crown closure on the number of treatments required to maintain red oak seedlings in a codominant position with vegetation within a 1 m (3.3 ft) radius around their crowns.

Research Question—Which of four tending treatments provides the best control of competing vegetation and the best growth response of planted and natural red oak regeneration?

Methods—Tending is essential to the establishment of red oak regeneration on this site because of the aggressive and vigorous growth of many species after harvesting.

Several species are in the "seedling bank" and respond to the increased light and disturbance created by the harvesting treatments, including red maple *(Acer rubrum),* sugar maple (A. *saccharum),* striped maple (A. *pensylvanicum),* and beaked hazel *(Corylus cornuta).* Species that have seeds stored in the "seed bank" are also stimulated to germinate and grow, for example, field bindweed *(Convolvulusarvensis),* pin cherry *(Prunus pensylvanica),* grasses and sedges, and raspberry *(Rubus* spp.). Other species invade the site through root suckers in response to the parent tree being cut during the harvest (trembling and largetooth aspen (*Populus treinloides* and *P. grandidentatal).* Finally, almost all tree species produce basal sprouts after cutting during the harvest and produce localized, but abundant, competition around their stumps, including red maple, white birch *(Betula populifolia),* and ironwood *(Ostrya virginiana).*

So tending is essential, but when and how should it be done? First, we established a threshold level of competing vegetation that we considered to be "threatening" to red oak regeneration, where "threatening" implies reduced growth or survival. We know the following from previous studies:

- Lateral competition is necessary for good form (small branching).
- Some vegetation on the site is necessary to reduce browsing pressure on red oak regeneration.
- Red oak seedlings need about 2 to 5 percent of full sunlight to meet the energy demands of existing tissue. Light levels below that can be fatal.
- Red oak seedlings require 20 percent of full sunlight to produce positive shoot growth.
- Red oak seedlings show increased height and diameter growth up to 50 to 70 percent of full sunlight.
- Residual trees intercept light, and light, levels in the understory are related to crown closure. However, the exact relationship between crown closure and under-story light levels is not yet known (we will be measuring this, but have not yet obtained the data). Our working assumption and rule of thumb, based on values reported in the literature, *is* that the percentage of full sunlight is inversely proportional to crown closure. Therefore, 50 percent crown closure results in 50 percent full sunlight, 40 percent crown closure results in 60 percent full sunlight, and so on.
- In a shelterwood situation, we need to control competing vegetation before it begins to overtop the oak if we wish to maintain 50 to 70 percent full sunlight required to maximize the growth and vigour of red oak regeneration.

Based on this threshold, each plot will be treated as needed.

Approaches Used to Answer Research Questions—Which of four tending treatments provides the best control of competing vegetation and the best growth response of planted and natural red oak regeneration? We will test four tending treatments replicated three times:

1) Mechanical brushing is the most common treatment currently used in central Ontario. Using a brush saw, the operator will clean a 1-m (3.3-ft) radius around the crop tree. The potential outcome will be: a) no control of herbaceous

vegetation; b) rapid sprouting of woody vegetation; or c) re-treatment required within 1 to 2 years.

2) Chemical tending with a backpack sprayer will be utilized. Using a pipe or shield, the operator will protect the oak seedling while spraying glyphosate using a backpack sprayer within a 1-m (3.3-ft) radius around the crop tree. The potential outcome will be: a) control of woody and herbaceous vegetation; b) possible injury to red oak; or c) re-treatment required within 3 to 5 years.

3) Prescribed burning with two consecutive burns will be done. Fire management staff will burn the plots under appropriate conditions to create a moderate intensity fire that will kill the above ground portion of all vegetation. This vegetation recovers with sprouting of woody vegetation and germination of seeds in the seedbank. The second fire in 1 or 2 years (depending on fuel build-up) kills the regrowth. The potential outcome will be: a) need to wait 3 years before the first fire to allow the red oak regeneration to build up a good root system and to become strong enough to avoid being killed by the fires; b) need good weather and timely and adequate human resources to conduct the fire; or c) re-treatment not required.

4) A nontreated control is needed as part of experimental design.

Each treatment plot measures 50 by 50 m (164 by 164 ft). We will compare the treatments by measuring the following:

1) The number of treatments required to obtain red oak seedlings measuring 3 m (10 ft) in height. Each plot will be assessed every year and evaluated according to the threshold. When more than 50 percent of the trees have vegetation taller than 40 cm (16 in) above their height, a treatment will be applied.

2) Survival, growth, and condition of planted and natural red oak. Within each treatment plot, we will measure the growth (height, diameter) and condition of each of 25 pinned red oak seedlings.

Regeneration Ecology

Dr. Jeff Dech from Nipissing University, North Bay, ON has recently been awarded 2 years of funding under the Natural Sciences and Engineering Research Council (NSERC) industrial research grant program to work on red oak. His research will be focused on regeneration ecology of red oak, including coppice dynamics, acorn predation, nutrient dynamics. competition effects, and so on.

Acknowledgments

These studies are in cooperation with the Forestry Research Partnership, Canadian Ecology Centre, PO Box 430, Hwy 17 W, Mattawa, ON POH 1VO.

For Further Information

Andree Morneault
Southern Science and Information Section
Ontario Ministry of Natural Resources
3301 Trout Lake Rd. North
Bay, ON PIA 4L7
Tel: 705-475-5566
Fax: 705-475-5570
E-mail: andree.rnorneault@mnr.gov.on.ca