Regeneration Monitoring

Procedures and Standards

MN DNR FORESTRY- April 1, 2013 revised December 2016

Conifer Planting on State Land

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Introduction

The regeneration survey is a key silvicultural monitoring tool. It provides the forester with information needed to make prescriptions for management activities beyond the initial regeneration action. The regeneration survey documents a site's status in regard to our regeneration standards, and is the primary means used to measure progress toward achieving our management objectives for each site during its early growth stage. Timely monitoring provides opportunities to protect investments already made in the site, and allows any necessary follow-up treatments to be made at a lower cost than if they are delayed. Finally, surveys help us to evaluate the effectiveness of the treatments that have been applied and to learn from our experience.

All personnel that conduct regeneration surveys are expected to follow the procedures described below. The Area Silviculture Program Leader is responsible to review this document with appropriate area staff annually.

Survey Scheduling

The timing of regeneration surveys is determined by the site's silvicultural prescription and associated management objectives, by regeneration standards reporting requirements, and by the knowledge and experience of the forester. The Regeneration Standards tables (Appendix A) define surveys at various intervals, depending on the cover type (or main species) and the floristic region. The standards check alone will provide sufficient monitoring for many sites, while other more intensively managed sites will require more frequent surveys. Additional surveys should be scheduled when needed for management decision making. Site monitoring is necessary until the preferred and acceptable species identified in the site prescription are free to grow, which may take 10 years or longer on some sites. Refer to the site prescription for guidance.

Regeneration surveys should not be scheduled solely to update forest inventory data.

Note that replanting, interplanting, or reseeding a site "starts the clock over", in terms of survey scheduling.

<u>Post-harvest survey scheduling:</u>

At the time that a timber sale is closed, the timber sale administrator must notify the Area Silviculture Program Leader to schedule an onsite survey if the site meets any of the following criteria:

- The site is prescribed for natural regeneration to a cover type other than aspen or black spruce.
- The planned cover type is aspen or black spruce, but there is reason to suspect that all or part of the site may subsequently fail to meet regeneration standards. For example, an aspen site harvested on unfrozen ground during a wet period.
- There are forest health concerns. For example, black spruce sites where the parent stand was infected with mistletoe.

Work planning

By June 1st of each year, the Area Silviculture Program Leader will enter in SRM either an onsite visit-regeneration survey action or a regeneration standards check action, as appropriate, for every site due to be checked in the coming fiscal year, and will update SRM to assign the forester responsible for each survey. The Area Silviculture Program Leader will provide each forester with a list of the sites for which they are responsible and the type of survey required for each site (standards check or regular).The Area Silviculture Program Leader will provide a summary list of all area regeneration survey assignments to the Area Forest Supervisor by July 1st annually.

All assigned sites with potential protection needs should be surveyed by May 15th of the following year, to facilitate inclusion in annual protection contracts. The balance of assigned surveys should be completed by June 30th of the following year.

Aerial Surveys

Aerial photography, rather than onsite surveys, will be used to monitor regeneration success on aspen/balm of gilead (A/BG), and lowland black spruce (BSL).

Resource Assessment staff will conduct photo analysis of a representative sample of regenerating (A/BG), after their third growing season after harvest. Results of this analysis will be used to characterize all (A/BG) sites in the candidate pool.

The same aerial survey process will be used to assess a representative sample of all (BSL) sites, following their seventh growing season after harvest. The survey candidate pool will include sites that have been artificially seeded as well as those prescribed for natural regeneration.

Standards check actions for A/BG and BSL sites should only be entered in SRM for those sites selected by Resource Assessment for photo analysis, or if there is reason to suspect that a site, or part of a site, may subsequently fail to meet regeneration standards.

Areas will receive digital images of all aerially surveyed sites from Resource Assessment, along with an estimate of trees per acre and percent stocking. Areas should review the photo interpretation of these images, update FIM, and then enter the interpretation results in SRM. Only sites aerially surveyed should be entered in SRM. No other aspen or black spruce sites require an action in SRM.

Aerially surveyed sites do not require an onsite visit except when photo analysis indicates that follow-up silvicultural treatments may be necessary.

See Appendix B for details of the aerial survey procedure.

Ground Surveys

The method of a regeneration check should match management objectives and the need for the data. Regardless of the method chosen, it is important that the survey provide adequate coverage of the site. The forester is responsible to ensure that the

information collected is sufficient to meet management needs. Refer to the site prescription for guidance.

Plot Surveys

The survey procedures outlined in this section are based on the assumption that tree growth and distribution are relatively homogenous within the area to be surveyed, and that areas where differences do exist will be grouped into strata before beginning a survey. A stratum is a contiguous area of at least 5 acres that is treated as a separate sampling unit based on variations in tree species, slope, aspect, soil type or native plant community. If different strata exist but have not previously been mapped, a walk-through of the site should be conducted to identify and map the strata, prior to taking any plots.

Plot surveys should be recorded on a PDA whenever possible, in order to simplify data entry in SRM. Paper regeneration survey forms may also be used, if approved by the Area Forester and the ASPL. Paper forms with a computer generated map can be printed from SRM (See SRM User Guide, Chapter 9). Blank forms are available on the Silviculture Program intranet page.

Plot surveys require one fixed-radius plot per acre for the first ten acres, with one additional plot for every 5 additional acres. Plots should be distributed evenly across the site, and plot centers should be selected randomly. Make sure that plots are numbered and mapped, and that the plot size used is recorded.

Plot size may vary from site to site depending on anticipated management activities, estimated stand density, and data needs. Specific plot sizes are required for some standards checks; see Appendix A.

General plot size recommendations are as follows:
1/1000 acre - 3.7 ft. radius - Sites with more than 1000 trees per acre
1/500 acre - 5.3 ft. radius - Sites with more than 500 trees per acre
1/250 acre - 7.4 ft. radius - Sites with more than 250 trees per acre
1/100 acre - 11.8 ft. radius - One-year planting sites; sites with less uniform stocking or a low stocking level

Use a larger plot size (1/250 or 1/100 acre) for planting sites whenever practical.

Field tips: A simple technique for measuring plot radius is to cut a short stick to a length equal to the desired plot diameter. Or, carry a high-pile stick or collapsible fishing pole marked at the plot diameter. Rotate the stick around a fixed plot center to delineate the plot boundary. For 1/100-acre plots, use a logger's tape to establish plot diameter, and carry a shovel with a screw in the top of the handle to serve as plot center.

Data Collection

The plot center and plot size should be the same for both crop tree and unwanted vegetation data. Remember to record the plot size used.

- Record the number of crop trees present and their average height. Crop trees are those tree species that are ecologically suited to the site, and which are consistent with the management objectives identified in the prescription. Crop trees include

preferred species (the primary targets of management activities) and acceptable species (secondary targets).

- Plot data that describes unwanted vegetation is required only for herbicide, hand release, or stand improvement prescriptions. If it is apparent that no such treatment is needed, recording unwanted vegetation is unnecessary. If one of these treatments may be needed, all significant species of unwanted vegetation should be inventoried on all plots. If certain species of vegetation have no competing significance, no data on these species need to be collected. For unwanted vegetation, either count and record the number of stems for each species, or visually assess the competition and record its rating. Categories for the visual method are as follows:
  - Light - Will not be significant competition before next check
  - Medium - Unwanted vegetation is at the point where it may be competing with crop trees before the next check
  - Heavy - Competition is severe and action is needed

- Record grass competition if it is significant (sod forming).

- Invasive plants that are observed, but not tallied as competition, should be recorded in the Remarks section.

- Damage: See Appendix C, Animal Damage, for aids in identifying the various types of animal damage. Deer Browse: Count only stems that have significant damage. **Significant damage is defined as: the terminal leader is browsed, or at least ⅓ of the lateral stems are browsed, or both.**

- Other Damage (examples are mice, rabbits, insects, disease): If damage is significant, record the number of damaged stems. If common or prevalent, record the type of damage in the Remarks section.

- Free to Grow definition: **A tree is free to grow if it is healthy and there is no foreseeable need for release treatments; for browse susceptible species, the terminal bud must be above browse height.** See Appendix D, Competition Assessment, for aids in determining the need for release from woody competition. If at least 75% of the crop trees on the plot are free to grow, the plot is scored as FTG. **Free to Grow status is an important metric and must be recorded**.

- Post-survey analysis and prescription: Record the type and start date of the Next Action(s), if any, including a follow-up regeneration survey if needed. Select No Treatment, Treat All, or Treat Part. If Treat Part is selected, indicate which part of the site on the map or in Remarks.

  If the survey is a Regeneration Standards Check, compare survey results with the appropriate regeneration standards (preferably those contained in the site prescription). Then record whether or not the site meets the identified standards.

Surveyors with limited experience are expected to consult the Area Silviculture Program

Leader as this decision is made.

Ocular Surveys

Ocular checks and estimates are acceptable if the forester is confident that the survey will adequately describe the entire site, and are especially appropriate if it is readily apparent that no further development treatments are necessary. Ocular surveys are not appropriate for 1-year standards checks on planted sites or for 3-year standards checks on seeding sites.

Record the following survey components on the paper survey form and submit to the Area Silviculture Program Leader for SRM data entry:

Site ID

- Date and type of survey
- Crop tree summary: species, stocking %, trees per acre, average height, and percent free-to-grow
- Next Action prescription and start date
- Recommendation (No Treatment Needed, Treat All, or Treat Part)
- Remarks—indicate ocular survey, include notes on any observed invasive species
- Regeneration Standards determination, if applicable

Ocular survey by helicopter is an effective technique, especially for monitoring large and/or remote sites. However, helicopter flight time is expensive. The Area Silviculture Program Lead must first consult the Region Silviculture program leader to determine if funding is available. Coordinate projects through the Helicopter Operations Specialist at MIFC and the Forest Management Helicopter Supervisor. Some pre-work is necessary in order to make the most efficient use of this tool. See Appendix E for details on setting up a helicopter regeneration survey project.

Summarizing Survey Data

Survey summarization and subsequent data entry is automated if a PDA is used. It is recommended that staff using a paper form for collecting plot data should enter that data into a PDA back in the office, then upload it into SRM. This will ensure that summarization is accurate and will minimize time spent on manual SRM data entry.

If a PDA is not available, first summarize the plot data in the table on the bottom of the back (page 2) of the form, then transfer that data to the appropriate summary block on the front of the form, and complete all indicated calculations. Note that for the Damage summary block, the required calculation is to divide the number of stems damaged by the total number of stems tallied. Once summarization is complete, navigate to the site in SRM and enter the data (See SRM Users Guide, Chapter 8).

Reporting Poor Survival

Planted sites with crop tree survival of 50% or less on the 1-year survey must be reported to the Region Forest Health Specialist, the Region Silviculturist, and the Area Silviculture Program Leader. The purpose of this reporting is to make the Area and the Region aware of problems that may potentially be wide spread. In such cases, it is

important that the search for causes, and possible solutions, begin as soon as possible. Specific reporting protocols may vary from Region to Region; contact your Region Silviculturalist for details. The following procedure may be used as a "default":

Make the initial report to Region Silviculturalist via email or phone call as soon as possible after the survey is completed. The Area Silviculture Program Specialist should transmit a copy of the survey data to the Region Forest Health Specialist and the Region Silviculturist. They will follow up with the reporting forester, and notify the Area of any further action needed.

Accomplishment Reporting

Accurate, complete, and on-time accomplishment reporting is a key component of the regeneration monitoring process. The Area Silviculture Program Leader is responsible to ensure that the following tasks are completed:

- Summary data for all formal surveys must be recorded in SRM, including aerial surveys (for those sites actually flown). Data entry for all such surveys completed in a given fiscal year must be completed by the following August 1st.

  In SRM, enter any required follow up treatment and start date from the Next Action or Remarks block, and an on-site visit for the next regeneration survey, if necessary. Also, document that the current survey was completed, by entering an Actual for that regeneration survey action.

- If a paper survey form was used, keep the completed form on file with other site information.

Provide a list of each area staff regeneration survey accomplishments for the preceding fiscal year to the Area Forest Supervisor prior to annual performance reviews, and no later than August 1st.

Appendix A: Regeneration Standards and Survey Schedule

Regeneration standards are a tool used to assess the sustainability of forest management and to help us determine if desired objectives are being met. They provide criteria that are compared to conditions in regenerating stands to assess whether the results of reforestation activity were successful. It is important to note that regeneration success on an individual site should be measured against the regeneration standards specified by the forester in the site prescription**. The regeneration standards components required in prescriptions are: a list of the preferred and acceptable species, the timeframe expected for crop trees to be free to grow, and the range of crop TPA that is desired at that time.** The criteria listed here are generalized, and are intended to provide a starting point or typical set of standards, which can be adjusted by the forester as necessary. The assumption behind the criteria is that the management objectives for the site include relatively full stocking of crop trees (see tables for details), and production of timber for harvest. That assumption may not be valid for all sites.

The standards are organized by cover type or main species and, for species whose behavior is significantly different across their range within Minnesota, by floristic region as well.

Where multiple species have been planted or seeded together, refer to the table for the dominant species present, and consult the site prescription for guidance on the standards to be applied. The site prescription is also the source for standards for species or cover types not listed in the Regeneration Standards tables. If the site prescription is not available, consult Area and Region silviculture program staff for assistance.

Definitions of terms in the tables:

- "Standards checks" are mandatory surveys, unless a prior survey has tagged the site as free to grow.
- Seeding standards checks apply to both natural and artificial seeding.
- "Recommended" surveys should be conducted unless the ASPL and the Area Forest Supervisor determine otherwise. A survey at this point in stand development can often maximize the timeliness and cost-effectiveness of any follow up treatments.
- "Optional" surveys may be useful, depending on the site's management objectives, but are less critical to complete than "Recommended" surveys.
- "Crop" trees are those species that are ecologically suited to the site, and which are consistent with the management objectives identified in the prescription. Crop trees include preferred species (the primary targets of management activities) and acceptable species (secondary targets).
- "Stocking" is a measure of occupancy; the percent of the site with the specified number of trees per acre
- "Initiation" is the year that the crop trees were planted, seeded, or naturally regenerated
- TPA = Trees per Acre; FTG = Free to Grow

Jack Pine						
Floristic Region	**Growing seasons since initiation**					
	1	**3**	**5**	**6**	**8**	**10**
Northern	Planting Standards Check 500-600 JP TPA 75% JP Stocking (1/100th ac. plots)	Seeding Standards Check 500-600 JP TPA 75% JP Stocking (1/100th ac. plots) Planting Survey Recommended	Planting Standards Check 400-600 JP TPA Seeding Survey Recommended	Seeding Standards Check 400-600 Crop TPA	Planting Standards Check 400-500 Crop TPA 75 % of plots are FTG	Seeding Standards Check 400-500 Crop TPA 75 % of plots are FTG
Central	Planting Standards Check 400-500 JP TPA 75% JP Stocking (1/100th ac. plots)	Seeding Standards Check 250-500 JP TPA 60% JP Stocking (1/100th ac. plots) Planting Survey Recommended	Planting Standards Check 300-500 Crop TPA	Seeding Standards Check 300-500 Crop TPA	Planting Standards Check 300-500 Crop TPA 75 % of plots are FTG	Seeding Standards Check 300-500 Crop TPA 75 % of plots are FTG

Red Pine						
	Growing seasons since initiation					
Floristic Region	**1**	**3**	**5**	**8**	**10**	
Northern & Central	Planting Standards Check 500-600 RP TPA 75% RP Stocking (1/100th ac. plots)	Seeding Standards Check 500-600 RP TPA 75% RP Stocking (1/100th ac. plots) Planting Survey Recommended	Planting Survey Recommended Seeding Survey Recommended	Planting Standards check 400-500 Crop TPA 75 % of plots are FTG Seeding Survey Recommended	Seeding Standards check 400-500 Crop TPA 75 % of plots are FTG Planting Survey Optional	

White Pine[1]						
	Growing seasons since initiation					
Floristic Region	**1**	**3**	**5**	**8**	**10**	**12**
Northern, Central, Southern	Planting Standards Check	Seeding Standards Check Planting Survey Recommended	Planting Standards Check Seeding Survey Recommended	Seeding Standards Check Planting Survey Recommended	Planting Standards Check 75 % of plots are FTG	Seeding Standards check 75 % of plots are FTG
[1]White Pine is normally planted or seeded as a component with other species. See individual site prescriptions for standards or consult Area and Region silviculture program leaders.						

White Spruce[1]					
	Growing seasons since initiation				
Floristic Region	**1**	**3**	**4-5[2]**	**8**	**10**
Northern, Northwestern	Planting Standards Check 300-400 WS TPA 75% WS Stocking (1/100th ac. plots)	Seeding Standards Check 300-400 WS TPA 75% WS Stocking (1/100th ac. plots) Planting Survey Recommended	Planting Standards check 600-900 Crop TPA Seeding Survey Recommended	Seeding Standards check 600-900 Crop TPA Planting Survey Recommended	Planting Standards Check 400-800 Crop TPA
[1]White spruce is normally planted as a component with aspen or other species. See individual site prescriptions for additional guidance or consult Area and Region silviculture program leaders. [2]Survey at container stock at 4 years, bare root stock at 5 years					

Lowland Black Spruce					
	Growing seasons since initiation				
Floristic Region	**1**	**3**	**5**	**7**	
Northern, Northwest, Southern	Post-harvest Dwarf Mistletoe assessment recommended*	Optional	Optional	Standards Check 600+ BS TPA, 90% Stocking (Aerial survey)	
*Survey only those sites where dwarf mistletoe was present in the parent stand. Evaluate the presence, abundance and distribution of potentially infected black spruce saplings and trees that survived the harvest, for possible follow-up mistletoe treatment. This is not a crop tree count.					

Lowland Tamarack					
	Growing seasons since initiation				
Floristic Region	**1**	**3**	**5**		
Northern, Northwest, Southern		Optional	Standards Check 600+ Crop TPA 90% Stocking		

Aspen/Balm of Gilead Natural Regeneration					
	Growing seasons since initiation				
Floristic Region	**1**	**3**			
Northern, Northwest, Central, Southern		Standards Check 1000+ Crop TPA 90% Stocking (Aerial survey)			

Birch Natural Regeneration				
	Growing seasons since initiation			
Floristic Region	**1**	**3**	**4**	
Northern, Central, Southern			Standards check 1200+ Crop TPA 90% Crop Tree Stocking	

Mesic Hardwoods						
	Growing seasons since initiation					
Floristic Region	**1**	**3**	**5**	**8**	**10**	**15**
Northern Open Planting	Standards Check 400-600 Oak TPA 75% Stocking 1/100th ac. plots	Survey Recommended	Standards Check 300-500 Crop TPA 90% Crop Tree Stocking		Survey Recommended	Standards Check 100-300 Crop TPA 75% of plots are FTG
Central Open Planting or Shelterwood	Standards Check 400-600 Oak TPA 75% Stocking 1/100th ac. plots	Survey Recommended	Standards Check 300-500 Oak TPA 75% Stocking		Survey Recommended	Standards Check 100-300 Crop TPA 75% of plots are FTG
Southern Pre-harvest under-planting	Standards Check 400-500 Crop TPA 75% Stocking 1/100th ac. plots	Survey Optional	Survey Optional		Standards Check 150-300 Crop TPA 75% Stocking 1/100th ac. plots	Standards Check 100-200 Crop TPA 75% of plots are FTG
Southern Direct Seeding	Standards Check 2000-3000 Crop TPA 90% Stocking 1/1000th ac. plots	Annual surveys recommended years 1 through 5	Standards Check 1500-2000 Crop TPA 75% of plots are FTG		Survey Recommended	
Southern Natural Regen (Growing seasons since harvest)	Standards Check 1000-3000 Crop TPA 75% Stocking 1/100th ac. plots	Survey Optional	Survey Optional	Standards Check 150-300 Crop TPA 75% Stocking 1/100th ac. plots		Standards Check 100-200 Crop TPA 75% of plots are FTG

Bottomland Hardwoods					
	Growing seasons since initiation				
Floristic Region	**1**	**3**	**5**	**8**	**10**
Southern Under-planting	Standards Check 400-500 Crop TPA 75 % Stocking 1/100th ac. plots	Survey Recommended	Survey Recommended	Standards Check 300-400 Crop TPA 90% Crop Tree Stocking 75 % of plots are FTG	Survey Optional
Direct Seeding	Standards Check 2000-3000 Crop TPA 90% Stocking 1/1000th ac. plots	Annual surveys recommended years 1 through 5	Standards Check 1500-2000 Crop TPA 75 % of plots are FTG		Survey Recommended

Standards Check Schedule Summary											
Cover Type	Floristic Region	Growing seasons since initiation									
		1	3	4	5	6	7	8	10	12	15
Jack Pine	**All**	Planting	Seeding		Planting	Seeding		Planting	Seeding		
Red Pine	**All**	Planting	Seeding					Planting	Seeding		
White Pine	**All**	Planting	Seeding		Planting			Seeding	Planting	Seeding	
White Spruce	**All**	Planting	Seeding	Planting (Containers)	Planting (Bareroot)			Seeding	Planting		
Black Spruce (Lowland)	**All**						Seeding & Natural				
Tamarack (Lowland)	**All**				Seeding & Natural						
Aspen/Balm	**All**		Natural								
Birch	**All**			Natural							
Mesic Hdwds	**Northern & Central**	Planting			Planting						Planting
	Southern	Planting Seeding Natural			Seeding			Natural	Planting		Planting Natural
Bottomland Hdwds	**Southern**	Planting Seeding			Seeding			Planting			

Appendix B: Aerial Survey Procedure

At the start of each fiscal year, Resource Assessment staff will query FIM to generate shapefiles of regenerating aspen/balm, and lowland black spruce. These files will comprise the candidate pools of sites to be surveyed. Site selection will be based on current age: aspen/balm age 3, and lowland black spruce age 7. Sites less than five acres, upland black spruce and all tamarack will be excluded.

Resource Assessment staff will select a random sample of aspen/balm and lowland black spruce sites to be flown, sufficient to provide a confidence level of no less than 95% in the survey results. Due to the low rate of regeneration failure on these sites, the number of sites necessary to be flown will be reduced for each cover type pool. Site selection will result in a random geographic distribution of sample sites across the full extent of each pool.

Anticipated pool sizes are as follows:

- Aspen/Balm (A/BG) = 70 sites for a range of 2,000-3,000 acres
- Lowland Black Spruce (BSL) = 100 sites for a range of 3,000-4,000 acres

True color digital imagery of each site will be taken with enough overlap to provide stereo coverage. Images taken will be distributed digitally to the appropriate areas for their own use.

Resource Assessment staff will conduct image analysis and associated ground truthing (up to 10% of the sites flown in each pool will be field checked), and will determine whether each site is sufficiently stocked. Minimum standards are as follows:

- Aspen/Balm (A/BG) = 1000 stems per acre over 90% of the site
- Lowland Black Spruce (BSL) = 600 stems per acre over 90% of the site

Sites not meeting standards or with questionable regeneration success will be noted and passed on to area field staff for an onsite visit.

Photo Interpretation and Analysis

Resource Assessment will provide the following photo interpretation and analysis:

For Aspen/Balm sites:

- Acres of each site with High (greater than 5000), Medium (1000-5000), or Low (less than 1000) trees per acre.
- Acres of each site comprised of roads, landings, and skid trails

For Lowland Black Spruce sites:

- Acres of each site with High (greater than 5000), Medium (1000-5000), or Low (less than 1000) trees per acre.
- Acres of each site comprised of roads, landings, and skid trails

As an aid to image analysis, Resource Assessment staff may request background information from the appropriate area field staff for each site that is flown including prescription, timber sale permit, harvest dates, type of equipment used, etc.

Flight Timing

- Aspen/Balm sites will be flown in late summer, 3 growing seasons after harvest.
- Lowland Black Spruce sites will be flown in late fall/early winter, when the ground is snow covered to a depth of 1-3 inches, 7 to 8 growing seasons after harvest.

Results

Resource Assessment staff will submit a full report of survey results and a corresponding shapefile of the sites flown to the Silviculture Program Coordinator no later than April 1st, annually. The Silviculture Program Coordinator will distribute survey results to each region and area as appropriate. Images taken will be distributed digitally to the appropriate areas for their own use. The Area Silviculture Program Leader is required to enter survey actions in SRM only for sites actually surveyed. Area field staff will conduct ground surveys of all sites not meeting standards no later than the following June 30th.

Appendix C: Animal Damage

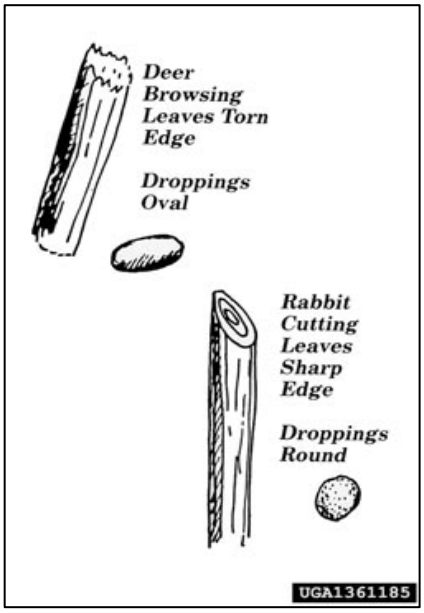
Many animals scar, deform or girdle trees by chewing, scratching, rubbing, shredding the bark and cambium, and browsing buds. The type and extent of damage varies with the animal and the availability of suitable trees. In most cases of chewing or marking, tooth or claw marks are clearly visible in the cambium or sapwood of damaged trees. The size of tooth marks on the stem may help distinguish between rodent, hare, gopher and bear damage.

- White-tailed Deer –Deer do not have upper incisors (front teeth). They browse by gripping a stem between their lower incisors and their upper hard palate and tearing it off. This leaves a characteristically ragged edge torn horizontally across the stem. They typically browse the tender tops of seedlings, particularly in winter and early spring. Browsed trees produce more stems and take on a broom-like form. They are often stunted due to repeated terminal and lateral shoot removal.

Deer Browsing Damage 1


Deer Browsing Damage 2

Deer Browsing Damage 3



- Hares and rabbits – Snowshoe hares and rabbits damage seedlings by gnawing or biting them off at various heights. They have upper and lower incisors, so they tend to snip twigs more cleanly than deer, leaving a characteristically sharp 45-degree cut.There are two signs in the field that will help foresters determine whether the seedlings were damaged by deer or rabbits: Deer clip the seedlings straight across and leave a ragged edge; rabbits clip them off at an angle. Droppings will also usually be present. Rabbit pellets are usually deposited at the base or near the base of damaged seedlings. Deer droppings are deposited at random throughout the area. It is not uncommon to find droppings from both animals in the same area. Rabbit droppings are round, whereas deer droppings are oval.

  Hares and rabbits also gnaw bark to the cambium more readily than deer. Look for medium-sized paired tooth marks indicative of the rodent-like front teeth.

Hare and Rabbit Damage 1

Hare and Rabbit Damage 2

- Mice and voles – Mice and meadow voles periodically damage young pines by gnawing at the base of trees, feeding on the cambium near the ground. This commonly scars or girdles trees. Look for small, paired tooth marks. Snow cover and tall grass provide cover from predators, allowing these animals to browse uncontrolled. Trimming lower branches may help reduce protective cover.

Mouse and Vole Damage 1

Mouse and Vole Damage 2

- Pocket gophers - Pocket gopher damage can be confused with mouse and vole damage, but pocket gophers commonly prune roots of seedlings and girdle or clip seedling stems at or near ground level. Small seedlings are the most vulnerable. Gophers may pull seedlings underground and stockpile them in their burrows. Young trees with most of their root connections severed by pocket gophers may be found tipped over or are easily pulled out of the ground by hand.

Pocket Gopher Damage 1

- Moose - Moose damage trees by browsing seedlings, suckers, saplings, and foliage, and by rubbing antlers on saplings and larger trees. Moose have been known to pull down trees (especially aspen) and brush 9 ft or higher and snap the top off while browsing. Preferred species include aspen, white cedar and fir.

Moose Damage 1

- Black bear - Bears will strip the bark off saplings and small trees to feed on the cambium, sometimes girdling large groups of trees in an area. They tend to select vigorously growing trees. Look for large, unpaired tooth marks perpendicular to the stem.

Black Bear Damage 1

Appendix D: Competition Assessment

Note that the diagrams and criteria below do not apply to seedlings intended to be grown in the understory.

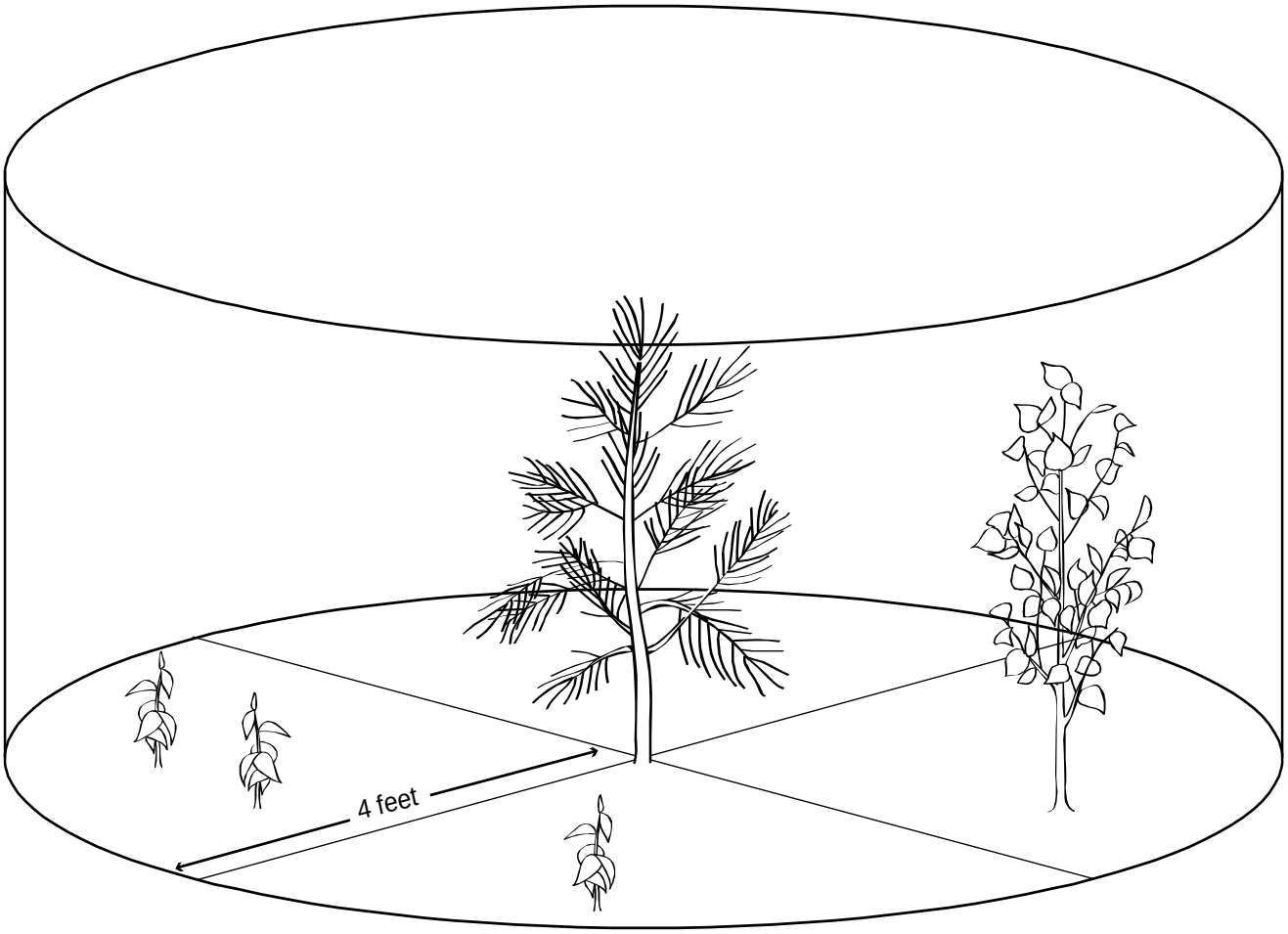


Figure 1

To assess vegetation competition, visualize a competition cylinder around the crop tree. The radius of the cylinder is 4 feet. Next, divide the cylinder into four quadrants. Orient the dividing lines so as to group the competition into as few quadrants as possible.

Crop trees are 'not free-growing' if:
1) tree competitors taller than half of the crop tree height occur in at least one quadrant of the competition cylinder and more than one quadrant is occupied by either woody shrub or non-crop tree competitors (see Figure 1) or,
2) woody shrub competitors taller than two thirds of the crop tree height occur in at least two quadrants around the crop tree and more than two quadrants are occupied by either woody shrub or non-crop tree competitors (see Figure 2).

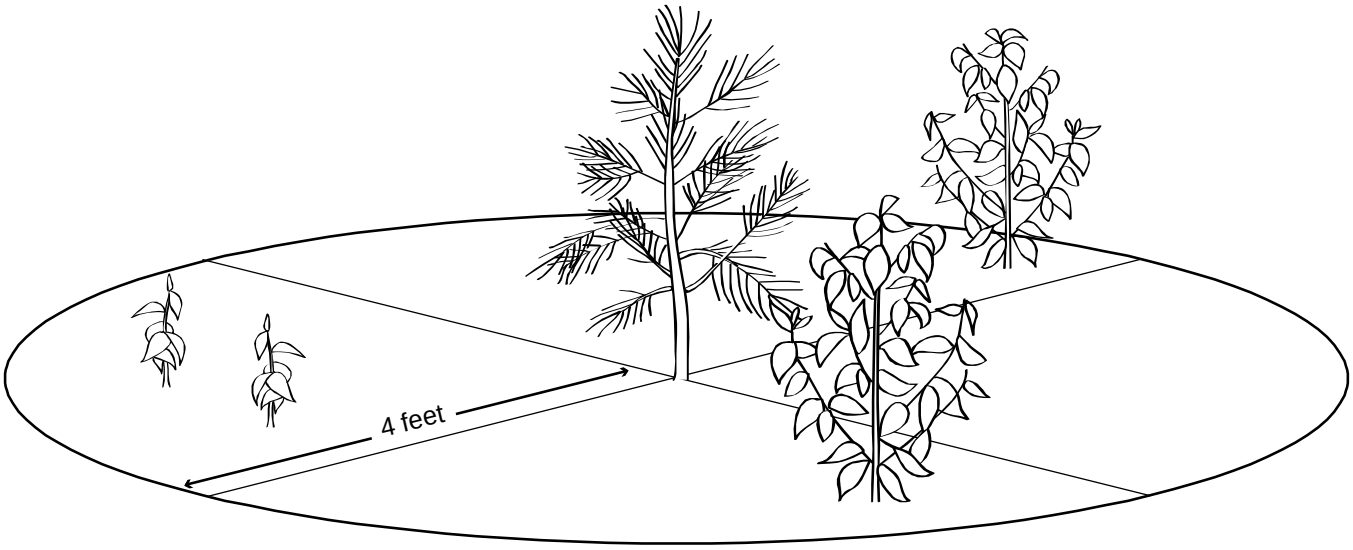


Figure 2

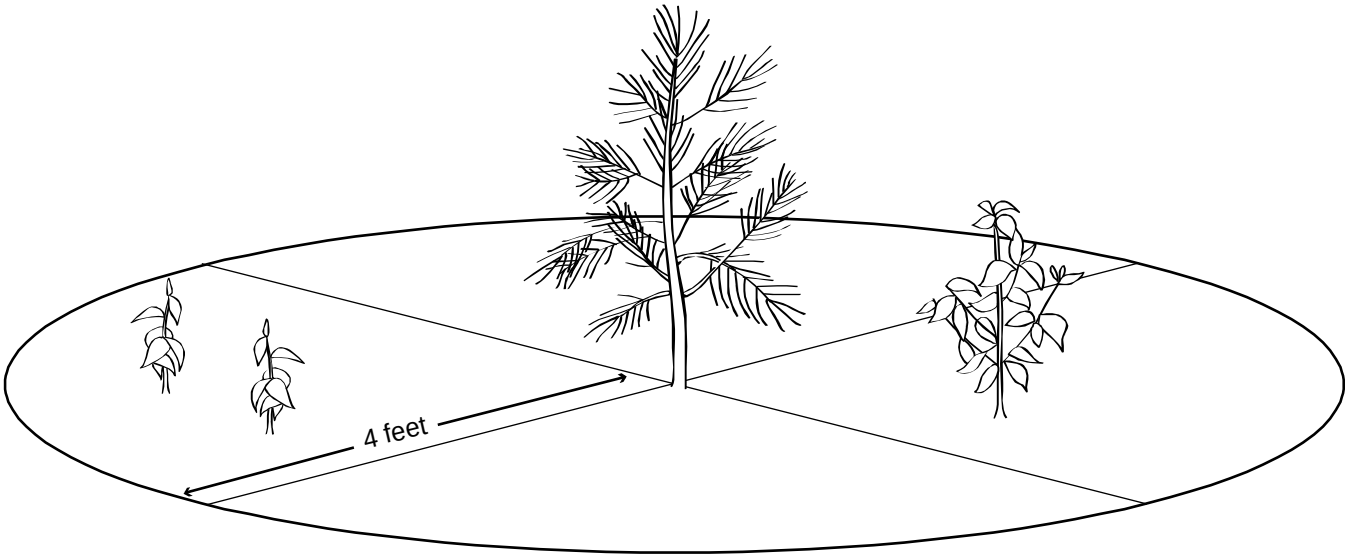


Figure 3

Figure 3 represents a crop tree that is free of woody competition.

Appendix E: Project Planning for Helicopter Regeneration Surveys

All proposed projects must be discussed in advance with the Region Silviculturist. Once Region approval is obtained, projects should be coordinated through the Helicopter Operations Specialist at MIFC, and the Forest Management Helicopter Supervisor.

Pre-work steps

1. Using Landview or ArcMap GIS:
   - Highlight the stands to be checked (Landview only-Area measure tool, Control, right click)
   - Determine a Lat/Long for at least one of the stands in a project area.
   - Obtain stand numbers, acres and species.
   - Zoom in/out to get a good view of project (include a significant landmark for navigation or another project area) then print the map. Use a FIM overlay and aerial photo background.
   - Zoom out to create a map that will show your entire project (use a different, background, or none), or use another map with highlighter to plot each site to ensure that most efficient flight route can be determined.
2. After determining the route, utilize the Aerial Survey Project tab on the Helicopter Project Information Sheet and fill in the information for each site. See format below. Load each site with Lat/Long in a Garmin handheld GPS.
3. Organize your project sheets, photos, and timber sale or project proposal maps in the order that you will fly the project, punch them with a 3-hole punch, and put them in a binder.

Survey process

1. Bring your map, binder, and handheld GPS unit on the helicopter. Use the map to give the pilot a general overview of the project and to give him/her a general bearing and distance until the exact bearing and distance can be confirmed with the handheld GPS.
2. The survey will proceed very fast. Use colored pens and highlighters to make notes on maps and project sheets as there will be limited to make just a few shorthand notes before moving to the next site.

Additional tips

- The person in the front seat has the best view! More than one seasoned aviator has become ill from riding in the back seat, looking hard for regenerating trees, and making notes. It may be best to fly this project with pilot plus one!
- When looking at black spruce that is 12 inches or less in height, have the pilot first check for snags in the cutover. If none are present, or the pilot can safely maneuver around them, have him/her move at a slow hover on the site, low enough so the rotor wash blows the grass. You will see the spruce “hiding” within the grass or other vegetation which should allow for a reasonable estimate of stems per acre.

Follow-up

Transfer ocular survey data to a PDA for uploading to SRM, or transfer data to regeneration survey forms and submit the completed forms to the Area Silviculture Program Leader.

AERIAL SURVEY PROJECT
INFORMATION SHEET

FORESTRY AREA:		**PROPOSED ACRES:**	
PROJECT TYPE:		**ESTIMATED DURATION:**	
PROPOSED DATE:		**START TIME:**	

#	Forty	SEC	TWP	RGE	STAND#	COVER TYPE	ACRES	AGE	LAT	LONG	REMARKS
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
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