FOREST REGENERATION SURVEY MANUAL

Michigan Department of Natural Resources
Division/Office

IC4145 (06/15/2009)

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INTRODUCTION

Procedures for Regeneration and Health Surveys

Regeneration surveys on State Forest lands are used to evaluate current conditions in young jack and red pine planted stands, furrow seedlings and regeneration resulting from broadcast seeding, scarification and natural regeneration methods. Specifically, these surveys are used to measure tree growth and stocking. Stocking is defined as the number of trees per acre and the distribution of those trees within the planted stand.

Stand and planted stand health is evaluated at the same time the regeneration surveys are conducted on State Forest lands. Health is assessed within the same fixed-radius plots used for the regeneration surveys. When symptoms or insect and disease signs are observed, their location on affected trees, percent of trees affected and number of trees affected are recorded. Distribution of the problem in the stand or planted stand is estimated, and any additional information that may help identify and quantify these problems is recorded. When no problems are observed, trees are recorded as being "healthy". See Appendix D and E for copies of the Planted Stand Stocking Survey (R-4070) and Forest Health Plot Survey (R-4145-1) data sheets.

The survey procedures outlined in this manual are based on the assumption that tree growth and distribution are relatively homogenous within planted and furrow seeded areas, 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 indicator species. Wherever possible, the Department of Natural Resources (DNR) will attempt to supply stand examiners with strata locations on the Forest Treatment Proposal (FTP) or Global Positioning System (GPS) maps. In some cases, strata will have to be identified by conducting a walk-through prior to sampling. Information from air photos, FTPs, GPS maps, and completion forms can also be used to identify strata in a planted stand.

REGENERATION ESTABLISHED USING PLANTED STOCK

ONE YEAR AFTER ESTABLISHMENT

Objectives:
- To stratify the planting based on species and soil moisture.
- To determine trees per acre, tree distribution and tree height.
- To evaluate health of the planted area.

Survey Schedule: One year after establishment.

Time of Year: Early spring or mid-to-late fall, when herbaceous cover will not hamper visibility.

Equipment:
- Survey pole marked in 0.1 ft. increments for height measurements
- Measuring rope with appropriate plot radius marks
- Tatum with data sheets
- Tallywacker
- FTP map, GPS map if available
- Random number table

Plot Size: 1/100th (r = 11.78 feet) or 1/50th (r = 16.65 feet)

Plot Density: Variable, depending on plot size used. Normally 1 plot/acre when using 1/100th plots.

For 1/50th acre plots, see below:

Planted acres	# of plots (1/50th acre)
1-10	5 to 8
11-20	10 -15
21-30	18 - 25
31-40	28 - 30
41+	add 1 plot / 2 acres

Procedure:

1. Review the FTP file map, or GPS map, to determine the size of the planted stand, boundaries, and areas not planted and/or areas that were furrowed but not planted.

2. *Important:* Walk through the planted stand to verify size, shape, areas not planted, tree distribution, and furrow orientation. **If necessary, stratify the planted stand into separate sampling units.** Strata should be **a minimum of 5 acres**. Strata are identified where variations exist in species and soil moisture conditions. Moderate to steep slopes can also be used as a strata layer, if it is apparent that differences in regeneration exist. Draw these strata on the map. Make any corrections or modifications to file map based on observations made during the walk-through.

3. If multiple strata exist, estimate the acres for each. Determine approximate number of plots and furrow transects needed for each stratum. Draw transects and approximate plot locations on the file map. See the work sheet for the area for more detailed information.

For each stratum:

4. Check the FTP summary sheets for information on how many check plots to put into an FTP.

5. Check the FTP summary sheet for information on the suggested sampling grid (3 chains by 3 chains, 3 chains by 5 chains, etc.)

6. Look at the FTP map and pick a corner to start from. Your first plot should be located ½ the distance in from both sides, e.g., if you are putting plots in on a 3 chain by 3 chain grid, your first plot will be located 1½ chains over and 1½ chains up from your starting corner. Once the first plot has been established, you will then follow the recommended sampling grid mentioned in #5, above.

7. Whenever you complete a transect and begin your return run back into the planted stand, always place the next plot ½ the distance in from the edge, e.g., if you are establishing survey plots every 3 chains along a transect, your first plot will be located 1½ chains in from the planted area edge. Once this plot has been established, you will then follow the recommended sampling grid mentioned in #5, above.

    - Do not include plots that fall in unplanted and/or un-furrowed areas.

      EXCEPTION: Kirtland's Warbler planted stands are established using the "opposing weave" pattern which results in unplanted openings scattered throughout the planted stand. **Regeneration plots <u>are</u> to be taken in these unplanted areas.** Consult with the Wildlife or Forest, Mineral and Fire Management representative for more information on this topic.

    - Include plots that fall along edges and in failed or poorly stocked areas.

8. Record the number of trees in the plot. Count only the trees that have at least 1 live bud. Indicate the number of volunteer (naturally-seeded) seedlings on the data sheet (both in the furrow and out). The number of volunteers on a plot can be substantial, so it is important to count these as accurately as possible. Consult with the Forest, Mineral and Fire Management or Wildlife representative for more information as to what tree seedlings are to be counted as volunteers.

Record the height of the last planted tree in every plot. Measure to nearest 0.1 feet.

9. Fill out the planted stand stocking data survey sheet. Make sure it is complete.

10. Fill out the Forest Health Plot Survey data sheet for each plot. Symptoms and signs of up to three different problems can be recorded for each plot. Use the "Symptoms/Signs" codes provided on the data sheet. If no problems are observed, indicate by checking the "No Problems Observed" box for that plot. Include any additional information in the "Comments" box.

REGENERATION ESTABLISHED USING PLANTED STOCK

THREE YEARS AFTER ESTABLISHMENT

Objectives:
- To stratify the planting based on species and soil moisture.
- To determine trees per acre, tree distribution and tree height.
- To evaluate health of the planted area.

Survey Schedule: 3rd growing season.

Time of Year: Early spring or mid-to-late fall, when herbaceous cover will not hamper visibility.

Equipment:
- Survey pole marked in 0.1 ft. increments for height measurements
- Measuring rope with appropriate plot radius marks
- Tatum with data sheets
- Tallywacker
- FTP map, GPS map if available
- Random number table

Plot Size: 1/50th-acre (r = 16.65 feet) or 1/100th acre, if the site surveyed has substantial numbers of natural regeneration.

Plot Density: If using 1/100th acre plots, put in one plot/acre.
For 1/50th acre plots, see below:

Planted acres	# of plots (1/50th acre)
1-10	5 to 8
11-20	10 -15
21-30	18 - 25
31-40	28 - 30
41+	add 1 plot / 2 acres

Procedure:

1. Review the FTP file map to determine size of planted stand, boundaries, and areas not planted and/or areas that were furrowed but not planted.

2. Important: Walk through the planted area to verify size, shape, areas not planted, tree distribution, and furrow orientation. If necessary, stratify the planted stand into separate sampling units. Strata should be a minimum of 5 acres. Strata are identified where variations exist in species and soil moisture. Moderate to steep slopes can be used as a strata layer, if it is apparent that differences in regeneration success exist. Draw these strata on the map. Make any corrections or modifications to the file map based on observations made during the walk-through.

3. If multiple strata exist, estimate the acres for each. Determine approximate number of plots and furrow transects needed for each stratum using the tables located in the Appendix. Draw transects and approximate plot locations on the file map.

For each stratum:

4. Determine the number of plots needed from the table.

5. Calculate the number of transects needed to evenly distribute the plots across the stratum. Determine the spacing between plots (see Appendix A).

6. Use a random number table to select a starting furrow at least ½ chain from a planted area edge. Distribute sample transects across entire planted stand using the spacing calculated above.

7. Place the first plot ½ to 1 chain in from beginning of furrow. Space plots evenly within furrows.

    - Do not take plots that fall in unplanted or un-furrowed areas.

    EXCEPTION: Kirtland's Warbler planted stands are established using the "opposing weave" pattern which results in unplanted openings scattered throughout the planted area. **Regeneration plots <u>are</u> to be taken in these unplanted areas.** Consult with the Wildlife or Forest, Mineral and Fire Management representative for more information on this topic.

    - Include plots that fall along edges and in failed or poorly stocked areas.

8. Record the number of trees in the plot. Count only the trees that have live buds on at least 50% of the shoots. Indicate the number of volunteer (naturally-seeded) trees on the data sheet. Look in the furrow and between furrows. Consult with the Forest, Mineral and Fire Management or Wildlife representative for more information as to what tree seedlings are to be counted as volunteers.

9. Record the height of the last tree in every plot. Measure to nearest 0.1 feet.

10. Fill out the planted stand stocking survey data sheet. Make sure it is complete.

11. Fill out the Forest Health Plot Survey data sheet for each plot. Symptoms and signs of up to three different problems can be recorded for each plot. Use the "Symptoms/Signs" codes provided on the data sheet. If no problems are observed, indicate by checking the "No Problems Observed" box for that plot. Include any additional information in the "Comments" box.

REGENERATION ESTABLISHED BY FURROW SEEDING

FIRST OR SECOND FULL GROWING SEASON

Objectives:
- To stratify the furrow seeding based on species and soil moisture.
- To determine trees per acre, tree distribution and tree height.
- To evaluate health of the regenerated area.

Survey Schedule: Following the first or second season, or as recommended by the Silviculturist or Wildlife representative.

Time of Year: Early spring or mid-to-late fall, when herbaceous cover will not hamper visibility.

Equipment:
- 6-foot long measuring pole
- Tatum with data sheets
- Tallywacker
- FTP map, GPS map if available
- Random number table

Plot Size: 6-foot linear in-furrow plot

Plot Density: 1 linear plot/chain

Sample Size: 10% of furrows (minimum sample: 3 furrows)

Note: *Six foot sampling pole to be placed **in the furrow.***

Procedure:

1. Review FTP file map, or GPS map, to determine the size of the seeded area, boundaries, and sections not seeded.

2. Important: Walk through the furrow seeding to verify size, shape, areas not seeded, tree distribution, and furrow orientation. If necessary, stratify the furrow seeded area into separate sampling units. Strata should be a minimum of 5 acres. Strata are identified where variations exist in species and soil moisture. Moderate to steep slopes can be used as a strata layer, if it is apparent that differences in regeneration exist. Draw these strata on the map. Make any corrections or modifications to the file map based on observations made during the walk-through.

For each stratum:

3. Estimate the number of furrows. At least 5% of the furrows (minimum of 3 furrows) in each stratum should be sampled. Almost all furrow seedings will come with GPS maps which can be used to estimate the number of furrows for any particular site. Remember that furrows are usually spaced about 8 feet apart. (As an example, a square 40 acre parcel with a furrow spacing of 8 feet will contain about 165 furrows. In this case, at least 8 furrows will need to be examined). Also note that furrows rarely run in straight lines. Most furrows will follow the general contour of the cover type and contain many sweeps, curves and bends. Some furrow patterns can take the shape of a spiral, as they wind their way throughout the treated area. It is imperative that this be taken into consideration while surveying the treated area for seedlings. It will be necessary to modify your sampling pattern to ensure that the entire furrow seeded area is adequately sampled. On sites where the furrow pattern is extremely variable, it may be necessary to run straight line transects throughout the furrowed area, placing the 6 foot measuring staff into the nearest available furrow at the specified sampling distance. In these situations, transects should be spaced 2 chains apart. Ask the Timber Management Specialist or Wildlife representative for advice on how to proceed when encountering extremely variable furrow seeded sites.

4. Begin sampling a ½ chain up and a ½ chain in from your beginning point (the edge of furrow seeded area). Use the survey pole to measure a 6-foot long sample area in the furrow (simply drop the 6-foot staff in the furrow).

5. Look for seedlings in the furrow along the length of the 6-foot sample area. Be sure to look at the sides of the furrow and beneath slash and herbaceous growth. **This is very important!!!!** Seedlings can be scattered **anywhere** in the furrow, not just in the center!! Indicate on the data sheet whether live seedlings were found along sample area. Live seedlings are seedlings with at least 1 live bud. It is not necessary to count seedlings -- just note whether they are present in each sample area. If you find seedlings, record this as a “yes”. If there are no seedlings, record it as a “no”. DO NOT record volunteers that are found growing outside of the furrow!

6. Continue sampling one 6-foot area per chain to the end of the furrow. Stagger the placement of the first sample in each sample furrow by ½ chain:

7. Fill out the planted stand stocking survey data sheet. Make sure it is complete.

8. Fill out the Forest Health Survey data sheet for each plot. Symptoms and signs of up to three different problems can be recorded for each plot. Use the “Symptoms/Signs” codes provided on the data sheet. If no problems are observed, indicate by checking the “No Problems Observed” box for that plot. Include any additional information in the “Comments” box.

REGENERATION ESTABLISHED BY FURROW SEEDING

THREE OR MORE FULL GROWING SEASONS AND LESS THAN 12" TALL

Objectives:
- To stratify the furrow seeding based on species and soil moisture.
- To determine trees per acre, tree distribution and tree height.
- To evaluate health of the regenerated area.

Survey Schedule: 3rd full growing season and beyond.

Time of Year: Early spring or mid-to-late fall, when herbaceous ground cover will not hamper visibility.

Equipment:
- Survey pole marked in 0.1 ft. increments for height measurements
- Measuring rope with appropriate plot radius marks
- Tatum with data sheets
- Tallywacker
- FTP map
- Random number table

Plot Size: $1/100^{th}$ (r = 11.78 feet)

Plot Density: 1 plot per acre

Procedure:

1. Review the FTP map, or GPS map, to determine the size of the area, boundaries, and areas not furrow seeded.

2. Important: Walk through the furrow seeding to verify size, shape, areas not seeded, tree distribution, and furrow orientation. If necessary, stratify the furrow seeding into separate sampling units. Strata should be a minimum of 5 acres. Strata are identified where variations exist in species and soil moisture. Moderate to steep slopes can be used as a strata layer, if it is apparent that differences in regeneration success exist. Draw these strata on the map. Make any corrections or modifications to the file map based on observations made during the walk-through.

3. If multiple strata exist, estimate the acres for each. Determine approximate number of plots and furrow transects needed for each stratum. Draw transects and approximate plot locations on file map.

For each stratum:

4. Check the FTP summary sheets for information on how many plots to sample.

5. Check the FTP summary sheet for information on the suggested sampling grid (3 chains by 3 chains, 3 chains by 5 chains, etc.)

6. Look at the FTP map and pick a corner to start from. Your first plot should be located ½ the distance in from both sides, e.g., if you are putting plots in on a 3 chain by 3 chain grid, your first plot will be located 1½ chains over and 1½ chains up from your starting corner. Once the first plot has been established, you will then follow the recommended sampling grid mentioned in #5, above.

7. Whenever you complete a transect and begin your return run back into the planted stand, always place the next plot ½ the distance in from the edge: e.g., if you are establishing survey plots every 3 chains along a transect, your first plot will be located 1½ chains in from the planted stand edge. Once this plot has been established, you will then follow the recommended sampling grid mentioned in #5, above.

    - Do not include plots that fall in unplanted and/or un-furrowed areas.

      EXCEPTION: Kirtland's Warbler planted stands are established using the "opposing weave" pattern which results in unplanted openings scattered throughout the planted stand. **Regeneration plots are to be taken in these unplanted areas.** Consult with the Wildlife or Forest, Mineral and Fire Management representative for more information on this topic.

    - Include plots that fall along edges and in failed or poorly stocked areas.

8. Record the number of trees in the plot. Count only trees that have at least 1 live bud. Indicate the number of volunteer (naturally-seeded) seedlings on the data sheet (both in furrow and out). <u>The number of volunteers on a plot can be substantial, so it is important to count these as accurately as possible</u>! Consult with the Forest, Mineral and Fire Management or Wildlife representative for more information as to what tree seedlings are to be counted as volunteers.

9. Record the height of the last tree in every plot. Measure to the nearest 0.1 feet.

10. Fill out the planted stand stocking survey data sheet. Make sure it is complete.

11. Fill out the Forest Health Survey data sheet for each plot. Symptoms and signs of up to three different problems can be recorded for each plot. Use the "Symptoms/Signs" codes provided on the data sheet. If no problems are observed, indicate by checking the "No Problems Observed" box for that plot. Include any additional information in the "Comments" box.

REGENERATION ESTABLISHED BY FURROW SEEDING

THREE OR MORE FULL GROWING SEASONS AND 12" TALL OR TALLER

Objectives:
- To stratify the furrow seeding based on species and soil moisture.
- To determine trees per acre, tree distribution and tree height.
- To evaluate health of the regenerated area.

Survey Schedule: 3rd full growing season and beyond.

Time of Year: Early spring or mid-to-late fall, when herbaceous cover will not hamper visibility.

Equipment:
- Survey pole marked in 0.1 ft. increments for height measurements
- Measuring rope with appropriate plot radius marks
- Tatum with data sheets
- Tallywacker
- FTP map
- Random number table

Plot Size: 1/50th-acre (r = 16.65 feet),
or 1/100th acre, if the site has substantial natural regeneration.

Plot Density: If using 1/100th acre plots, put in one plot/acre.
For 1/50th acre plots, see below:

Planted acres	**# of plots (1/50th acre)**
1-10	5 to 8
11-20	10 -15
21-30	18 - 25
31-40	28 - 30
41+	add 1 plot / 2 acres

Procedure:

1. Review the FTP file map, or GPS map, to determine the size of the furrow seeding, boundaries, and areas not seeded.

2. Important: Walk through the furrow seeding to verify size, shape, areas not seeded, and tree distribution. If necessary, stratify the furrow seeding into separate sampling units. Strata should be a minimum of 5 acres. Strata are identified where variations exist in species and soil moisture. Moderate to steep slopes can also be used as a strata layer, if it is apparent that differences in regeneration success exist. Draw these strata on the map. Make any corrections or modifications to file map based on observations made during the walk-through.

3. If multiple strata exist, estimate the acres for each. Determine the approximate number of sample plots needed for each stratum using the table above. Draw and approximate plot locations on file map.

   For each stratum:

4. Check the FTP summary sheets for information on how many plots to sample.

5. Check the FTP summary sheet for information on the suggested sampling grid (3 chains by 3 chains, 3 chains by 5 chains, etc.)

6. Look at the FTP map and pick a corner to start from. Your first plot should be located ½ the distance in from both sides, e.g., if you are putting plots in on a 3 chain by 3 chain grid, your first plot will be located 1½ chains over and 1½ chains up from your starting corner. Once the first plot has been established, you will then follow the recommended sampling grid mentioned in #5, above.

7. Whenever you complete a transect and begin your return run back into the planted stand, always place the next plot ½ the distance in from the edge, e.g., if you are establishing survey plots every 3 chains along a transect, your first plot will be located 1½ chains in from the planted stand edge. Once this plot has been established, you will then follow the recommended sampling grid mentioned in #5, above.

   - Do not include plots that fall in unplanted and/or un-furrowed areas.

     EXCEPTION: Kirtland's Warbler planted stands are established using the "opposing weave" pattern which results in unplanted openings scattered throughout the planted area. **Regeneration plots <u>are</u> to be taken in these unplanted areas.** Consult with the Wildlife or Forest, Mineral and Fire Management representative for more information on this topic.

8. Record the number of trees in the plot. Count only the trees that have live buds on at least 50% of the shoots. Indicate the number of volunteer (naturally seeded) trees on the data sheet. <u>The number of volunteers on a plot can be substantial, so it is important to count these as accurately as possible</u>! Consult with the Forest, Mineral and Fire Management or Wildlife representative for more information as to what tree seedlings are to be counted as volunteers.

9. Record the height of the last tree in every plot. Measure to the nearest 0.1 feet.

10. Fill out the planted stand stocking survey data sheet. Make sure it is complete.

11. Fill out the Forest Health Survey data sheet for each plot. Symptoms and signs of up to three different problems can be recorded for each plot. Use the "Symptoms/Signs" codes provided on the data sheet. If no problems are observed, indicate by checking the "No Problems Observed" box for that plot. Include any additional information in the "Comments" box.

REGENERATION ESTABLISHED BY BROADCAST (DIRECT) SEEDING AND SCARIFICATION

Objectives:

- To stratify the regenerated area based on species and whether the regeneration is seed or sprout origin.
- To estimate tree stocking and tree distribution.
- To assess release needs.
- To evaluate health of the regenerated area.

Information from this survey will be used by the Silviculturist to determine where stocking is adequate and where planting or re-seeding may be necessary.

Survey Schedule: As recommended by the Silviculturist.

Time of Year: Variable. Early spring, summer or fall, depending on the species being surveyed.

Equipment:

- FTP map
- Tatum with data sheets
- Tallywacker
- Flagging
- 6-foot survey pole
- Hip chain

Transect Density: 10% of area distributed across designated area

Plot Density: 1 plot every 3 chains along transect

Procedure:

1. Review the FTP map, GPS map, or timber sale map to determine the size of the treated area and boundaries.

2. Walk through the area to verify size, shape, and overall tree distribution. If necessary, stratify the treatment area into separate sampling units. Strata are identified where variations exist in species, slope, aspect, soil type, or indicator species (e.g. upland vs. lowland). Draw these strata on the map. Make any corrections or modifications to the file map based on observations made during the walk-through. Consult with the Forest, Mineral and Fire Management or Wildlife representative for more information on strata.

   For each stratum:

3. Estimate the length of the short side of the stratum in feet (most maps come with an attached scale). Divide by 10 to determine the sampling transect spacing in feet.

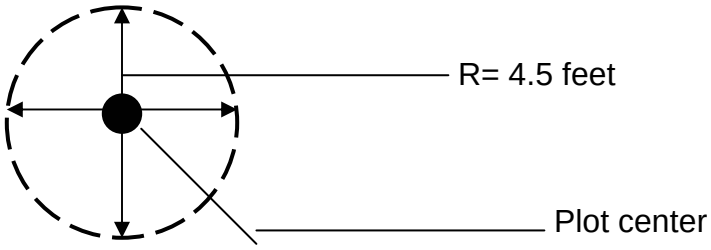
4. Examine the map and pick a corner to start from. Your first plot should be located ½ the distance in from both sides, e.g., if you are putting plots in on a 3 chain by 3 chain grid, your first plot will be located 1½ chains over and 1½ chains up from your starting corner. Once the first plot has been established, you will then follow the sampling grid as detailed in #3, above.

5. Whenever you complete a transect and begin your return run back into the area being sampled, always place the next plot ½ the distance in from the edge, e.g., if you are establishing survey plots every 3 chains along a transect, your first plot will be located 1½ chains in from the planted stand edge. Once this plot has been established, follow the recommended sampling grid.

6. Observations will be made by walking transects in the direction of the long axis of the stratum. Note that some of the treatment areas could be a mile in length. It will be necessary to take a compass bearing to identify a landmark as you walk through the treatment area. Flagging may have to be used along the transect for orientation.

7. Visually assess tree density and spacing along each transect. Record the approximate transect location and plot location on the map. Record observations and comments on broadcast seeding and scarification treatment regeneration survey data sheet (see Appendix C) and map. Be sure to record plot numbers on the map and to show the direction of travel for each transect.

8. Every 3 chains along the sample transect, use the survey pole to establish a circular plot with a radius of 4.5 feet (1/685th acre). Visually divide the plot into 4 equal-sized quadrants:



9. Determine how many quadrants contain live trees (live trees are trees with at least one live bud). Record presence for each tree species (and some shrubs) in the plot, being sure to record seed origin and sprout origin seedlings/saplings separately (e.g., record seed-origin Red Maple seedlings separately from Red Maple stump sprouts). Rate presence for each species/origin combination using the codes in the table below:

RATING	NUMBER OF QUADRANTS WITH TREES
0	No quadrants have trees
1	1 quadrant has tree of a specific species
2	2 quadrants have trees of a specific species
3	3 quadrants have trees of a specific species
4	All quadrants have trees of a specific species

10. For each plot, individual species, and species-origin combination, record the average height among the stocked quadrants. Use the following height classes, checking the appropriate data sheet column for each species/origin combination:

Column	Height Class
1	<1 foot
2	> 1 foot and < 4.5 feet
3	>1 foot and < 1 inch DBH

11. For each plot, basal area (using a 10 factor gauge) and percent crown cover (using a spherical densiometer) may also be required. Check with the Timber Management Specialist or Wildlife representative for more information.

12. Continue sampling transects at the predetermined spacing.

13. Fill out data sheet and make sure it is complete.

14. Fill out the Forest Health Survey data sheet for each plot. Symptoms and signs of up to three different problems can be recorded for each plot. Use the "Symptoms/Signs" codes provided on the data sheet. **If no problems are observed, indicate by checking the "No Problems Observed" box for that plot.** Include any additional information in the "Comments" box.

USING THE QUADRANT METHOD TO ESTIMATE TREES PER ACRE

While not specifically designed to estimate trees/acre, the quadrant sampling method can be used to roughly estimate stocking for any species that is found on a site. The "minimum trees/acre" column in the table below shows the lower stocking level associated with any one quad.

RATING	NUMBER OF QUADRANTS WITH TREES	MINIMUM TREES/ACRE
0	No quadrants have trees	0
1	1 quadrant has tree of a specific species	685
2	2 quadrants have trees of a specific species	1,370
3	3 quadrants have trees of a specific species	2,055
4	All quadrants have trees of a specific species	2,740

REGENERATION ESTABLISHED BY SCARIFICATION AND OTHER NATURAL REGENERATION

Objectives:

- To assess density, height, and distribution of regeneration in areas that have been scarified to encourage natural regeneration, and other in other areas prescribed for natural regeneration following timber harvests.
- To evaluate health of the regenerated area.

Information from this survey will be used to determine where stocking is adequate, and where additional evaluation by the Silviculturist is needed.

Responsibility: Unit staff is responsible for conducting pass/fail ocular examinations of all stands prescribed for natural regeneration, and for maintenance and updates of the Unit Regeneration Timeclock spreadsheet.

The TMS is responsible for all follow-up examinations and surveys for stands that are rated as "borderline" or "failures". The TMS will coordinate with the Unit to ensure that stand records in the Inventory and Unit Regeneration Timeclock are updated with the results of further examination.

Survey Schedule: Primarily within the next compartment inventory year following harvest completion (TCR Date). Generally this will occur within 4 to 6 years post-harvest.

Exceptions:
Stands of special concern (oak, jack pine, red pine) may require out-of-entry year inventory scheduled in the fourth year post-harvest (TCR date + 4 years). Other stands or cover types may also be defined as special concern at the Unit level.

Time of Year: Variable. Early spring, summer or fall, depending on the species being surveyed.

Equipment:

- FTP map
- Tatum with IFMAP Stage 1 Survey data sheets
- Minimum Acceptable Regeneration Density Table

Procedure:

UNIT STAFF

1. Review the FTP map, or GPS map, to determine the size of the area, boundaries, and where applicable, areas scarified.

2. Review the inventory records for the stand to identify acceptable regeneration species.

3. Examine the treatment area per IFMAP Stage 1 Survey Procedures for Forested or Non-Forested stands:
   a. Stands with residual overstory that have > or + 25% canopy closure (i.e., that had selection, shelterwood, or seed tree harvests) will be documented using IFMAP Stage 1 Forested survey.
   b. Stands with regeneration that is >3 feet tall and having 25% or greater canopy closure (i.e., aspen sapling-sized stands) will be documented using IFMAP Stage 1 Forested survey.
   c. Stands with regeneration less than 3 feet tall will be documented using the IFMAP Stage 1 Non-Forested survey.

4. Following IFMAP procedures, stands may be evaluated via 1) field site walk-through, 2) remote call, or 3) edge call. Decisions to use remote or edge calls should be clearly documented by the examiner and must stand up to scrutiny during the quality control process.

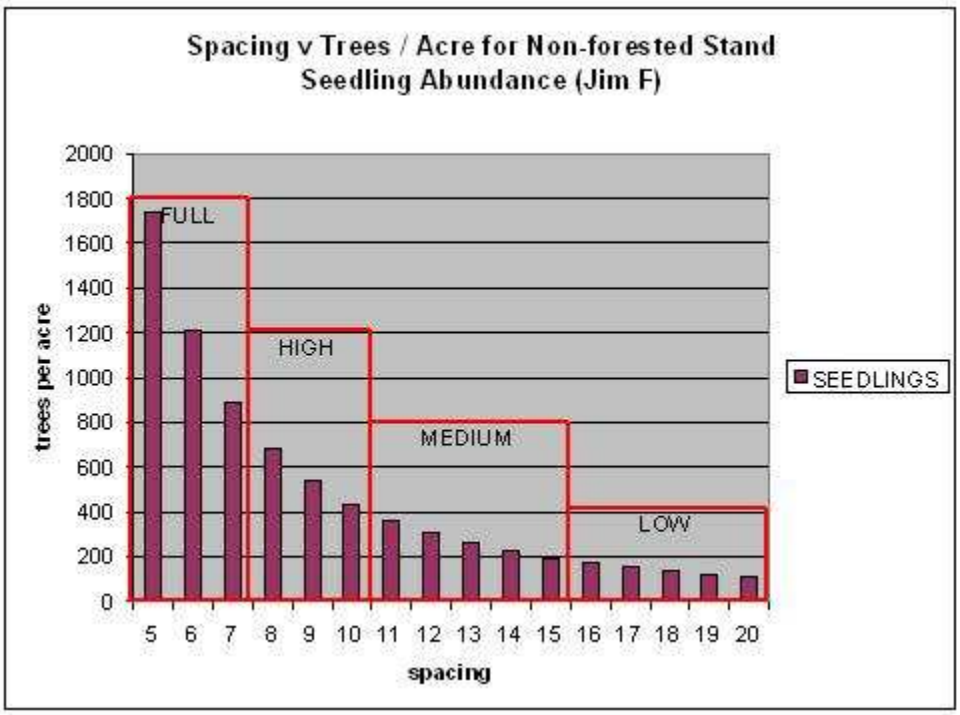
5. During on-site evaluation, the field examiner should ocularly evaluate the density, height and distribution of regeneration, in comparison with the DNR State Forest Minimum Acceptable Regeneration Density & Height Table, and with the species listed as "acceptable" in the inventory record for the stand. <u>The examiner must make a determination of whether the stand falls in to one of the following two categories:</u>

   a. "Pass" = stand clearly exceeds minimum density and height standards for cover type, and matching the OI/IFMAP inventory DB prescription.
   b. "Failure" = stem density and height are clearly lower than minimum height and density for the cover type, and composition listed in the prescription. REFER TO THE TMS FOR A MORE DETAILED SURVEY AND/OR TREATMENT RECOMMENDATIONS.

6. If the regeneration appears to be "Borderline" -- e.g., density and height of regeneration appear close to minimum levels -- the examiner has the OPTION of taking sample plot counts to verify that it meets or exceeds the minimum density (PASS or FAIL). See **Appendix C** for a full description of the optional natural regeneration sample plot procedure and data sheet.

7. Document regeneration characteristics using the appropriate Stage 1 Survey data sheet:

a. Forested Surveys: In the canopy or sub-canopy as appropriate; record species, density, average height, and size class.
b. Non-Forested Surveys: record tree & shrub species, abundance, distribution, and size class. Use the figure below as a guide for rating abundance.



8. FAILURES: If acceptable regeneration density and height are clearly below the minimum for the stand cover type specified in the Minimum Acceptable Regeneration Density Table:
   a. Designate the stand as "of interest" as follows:
      i. Forested Surveys—under "Stand of Interest", circle or select "yes". When updating the inventory, nominate the stand or appropriate portion of the stand as an Area of Interest—AOI—and identify the TMS as the sponsor.
      ii. Non-Forested Surveys—under "Management Priority", code the stand as HIGH, and under "Stand of Interest", select YES. When updating the inventory, create an AOI for the stand or the appropriate portion of the stand, and identify the TMS as the sponsor.

   b. Take notes and be prepared to provide the TMS the following information:
      i. What species of seedlings were present, if any?
      ii. What was the average size and stocking level of the seedlings present?
      iii. Are there any observations you made in the field that would lead you to believe that the regeneration will be successful given more time?
      iv. What impacts are deer or other animals having on the regeneration?
      v. What is the most important competing vegetation?

9. For partial regeneration failures, fill out the Stage 1 survey form as reflecting the majority of the stand or treatment area's condition. Make notes on the portion of the stand that has inadequate regeneration under "management considerations", and document as of interest in 7) above.

10. PASSES: If acceptable regeneration clearly meets or exceeds the minimum specified for the cover type in the Minimum Acceptable Regeneration Density and Height Table, document regeneration composition & characteristics using the appropriate Stage 1 survey form.

11. FOR ALL NATURAL REGENERATION stands, update the Unit Regeneration Timeclock record with the results of the pass/fail survey.

12. Fill out the Forest Health Survey data sheet for each plot. Symptoms and signs of up to 3 different problems can be recorded for each plot. Use the "Symptoms/Signs" codes provided on the data sheet. **If no problems are observed, indicate by checking the "No Problems Observed" box for that plot.** Include any additional information in the "Comments" box.

TIMBER MANAGEMENT SPECIALISTS

1. TMSs will conduct or coordinate further examination of all "borderline" and "failures".

2. Options for "failures":
   a. **In cases where no significant impeding factor is observed, AND the TMS thinks in-growth of sufficient seedlings is likely:**
      i. schedule the stand for re-survey by Unit staff at next compartment inventory (in 6 to 10 more years), and
      ii. record original survey date in the comments column in the Unit Regeneration Timeclock.

   b. **In all other cases (ingrowth not likely):**
      i. Recommend Ch. 7 MO change to accept current condition, **OR**,
      ii. Prescribe treatments for correction, which may include:
         1)Scarification to favor regeneration via natural seed fall
         2)Prescribed fire
         3)Trenching & direct seeding (artificial regeneration)
         4)Trenching & planting
         5)Herbicide release treatment

APPENDIX A - Calculating Plot Spacing in Chains

Example:

You have a 32-acre planted stand, and you want to know how many chains down and how many over you need to go to space your plots evenly, over the whole planted stand.

You determine that you will be using 1/50th-acre plots.

The regeneration manual tells you that you need to put in 28 plots.

Procedure:

Divide acres by number of plots, multiply by 10, and take the square root.

$\frac{32 acres}{28 plots}$ X 10 = 11.428571 $\rightarrow$ $\sqrt{11.428571}$ = 3.38

Spacing comes out to about 3.4 chains between plots.

APPENDIX B - DNR State Forest Minimum Acceptable Regeneration Density & Height* Table

OI Cover Type Name	OI Code	IFMAP Level 3 & 4 Codes	IFMAP Level 4 Cover Type Name	MINIMUM** Stems / Acre at 4-years post-harvest	Rough Spacing (ft.)	Comment
Aspen	A	4130	Aspen	2,000	5 x 5	As a combination of acceptable species defined in the prescription
		4131	Aspen, Oak			
		4132	Aspen, Jack Pine			
		4133	Aspen, Mixed Pine			
		4134	Aspen, Spruce/Fir			
		4135	Aspen, Cedar			
		4136	Aspen, Mixed Conifer			
		4137	Aspen, Birch			
		4139	Aspen, Mixed Deciduous			
Birch	B	414	Other Upland Deciduous	1,200	6 x 6	**Minimum density = 1,200 stems of BIRCH-- not in combination with other species.** Examiners should consider the potential for preferential browsing on stump sprout origin maple and birch when evaluating the likelihood of success. Consider 'failing' stands with regeneration composed chiefly of stump sprouts that have borderline density and that appear to have high browse pressure.
		4140	Other Upland Deciduous			
		4193	Birch, Aspen			
		6116	Lowland Birch			
Cedar	C	6120	Lowland Cedar	600	8 x 8	Minimum density = 600 CEDAR stems, not in combination with other species
		42360	Upland Cedar			
		42370	Upland Cedar, Aspen			
Swamp Hardwoods	E	611	Lowland Deciduous Forest	2,000	5 x 5	As a combination of acceptable species defined in the prescription
		6110	Cottonwood			
		6113	Lowland Maple			
		6114	Lowland Oak			
		6115	Lowland Ash			
		6117	Lowland Deciduous, Mixed Coniferous			
		6118	Lowland Deciduous with Cedar			
		6119	Mixed Lowland Deciduous Forest			
		6130	Fir, Aspen, Maple			

*Stands with regeneration falling below these minimum densities must be corrected or the MO revised via Chapter 7 process.

**Minimum heights for seedlings to count toward the above are: hardwoods--12 inches; conifers 6 inches.

DNR State Forest Minimum Acceptable Regeneration Density & Height* Table (Continued)

OI Cover Type Name	OI Code	IFMAP Level 3 & 4 Codes	IFMAP Level 4 Cover Type Name	MINIMUM** Stems / Acre at 4-years post-harvest	Rough Spacing (ft.)	Comment
Spruce-Fir (Upland)	F	42310	Planted Spruce	600	8 x 8	As a combination of acceptable species defined in the prescription
		42311	Planted Spruce, Mixed Deciduous			
		42320	Upland Spruce			
		42330	Upland Fir			
		42340	Upland Spruce/Fir			
Hemlock	H	42350	Upland Hemlock	600	8 x 8	Minimum density = 600 hemlock seedlings, not as a combination of other species
Jack Pine	J	6126	Lowland Jack Pine	600	8 x 8	Note—KW mgt. requires a minimum of 1,200 stems/acre.
		42120	Planted Jack Pine			
		42121	Planted Jack Pine, Mixed Deciduous			
		42220	Natural Jack Pine			
		42221	Natural Jack Pine, Mixed Deciduous			
Northern Hardwood	M	4110	Sugar Maple Association	2,000	5 x 5	As any combination of the 'desirable' species listed in the prescription. Applies to both even- and uneven-aged stands. Examiners should consider the potential for preferential browsing on stump sprout origin maple and birch when evaluating the likelihood of success--consider 'failing' stands with regeneration composed chiefly of stump sprouts that have borderline stem densities and that appear to have high browse pressure or browse damage.
		4111	S.Maple, Hard Mast Association			
		4112	Maple, Beech, Cherry Association			
		4113	R.Maple, Conifer			
		4114	Beech, Hemlock			
		4115	Y.Birch, Hemlock NH			
		4116	Mixed N. Hardwood – Aspen			
		4117	Mixed N. Hardwood - Pine			
		4119	Mixed Northern Hardwoods			
Oak	O	4120	Oak, Hickory	500	9 x 9	Minimum density = 500 oak stems that are >4.5 ft.; <u>not</u> in combination with other species
		4121	Oak, Aspen			
		4122	Oak, Pine			
		4123	Red Oak			
		4124	Red with White Oak			
		4125	Black, N. Pin Oak			
		4126	White, Black, N. Pin Oak			
		4129	Mixed Oak			

*Stands with regeneration falling below these minimum densities must be corrected or the MO revised via Chapter 7 process.

**Minimum heights for seedlings to count toward the above are: hardwoods--12 inches; conifers 6 inches.

DNR State Forest Minimum Acceptable Regeneration Density & Height* Table (Continued)

OI Cover Type Name	OI Code	IFMAP Level 3 & 4 Codes	IFMAP Level 4 Cover Type Name	MINIMUM** Stems / Acre at 4-years post-harvest	Rough Spacing (ft.)	Comment
Lowland Poplar	P	6111	Lowland Balsam Poplar	2,000	5 x 5	As a combination of acceptable species defined in the prescription.
		6112	Lowland Aspen			
Mixed Swamp Conifer	Q	612	Lowland Coniferous Forest	600	8 x 8	As a combination of acceptable species defined in the prescription.
		6123	Lowland Fir			
		6124	Lowland Spruce-Fir			
		6125	Lowland Black Spruce, Jack Pine			
		6128	Lowland Coniferous, Mixed Deciduous			
		6129	Mixed Coniferous Lowland Forest			
Red Pine	R	42110	Planted Red Pine	600	8 x 8	Minimum density = 600 red pine stems; not in combination with other species.
		42111	Planted Red Pine, Mixed Deciduous			
		42210	Natural Red Pine			
		42211	Natural Red Pine, Mixed Deciduous			
Black Spruce (Swamp)	S	6122	Black Spruce	600	8 x 8	As a combination of acceptable species defined in the prescription.
Tamarack	T	6121	Tamarack	600	8 x 8	As a combination of acceptable species defined in the prescription.
		42300	Planted Larch			
		42301	Planted Larch, Mixed Deciduous			
White Pine	W	6127	Lowland Pine	600	8 x 8	As a combination of acceptable species defined in the prescription.
		42100	Planted White Pine			
		42101	Planted White Pine, Mixed Deciduous			
		42200	Natural White Pine			
		42201	Natural White Pine, Mixed Deciduous			
Lowland Mixed	LM	613	Lowland Mixed Forest	600	8 x 8	As a combination of acceptable species defined in the prescription.
		6131	Hemlock, White Pine, Maple, Birch			
		6132	Mixed Lowland Forest with Cedar			
		6139	Mixed Lowland Forest			

*Stands with regeneration falling below these minimum densities must be corrected or the MO revised via Chapter 7 process.

**Minimum heights for seedlings to count toward the above are: hardwoods--12 inches; conifers 6 inches.

DNR State Forest Minimum Acceptable Regeneration Density & Height* Table (Continued)

OI Cover Type Name	OI Code	IFMAP Level 3 & 4 Codes	IFMAP Level 4 Cover Type Name	MINIMUM** Stems / Acre at 4-years post-harvest	Rough Spacing (ft.)	Comment
Mixed Conifer	MC	429	Mixed Upland Conifers	600	8 x 8	As a combination of acceptable species defined in the prescription.
		42130	Planted Scotch Pine			
		42140	Planted Mixed Pine			
		42141	Planted Mixed Pine, Mixed Deciduous			
		42250	Pine, Oak			
		42260	Natural Pine, Mixed Deciduous			
		42290	Natural Mixed Pine			
		42380	Non Pine Upland Conifer, Mixed Deciduous			
		42390	Mixed Non-Pine Upland Conifers			
Mixed Upland Deciduous	MD	4190	Mixed Upland Deciduous with Cedar	600	8 x 8	As a combination of acceptable species defined in the prescription.
		4191	Mixed Upland Deciduous with Conifer			
		4192	Mixed Southern Upland Deciduous			
		4199	Other Mixed Upland Deciduous			

*Stands with regeneration falling below these minimum densities must be corrected or the MO revised via Chapter 7 process.

**Minimum heights for seedlings to count toward the above are: hardwoods--12 inches; conifers 6 inches.

Prepared by DNR FMFM, FRM Section, 04/15/09

APPENDIX C – BROADCAST SEEDING AND SCARIFICATION TREATMENT REGENERATION SURVEY

Michigan Department of Natural Resources - Forest, Mineral and Fire Management

BROADCAST SEEDING AND SCARIFICATION TREATMENT REGENERATION SURVEY

INSTRUCTIONS: Record species and origin type in separate columns (e.g., RM-sprout or RM-seed). For each species/origin combination, record the number of stocked quadrants in the "Rg" column. Check the cell for the appropriate average height class for each species (columns headed 1, 2, 3.). Record BA and/or % Crown Cover for each plot, if required by the TMS or WLD Biologist.

Survey by	FTP	Date

	SPECIES																									
	SPP:				SPP:				SPP:				SPP:				SPP:				SPP:					
Plot #	Rg	1	2	3	Rg	1	2	3	Rg	1	2	3	Rg	1	2	3	Rg	1	2	3	Rg	1	2	3	BA	% Crown Cover
Total																										
Ave.																										

RATING	NUMBER OF QUADRANTS WITH TREES
0	No quadrants have trees.
1	1 quadrant has trees.
2	2 quadrants have trees.
3	3 quadrants have trees.
4	All quadrants have trees.

NOTES:

HEIGHT CLASSES:
1 = < = 1 ft.
2 = > 1 ft. and <= 4.5 ft.
3 = > 4.5 ft. and <= 1 inch DBH

IC4145 (06/15/2009)

Michigan Department of Natural Resources - Forest, Mineral and Fire Management

PLANTATION STOCKING SURVEY

Surveyed by	Date
FTP	Plot Size

Spp:

PLOT	PLANT/ SEED #	# VOL	# VOL	# VOL	# DEAD	AVG HT	COMP TYPE (grass, shrub, tree spp)	COMMENTS
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
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25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								

Avg. planted tree height: _____

Free to Grow (RP only): _____

DEER BROWSING

None Light Moderate Heavy

R4070 (04/30/2009)

Plot	Forest Health Survey 1					Forest Health Survey 2					Forest Health Survey 3				
	No Problems Observed	Symptoms	Location on tree	% of tree affected	# of trees affected	No Problems Observed	Symptoms	Location on tree	% of tree affected	# of trees affected	No Problems Observed	Symptoms	Location on tree	% of tree affected	# of trees affected
1															
2															
3															
4															
5															
6															
7															
8															
9															
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33															
34															
35															

Symptom & Sign Codes

Bor	Boring
Brk	Broken
Chw	Chewing
Dd	Dead
Def	Defoliation
Disc	Discolora-tion
Fl	Flagging
H	Healthy
St	Stunting
Web	Webbing

Location on Tree

B	Bole
Br	Branches
R	Roots
Sh	Shoots
T	Terminal leader

Forest Health Survey

General distribution of problem(s) in Stand (check one)

Scattered Pockets Entire stand

Approximate acres affected: _____

Comments

APPENDIX E - Optional Natural Regeneration Survey Sample Plot Procedure and Datasheet

The following “walk-through” sampling procedure was developed to help stand examiners determine if natural regeneration has passed or failed. This survey is a Pass/Fail-type survey; it should only be used to help determine if the minimum number of suitable trees is present for the stand to be considered acceptably stocked. For a more formal survey or to get an accurate “trees per acre” estimate, refer to the Regeneration Survey Manual or consult the Timber Management Specialist.

Walk-through plot sampling procedure:

1. Plan a walk through route (transect) through the stand to be surveyed. This route should be representative of the entire stand.

2. Sample a minimum of 3 plots per stand, and one additional plot per 10 acres for stands >30 acres, evenly distributed along the survey transect.

3. The sample plots will be linear -- 1 chain long and 6 feet wide. Pace or measure using your loggers tape, looking 3 feet either side of the tape as you walk out 66 feet. Count the number of acceptable seedlings within the plot as you walk.

4. Refer to the Minimum Acceptable Regeneration Density & Height Table in the Regeneration Survey Manual to find the minimum number and definition of “suitable tree” for your cover type.

5. These plots are 1/110 of an acre. Since we are looking for the minimum suitable trees per acre, you only have to count up to the minimum equivalent number of suitable trees to have adequate stocking (e.g., in northern hardwood stands the minimum is 2,000 stems per acre; therefore, for a 1/110 acre plot, the examiner only has to observe ~19 seedlings meeting minimum height for the plot to be considered acceptably stocked). When the minimum number of suitable trees has been counted, you do not need to count any more trees in that plot.

6. Record your observations on the Walk-through Plot (R-4145-1) data sheet, on the next page.

7. For the stand to be considered adequately stocked, the average of all plots must meet the minimum number of suitable trees.

8. Keep the data sheet in the stand file, and be prepared to forward a copy to the TMS for stands that “fail” the regeneration survey.

Michigan Department of Natural Resources - Forest, Mineral and Fire Management

OPTIONAL NATURAL REGENERATION SURVEY SAMPLE PLOT

Cruiser | **Date**

Compartment | **Stand** | **Acres**

Sale

Acceptable Species | **Most Common Species**

Significant browsing? Yes No

Plot	#	SP	SZ		Plot	#	SP	SZ

If you have less than 80% stocked plots of acceptable seedlings, refer the stand to the TMS for a formal survey.

Map: show transect and stand

Instructions: Plot Size = 66 ft x 6 ft (1/110A)
less than 30 A = 3 plots
add 1 plot / 10 acres above 30 acres

Size: **1: 6"- 11"***(conifers only)*, **2: 1ft - 3 ft,**
3: 3 ft - 5 ft, 4: > 5 ft

Distribute plots evenly throughout the stand.

Hardwoods: center plots in regen holes where possible

Walk counting seedlings 3 ft. either side of center line

Record up to minimum seedlings total / plot

Record a new line for each new species by size class

Acceptable species are listed in the inventory and at least **12 in. for deciduous and 6 in. for conife**r.

Oak should be **4 ft tall.** Count all stump sprouts.

Notes:

R4145-1 (05/15/2009)

CITATIONS

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