Baxter State Park Scientific Forest Management Area

Forest Inventory Protocols

Developed: Summer 2011------Most Recent Update: 9/14/2011

BSP SFMA Inventory Protocol Overview

The SFMA is an intensively managed area when it comes to the collection of Forest Inventory data. Large amounts of data have been collected, at a variety of levels and intensities, in order to accurately portray forest conditions. This tradition continues in 2011 and forms an essential element in the development of a landscape level forest modeling program designed to inform management planning activities. To better reflect information needs and to align with the requirements of forest modeling work, the SFMA inventory system and protocol have been updated in 2011. Inventory work has been divided into 4 types with an inventory protocol developed for each type.

1. Pre-Harvest Inventory Protocol: To be conducted **only** when existing data is insufficient or new data is otherwise deemed necessary by managers. Inventory of current years harvest units, operational units only. One BAF 20 variable radius point sample per sample center.

2. Immediate Post-Harvest Inventory Protocol: Inventory of current years harvest units, operational units only. One BAF 10 variable radius point sample per sample center.

3. Planning Inventory Protocol: Individual polygon based inventory of: a. Operation units on a rolling 15 year basis; b. Stratified inventory of reserve Units on a rolling 15 year basis; c. Stratified inventory of RMZ Units on a rolling 15 year basis. One BAF 20 variable radius point (VRP) sample per sample center. Selected samples also have one dead and down wood line intersect sample (LIS) originating from the VRP center, and two 1/100ac fixed radius plots (FRP) paired on each end of the LIS.

4. 5 Year Post Harvest Inventory Protocol: Stratified inventory of inventory of operational units 5 years after harvest. One 1/100ac fixed radius plot (FRP) measuring trees in 1-4 inch classes. Selected samples also have one dead and down wood line intersect sample (LIS) originating from the FRP center, and a second 1/100ac fixed radius plot on the end of the LIS.

Contents

1. BSP SFMA Pre-Harvest Inventory Protocol

Protocol Created 2011June7 by Rick Morrill (RM) Updated on:2011Sep12________________________

Inventory Description:

To be conducted **only** when existing data is insufficient or new data is otherwise deemed necessary by managers. Inventory of current years harvest units, operational units only. One BAF 20 variable radius point sample per sample center. The inventory is designed on an individual polygon basis.

Sample Center Location:

All point centers have been established in GIS and uploaded to Garmin GPS units. Centers are to be located using the GPS unit. This should be done in an "unbiased way" by keeping one's head down while following the GPS azimuth directions until the unit displays 2 meters (or 6ft) or less as the distance from the target waypoint. NOTE: true point center locations in the field DO NOT need to be GPS recorded.

The point center should be marked with the Haglof transponder pole at the point center.

*****All plot locations have been recorded using UTM coordinates in meters for UTM Zone 19N with reference to the North American Datum for 1983 (NAD83).

The point centers have been distributed on a **MUID basis** in each MUID polygon with ArcGIS using a random point distribution tool (Spatial Ecology Tools). Each point is tied to a specific MUID and thus measurements taken on that point should be of the desired MUID. In the event that a point center falls **outside** the specified MUID that point center should be moved **20 feet** into the MU from the **nearest** edge of that polygon based on following the shortest distance from the GPS directed point to the new location in the correct polygon. If this distance is greater than 50ft the new center location should be GPS and given an Ident (ID) value of (SID + "T") to indicate it is a new location for that SID.

Sample Structure:

1: Overstory: BAF 20 Variable Radius Point (VRP) Sample; with BAF 75 used to select height measurement trees.

Variable Radius Point (VRP) Sample:

Overstory: BAF 20 Variable Radius Point Sample; with BAF 75 used to select height measurement trees.

Key Tasks to Complete:

1. **Each tally sheet /tree record *must have the SID (Sample ID) recorded on it!* Without this information the data collected is worthless.**

2. **The Haglof should be calibrated at the start of each day and potentially in the midday as the air temperature changes. Calibrate at 10 meters (32.8 feet, 32feet and 9.5 inches)**

3. **Limiting distances for <u>ALL</u> borderline trees <u>must be checked</u>. A. DBH is measured of the tree face oriented towards the sample center; B. The tree distance from the sample center is measured to the center of the tree. Use the Haglof with the BAF preset to the correct sample BAF so it calculates the Minimum DBH that the tree must meet. There is no excuse for not doing this as this technology makes it way to easy. If the units fail to function the distance from sample center to tree center can be measured with a loggers tape, and the limiting distance read off the cheat sheet on the clipboard or calculated using the formula DBH X PRF of _____(ex 1.944) = limiting distance.**

4. **A sample with no vegetation to be tallied must be given a record indicating such. A sample with zero trees is just as important as one with 1000 trees!**

Edge Correction:

For samples located along the edge of a poly, the "**walk through method**" should be used to "double count" those trees that qualify under the correction method (SEE Appendix B for details). While the example given is for a traditional point sample the method will work the same for a BAF H-Line sample. In the case of a **"hard"** edge (ex. plantation vs. natural forest or a boundary line) the edge of the stand will be clear and the correction can be properly applied. For stand boundaries that are **"soft"** (ex. Mixed-wood trending to higher % softwood) making a boundary determination, for the purpose of using the walk through method, is not necessary. In this case the edge of the stand is not significantly different enough to warrant precise delineation and therefore correcting for edge bias has been deemed unnecessary. For samples which the GPS locates outside the MUID, in an area of open water, or a location otherwise deemed totally unsuitable (a point center landing in a harvesting trail **shall NOT be re-located**), a new sample center and a new waypoint will be created and recorded with a minimum of 100 averaged readings. The new waypoint X and Y coordinates should be recorded in the comment field for the sample, (Using NAD 83 UTM 19N coords) to update current maps.

Slope Correction:

For samples located on slopes >15 degrees an individual tree correction must be applied for those trees that lie on a slope from the sample center which exceeds this threshold. This correction can be applied using the "cruisers crutch" tool or using the haglof hypsometer. Applying this correction will allow the field crew to accurately determine if a tree is "IN" or "OUT" of the sample.

Using the Cruisers Crutch: Provides correct readings on 0 to 90% slopes for English BAF's: 10, 20, 30 or 40, or for Metric BAF's 2, 3, 4, 5, or 6. Clear, tough Lexan with 26" nickel-plated chain has four brass balls, one for each BAF. To use, determine slope to the nearest five percent. Hold the brass ball for the selected BAF under your eye and extend the Crutch away until chain is taut. Line up tree with appropriate slope percent line on the gauge. If the tree at dbh is wider than the line on the angle gauge being sighted across, tally the tree.

VRP Point Sample Measurement Data:

BAF = 20

*Information will be taken of all live trees 4.6 inches DBH and greater. Trees should be recorded beginning with the 1st tree due north of the point center and proceeding in a clockwise direction. The following information will be recorded for ALL "IN" trees.

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Tree Number]: i,e: 1,2,3… *Note- this is **not** a tree count, each tree is tallied on a separate row of the sheet.

[Species]: FVS code list see clip board.

[DBH (in)]: Measured on the high-side of the tree, on trees greater than 4.6 inches DBH, to the nearest 1/10th of an inch. To be recorded with Calipers. (See Appendix A for DBH measurement protocols for problem trees.)

[Total Hgt. (ft)]: The height to the highest live portion of the tree will be measure using a haglof hypsometer or sunto clinometer. Only trees that are deemed "in" using a **BAF 75 (PRF =1 so 1in of DBH equals 1ft of distance, (ie. a 12in DBH tree can be a max of 12ft from the sample center and still be considered in.))**

[Status]: Tree is noted to be either **Live** or **Dead.** Tree must be standing with a measurable DBH, can be given a species if known. Tree assumed to be LIVE if no status is assigned to tree.

[Quality]: AGS+; AGS; UGS; CULL. *Note this is not a measure of whether the tree should be harvested based on a silvicultural objective, rather it is a classification of the trees product class capability. "**AGS+" =** Tree meets acceptable growing stock criteria and has at least one 8ft log that is of very high quality (ie 3-4 defect free sides). "**AGS"** = acceptable growing stock (tree must be capable of producing a sawlog product either now or in the future when it reaches a larger diameter and not have major crown defects) **UGS** = unacceptable growing stock, tree does not meet the qualifications of an AGS but can still produce pulp or firewood grade product. **CULL** = A live and standing tree that is not capable of producing a commercial product (ie. Completely hollow tree).

***Dead Trees:** Dead trees "SNAGS" **will be** recorded as part of this inventory, "Dead" in [STATUS] field)

Equipment list:

1. Paper tally sheets
2. Garmin 60Csx or 76 GPS with spare AA batteries
3. Clipboards with pencils: pocket knife or pencil sharpener
4. Suunto compass or mirror type sighting compass set for magnetic azimuths
5. 1 Haglof Vertex 4 Hypsometer for tree height and distance: spare AA batteries
6. 1 Haglof Transponder
7. 24in Tree Calipers
8. Small plastic tree calipers for small trees.

9. 1 D-tape

References:

1. Iles, K. 2003. A sampler of inventory topics. Kim Iles and Associates, Ltd. 869 p

   Husch, B., Miller, T.W. Beers, and J. Kershaw. 2003. Forest Mensuration. 4th Edition. Wiley. New York.

2. BSP SFMA Immediate Post-Harvest Inventory Protocol

Protocol Created 2011June7 by Rick Morrill (RM) Updated on:2011Sep12________________________

Inventory Description:

This inventory covers MUs that have received a silvicultural treatment within the last 12 months. The data is intended to update the MU dataset to represent the new conditions created by the treatment. The inventory is designed on an individual polygon basis.

Sample Center Location:

All point centers have been established in GIS and uploaded to Garmin GPS units. Centers are to be located using the GPS unit. This should be done in an "unbiased way" by keeping one's head down while following the GPS azimuth directions until the unit displays 2 meters (or 6ft) or less as the distance from the target waypoint. NOTE: true point center locations in the field DO NOT need to be GPS recorded.

The point center should be marked with the Haglof transponder pole at the point center.

*****All plot locations have been recorded using UTM coordinates in meters for UTM Zone 19N with reference to the North American Datum for 1983 (NAD83).

The point centers have been distributed on a **MUID basis** in each MUID polygon with ArcGIS using a random point distribution tool (Spatial Ecology Tools). Each point is tied to a specific MUID and thus measurements taken on that point should be of the desired MUID. In the event that a point center falls **outside** the specified MUID that point center should be moved **20 feet** into the MU from the **nearest** edge of that polygon based on following the shortest distance from the GPS directed point to the new location in the correct polygon. If this distance is greater than 50ft the new center location should be GPS and given an Ident (ID) value of (SID + "T") to indicate it is a new location for that SID.

Sample Structure:

1: Overstory: BAF 10 Variable Radius Point (VRP) Sample; with BAF 75 used to select height measurement trees.

Variable Radius Point (VRP) Sample:

Overstory: BAF 10 Variable Radius Point Sample; with BAF 75 used to select height measurement trees.

Key Tasks to Complete:

5. **Each tally sheet /tree record *must have the SID (Sample ID) recorded on it!* Without this information the data collected is worthless.**

6. **The Haglof should be calibrated at the start of each day and potentially in the midday as the air temperature changes. Calibrate at 10 meters (32.8 feet, 32feet and 9.5 inches)**

7. **Limiting distances for <u>ALL</u> borderline trees <u>must be checked</u>. A. DBH is measured of the tree face oriented towards the sample center; B. The tree distance from the sample center is measured to the center of the tree. Use the Haglof with the BAF preset to the correct sample BAF so it calculates the Minimum DBH that the tree must meet. There is no excuse for not doing this as this technology makes it way to easy. If the units fail to function the distance from sample center to tree center can be measured with a loggers tape, and the limiting distance read off the cheat sheet on the clipboard or calculated using the formula DBH X PRF of _____(ex 1.944) = limiting distance.**

8. **A sample with no vegetation to be tallied must be given a record indicating such. A sample with zero trees is just as important as one with 1000 trees!**

Edge Correction:

For samples located along the edge of a poly, the "**walk through method**" should be used to "double count" those trees that qualify under the correction method (SEE Appendix B for details). While the example given is for a traditional point sample the method will work the same for a BAF H-Line sample. In the case of a **"hard"** edge (ex. plantation vs. natural forest or a boundary line) the edge of the stand will be clear and the correction can be properly applied. For stand boundaries that are **"soft"** (ex. Mixed-wood trending to higher % softwood) making a boundary determination, for the purpose of using the walk through method, is not necessary. In this case the edge of the stand is not significantly different enough to warrant precise delineation and therefore correcting for edge bias has been deemed unnecessary. For samples which the GPS locates outside the MUID, in an area of open water, or a location otherwise deemed totally unsuitable (a point center landing in a harvesting trail **shall NOT be re-located**), a new sample center and a new waypoint will be created and recorded with a minimum of 100 averaged readings. The new waypoint X and Y coordinates should be recorded in the comment field for the sample, (Using NAD 83 UTM 19N coords) to update current maps.

Slope Correction:

For samples located on slopes >15 degrees an individual tree correction must be applied for those trees that lie on a slope from the sample center which exceeds this threshold. This correction can be applied using the "cruisers crutch" tool or using the haglof hypsometer. Applying this correction will allow the field crew to accurately determine if a tree is "IN" or "OUT" of the sample.

Using the Cruisers Crutch: Provides correct readings on 0 to 90% slopes for English BAF's: 10, 20, 30 or 40, or for Metric BAF's 2, 3, 4, 5, or 6. Clear, tough Lexan with 26" nickel-plated chain has four brass balls, one for each BAF. To use, determine slope to the nearest five percent. Hold the brass ball for the selected BAF under your eye and extend the Crutch away until chain is taut. Line up tree with appropriate slope percent line on the gauge. If the tree at dbh is wider than the line on the angle gauge being sighted across, tally the tree.

VRP Point Sample Measurement Data:

BAF = 10

*Information will be taken of all live trees 4.6 inches DBH and greater. Trees should be recorded beginning with the 1st tree due north of the point center and proceeding in a clockwise direction. The following information will be recorded for ALL "IN" trees.

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Tree Number]: i,e: 1,2,3… *Note- this is **not** a tree count, each tree is tallied on a separate row of the sheet.

[Species]: FVS code list see clip board.

[DBH (in)]: Measured on the high-side of the tree, on trees greater than 4.6 inches DBH, to the nearest $1/10^{th}$ of an inch. To be recorded with Calipers. (See Appendix A for DBH measurement protocols for problem trees.)

[Total Hgt. (ft)]: The height to the highest live portion of the tree will be measure using a haglof hypsometer or sunto clinometer. Only trees that are deemed "in" using a **BAF 75 (PRF =1 so 1in of DBH equals 1ft of distance, (ie. a 12in DBH tree can be a max of 12ft from the sample center and still be considered in.))**

[Status]: Tree is noted to be either **Live** or **Dead.** Tree must be standing with a measurable DBH, can be given a species if known. Tree assumed to be LIVE if no status is assigned to tree.

[Quality]: AGS+; AGS; UGS; CULL. *Note this is not a measure of whether the tree should be harvested based on a silvicultural objective, rather it is a classification of the trees product class capability. "**AGS+" =** Tree meets acceptable growing stock criteria and has at least one 8ft log that is of very high quality (ie 3-4 defect free sides). "**AGS"** = acceptable growing stock (tree must be capable of producing a sawlog product either now or in the future when it reaches a larger diameter and not have major crown defects) **UGS** = unacceptable growing stock, tree does not meet the qualifications of an AGS but can still produce pulp or firewood grade product. **CULL** = A live and standing tree that is not capable of producing a commercial product (ie. Completely hollow tree).

***Dead Trees:** Dead trees "SNAGS" **will be** recorded as part of this inventory, "Dead" in [STATUS] field)

Equipment list:

10. Paper tally sheets
11. Garmin 60Csx or 76 GPS with spare AA batteries
12. Clipboards with pencils: pocket knife or pencil sharpener
13. Suunto compass or mirror type sighting compass set for magnetic azimuths
14. 1 Haglof Vertex 4 Hypsometer for tree height and distance: spare AA batteries
15. 1 Haglof Transponder
16. 24in Tree Calipers
17. Small plastic tree calipers for small trees.

18. 1 D-tape

References:

2. Iles, K. 2003. A sampler of inventory topics. Kim Iles and Associates, Ltd. 869 p
3. Husch, B., Miller, T.W. Beers, and J. Kershaw. 2003. Forest Mensuration. 4th Edition. Wiley. New York. 443 p.

3. BSP SFMA Planning Inventory Protocol

Protocol Created 2011June7 by Rick Morrill (RM) Updated on:________________________

Inventory Description:

This inventory covers a variety of areas and conditions including: **15 year post harvest**, stratified **undesignated** MUs, stratified **riparian** MUs, **reserve** MUs using stratified or individual polygon approach.

Sample Center Location:

All point centers have been established in GIS and uploaded to Garmin GPS units. Centers are to be located using the GPS unit. This should be done in an "unbiased way" by keeping one's head down while following the GPS azimuth directions until the unit displays 2 meters (or 6ft) or less as the distance from the target waypoint. NOTE: true point center locations in the field DO NOT need to be GPS recorded.

The point center should be marked with the Haglof transponder pole at the point center.

*****All plot locations have been recorded using UTM coordinates in meters for UTM Zone 19N with reference to the North American Datum for 1983 (NAD83).

The point centers have been distributed on a **MUID basis** in each MUID polygon with ArcGIS using a random point distribution tool (Spatial Ecology Tools). Each point is tied to a specific MUID and thus measurements taken on that point should be of the desired MUID. In the event that a point center falls **outside** the specified MUID that point center should be moved **20 feet** into the MU from the **nearest** edge of that polygon based on following the shortest distance from the GPS directed point to the new location in the correct polygon. If this distance is greater than 50ft the new center location should be GPS and given an Ident (ID) value of (SID + "T") to indicate it is a new location for that SID.

Sample Structure:

Type:

1. Overstory: BAF 20 Variable Radius Point Sample; with BAF 75 used to select height measurement trees.

2. Sapling: Fixed Radius 1/100th acre circular plot, paired on either end of LIS DDW transect

3. Dead and Down Wood: LIS Transect 123ft (37.5m) long, following random azimuth.

Variable Radius Point Sample:

Overstory: BAF 20 Variable Radius Point Sample; with BAF 75 used to select height measurement trees.

Edge Correction:

For samples located along the edge of a poly, the "**walk through method**" (See appendix B) should be used to "double count" those trees that qualify under the correction method. While the example given is for a traditional point sample the method will work the same for a BAF H-Line sample. In the case of a **"hard"** edge (ex. plantation vs. natural forest or a boundary line) the edge of the stand will be clear and the correction can be properly applied. For stand boundaries that are **"soft"** (ex. Mixed-wood trending to higher % softwood) making a boundary determination, for the purpose of using the walk through method, is not necessary. In this case the edge of the stand is not significantly different enough to warrant precise delineation and therefore correcting for edge bias has been deemed unnecessary. For samples which the GPS locates outside the MUID, in an area of open water, or a location otherwise deemed totally unsuitable (a point center landing in a harvesting trail **shall NOT be re-located**), a new sample center and a new waypoint will be created and recorded with a minimum of 100 averaged readings. The new waypoint X and Y coordinates should be recorded in the comment field for the sample, (Using NAD 83 UTM 19N coords) to update current maps.

Key Tasks to Complete:

1. **Each tally sheet *must have the SID (Sample ID) recorded on it!* Without this information the data collected is worthless.**
2. **The Haglof should be calibrated at the start of each day and potentially in the midday as the air temperature changes. Calibrate at 10 meters (32.8 feet, 32feet and 9.5 inches)**
3. **Limiting distances for <u>ALL</u> borderline trees <u>must be checked</u>. DBH is measured of the face tree face oriented towards the sample center. Done using the Haglof with the BAF preset to the correct sample BAF so it calculates the Minimum DBH that the tree must meet. There is no excuse for not doing this as this technology makes it way to easy. If the units fail to function the distance from sample center to tree center can be measured with a loggers tape, and the limiting distance read off the cheat sheet on the clipboard or calculated using the formula DBH X PRF of _____(ex 1.944) = limiting distance.A sample with no vegetation to be tallied must be given a record indicating such. A sample with zero trees is just as important as one with 1000 trees!**

Overstory Point Sample Measurement Data:

BAF = 20

*Information will be taken of all live trees 0.6 inches DBH and greater. Trees should be recorded beginning with the 1st tree due north of the point center and proceeding in a clockwise direction. The following information will be recorded for each live "IN" tree.-

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Tree Number]: i,e: 1,2,3…. *Note- this is **<u>not</u>** a tree count, each tree gets tallied on a separate row of the tally sheet.

[Species]: FVS code list see clip board.

[DBH (in)]: To the nearest 1/10th of an inch. To be recorded with Calipers.

[Total Hgt. (ft)]: The height to the highest live portion of the tree will be measure using a haglof hypsometer or sunto clinometer. Only trees that are deemed "in" using a **BAF 75 (PRF =1 so 1in of DBH equals 1ft of distance, (ie. a 12in DBH tree can be a max of 12ft from the sample center and still be considered in.))**

[Status]: Tree is noted to be either **Live** or **Dead.** Tree must be standing with a measurable DBH, can be given a species if known. Tree assumed to be LIVE if no status is assigned to tree.

[Quality]: AGS+; AGS; UGS; CULL. "**AGS+" =** Tree meets acceptable growing stock criteria and has at least one 8ft log that is of very high quality (ie 3-4 defect free sides). "**AGS"** = acceptable growing stock (tree must be capable of producing a sawlog product either now or in the future when it reaches a larger diameter and not have major crown defects) *Note this is not a measure of whether the tree should be harvested based on a silvicultural objective, rather it is classification of the trees product class capability. **UGS** = unacceptable growing stock, tree does not meet the qualifications of an AGS but can still produce pulp or firewood grade product. **CULL** = A live and standing tree that is not capable of producing a commercial product (ie. Completely hollow tree).

***Dead Trees:** Dead trees "SNAGS" **will be** recorded as part of this inventory. (See section on STATUS above)

Fixed Radius Sapling Plot Sample:

Sapling: Fixed Radius 1/100th acre circular plot (11.8ft radius), paired on either end of LIS DDW transect.

Sapling Plot Sample Measurement Data:

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Species]: FVS code list see clip board.

[Quality]: AGS; UGS. "**AGS"** = acceptable growing stock (tree must be capable of producing a sawlog product in the future when it reaches a larger diameter and not have major crown defects). **UGS** = unacceptable growing stock, tree does not meet the qualifications of an AGS. ***Dead Trees:** Dead trees "SNAGS" **will NOT BE** recorded as part of the sapling plot inventory.

[DBH Class 1"]: Stems with DBH > 0.6" and >= 1.5". To be recorded with calipers.

[DBH Class 2"]: Stems with DBH > 1.6" and >= 2.5". To be recorded with calipers.

[DBH Class 3"]: Stems with DBH > 2.6" and >= 3.5". To be recorded with calipers.

[DBH Class 4"]: Stems with DBH > 3.6" and >= 4.5". To be recorded with calipers.

[Avg Total Hgt. by DBH Class (ft)]: The measured height of a tree deemed to be of average height for the DBH class. The height to the highest live portion of the tree will be measure using a haglof hypsometer or sunto clinometer.

Line Intersect Sample Dead and Down Wood Sample

Transect Length = 123.0ft or 37.5 meters

Orientation= Random azimuth based on pre-assigned value

***Line Intersect Sample** method to sample Dead and Down Wood (DDW). Start transect at center point of "parent" overstory sample point. Run transect tape to full distance following azimuth as straight as possible (this is not a survey line but it should not have major bends.) Measure all DDW which intersect the transect and has a DBH Xing >=4.6 inches.

Edge Correction:

Use bounce back method (Iles, 2003). When edge is reached simply retrace transect for remaining distance, recording the same stems already measured. Since distance of each piece along the transect has been recorded there is no need to re-measure each piece simply duplicated existing measurements to the correct point on the transect.

Line Intersect Sample Dead and Down Wood Measurement Data:

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Transect Distance]: Distance along the transect at which the piece and transect intersect. Read distance directly off transect tape to 10^{th} of foot increment.

[**Piece No.**]: Simple count of items on tally sheet, each piece gets a row. **Not the same as count of pieces like a dot tally.*

[**SP Code**]: FVS Species code for DDW if it can be determined, otherwise Hardwood (HDWD) or Softwood (STWD), otherwise Unknown (UNKWN). *Notes from Fraver et al. 2002: We recorded the species of all CWD assigned to decay classes 1 and 2. The advanced state of decay of classes 3 and 4 often precluded species identification in the field. When possible, such pieces were assigned to a species group (hardwood or softwood). Many pieces, however, were decayed beyond recognition of species group. When this occurred, these pieces were listed as unknowns.*

[**DBH Xing**]: DBH at transect crossing point, measured with calipers perpendicular to piece just as if it were a standing tree deb measurement. ONLY Pieces with DBH Xing of >= 4.6" will be measured, smaller pieces will not be measured.

[**DBH SE**]: DBH at small end of piece, measured with calipers perpendicular to piece just as if it were a standing tree deb measurement.

[**DBH LE**]: DBH at large end of piece, measured with calipers perpendicular to piece just as if it were a standing tree deb measurement.

[**Piece Length**]: Measured length of piece based on straight line distance from large end to small end, using Haglof or loggers tape

[**Decay Class**]: 1, 2, 3, or 4 (See protocol below for class descriptions) -Adapted from Fraver et al. 2002-

1. Wood is sound and cannot be penetrated with thumbnail; bark is intact; smaller to medium sized branches are present; and log is often suspended by its own branches.
2. Wood is sound to somewhat rotten; bark may or may not be attached; branch stubs are firmly attached but only larger stubs are present; and log retains round shape and lies on duff.
3. Wood is substantially rotten, enough that branch stubs pull out easily (softwoods) and thumbnail penetrates readily; wood texture is soft and may be "squishy" if moist; bark is lightly attached, sloughing off or detached; and bole may assume a slightly oval shape and may be partly buried in duff.
4. Wood is mostly rotten, "fluffy" when dry and "doughy" when wet; branch stubs are rotted down; bark is detached or absent (except *Betula*); and log is decidedly oval in cross section and usually substantially buried in duff. The lower cut-off point for this class occurs when the top of the log has been lowered by decay to the general duff level at its sides making it indistinguishable, except for traces of decayed wood or plant covering, from the surrounding duff.

[**DDW Origin**]: Assessment of the origin of the DDW. (ie. What caused the mortality which resulted in the piece to becoming DDW.) Select from 1 of 4 categories: HARV; TIPUP; FRACT; or UNKWN

HARV. Harvest origin, piece is from bucked log or other harvest residue.

TIPUP. Clearly the result of a wind thrown, showing signs of root ball "tip up". Look for tip up mound.

FRACT. Stem was fractured by wind or some other source of disturbance. Look for nearby stump.

UNKWN. Origin of DDW cannot be determined. Most common category as origin is normally not clear.

Equipment list:

1. Paper tally sheets (TreeX2, SaplingX2, LIS DDW, Sample Info Sheet).
2. Garmin 60Csx or 76 GPS with spare AA batteries
3. Clipboards with pencils: pocket knife or pencil sharpener
4. 1x Suunto compass or mirror type sighting compass set for magnetic azimuths
5. 1x Haglof Vertex 4 Hypsometer for tree height and distance: spare AA batteries
6. 1x Haglof Transponder
7. 2x 24in Tree Calipers
8. 2x Small plastic tree calipers for small trees.
9. 2x Tree crayons for sapling plots
10. 1x 123ft (37.5 meters) flexible surveyors rope for LIS DDW transects
11. 2x Steel pins painted white to mark ends of transect and hold surveyors rope.
12. 1x Small D-tape

References:

1. Iles, K. 2003. A sampler of inventory topics. Kim Iles and Associates, Ltd. 869 p

2. Husch, B., Miller, T.W. Beers, and J. Kershaw. 2003. Forest Mensuration. 4th Edition. Wiley. New York. 443 p.

3. Fraver S, Wagner RG, Day M (2002) Dynamics of coarse woody debris following gap harvesting in the Acadian forest of central Maine, USA. Can J Res 32:2094–2105. doi:10.1139/x02-131

4. Jordan, G.J., M.J. Ducey and J.H. Gove. In press. Comparing line-intersect, fixed-area, and point relascope sampling for dead and downed coarse woody material in a managed northern hardwood forest. *Canadian Journal of Forest Research* 0:000-000.

5. Ducey, M.J., J.H. Gove, and H.T. Valentine. In press. A walkthrough solution to the boundary overlap problem. *Forest Science* 0:000-000.

4. BSP SFMA 5 Year Post Harvest Inventory Protocol

Protocol Created 2011June7 by Rick Morrill (RM) Updated on:________________________

Inventory Description:

This inventory covers MUs that have received a silvicultural treatment within the last 12 months. The data is intended to update the MU dataset to represent the regeneration conditions in the sapling class created by the treatment. Samples that include a LIS DDW transect are designed to provide data on DDW remaining post harvest or which has accumulated since the harvest due to mortality sources. The inventory is designed using a stratified polygon approach.

Sample Center Location:

All point centers have been established in GIS and uploaded to Garmin GPS units. Centers are to be located using the GPS unit. This should be done in an "unbiased way" by keeping one's head down while following the GPS azimuth directions until the unit displays 2 meters (or 6ft) or less as the distance from the target waypoint. NOTE: true point center locations in the field DO NOT need to be GPS recorded.

The point center should be marked with the Haglof transponder pole at the point center.

*****All plot locations have been recorded using UTM coordinates in meters for UTM Zone 19N with reference to the North American Datum for 1983 (NAD83).

The point centers have been distributed on a **MUID basis** in each MUID polygon with ArcGIS using a random point distribution tool (Spatial Ecology Tools). Each point is tied to a specific MUID and thus measurements taken on that point should be of the desired MUID. In the event that a point center falls **outside** the specified MUID that point center should be moved **20 feet** into the MU from the **nearest** edge of that polygon based on following the shortest distance from the GPS directed point to the new location in the correct polygon. If this distance is greater than 50ft the new center location should be GPS and given an Ident (ID) value of (SID + "T") to indicate it is a new location for that SID.

Sample Structure:

Type:

1. Sapling: Fixed Radius 1/100th acre circular plot.
2. Dead and Down Wood: LIS Transect 123ft (37.5m) long, following random azimuth.
3. Sapling: Fixed Radius 1/100th acre circular plot. Paired with initial FRP on end of LIS DDW transect

Fixed Radius Sapling Plot Sample:

Sapling: Fixed Radius 1/100th acre circular plot (11.8ft radius), paired on either end of LIS DDW transect.

Sapling Plot Sample Measurement Data:

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Species]: FVS code list see clip board.

[Quality]: AGS; UGS. "**AGS"** = acceptable growing stock (tree must be capable of producing a sawlog product in the future when it reaches a larger diameter and not have major crown defects). **UGS** = unacceptable growing stock, tree does not meet the qualifications of an AGS. ***Dead Trees:** Dead trees "SNAGS" **will NOT BE** recorded as part of the sapling plot inventory.

[DBH Class 1"]: Stems with DBH > 0.6" and >= 1.5". To be recorded with calipers.

[DBH Class 2"]: Stems with DBH > 1.6" and >= 2.5". To be recorded with calipers.

[DBH Class 3"]: Stems with DBH > 2.6" and >= 3.5". To be recorded with calipers.

[DBH Class 4"]: Stems with DBH > 3.6" and >= 4.5". To be recorded with calipers.

[Avg Total Hgt. by DBH Class (ft)]: The measured height of a tree deemed to be of average height for the DBH class. The height to the highest live portion of the tree will be measure using a haglof hypsometer or sunto clinometer.

Line Intersect Sample Dead and Down Wood Sample

Transect Length = 123.0ft or 37.5 meters

Orientation= Random azimuth based on pre-assigned value

***Line Intersect Sample** method to sample Dead and Down Wood (DDW). Start transect at center point of "parent" overstory sample point. Run transect tape to full distance following azimuth as straight as possible (this is not a survey line but it should not have major bends.) Measure all DDW which intersect the transect and has a DBH Xing >=4.6 inches. Transect must pass through centerline of the DDW piece.

Edge Correction:

Use bounce back method (Iles, 2003). When edge is reached simply retrace transect for remaining distance, recording the same stems already measured. Since distance of each piece along the transect has been recorded there is no need to re-measure each piece simply duplicated existing measurements to the correct point on the transect.

Line Intersect Sample Dead and Down Wood Measurement Data:

[SID]: Sample ID, same as given in the Ident field of the GPS and on the INV Sample List showing all the points in a given inventory project (PID).

[Transect Distance]: Distance along the transect at which the piece and transect intersect. Read distance directly off transect tape to 10th of foot increment.

[**Piece No.**]: Simple count of items on tally sheet, each piece gets a row. **Not the same as count of pieces like a dot tally.*

[**SP Code**]: FVS Species code for DDW if it can be determined, otherwise Hardwood (HDWD) or Softwood (STWD), otherwise Unknown (UNKWN). *Notes from Fraver et al. 2002: We recorded the species of all CWD assigned to decay classes 1 and 2. The advanced state of decay of classes 3 and 4 often precluded species identification in the field. When possible, such pieces were assigned to a species group (hardwood or softwood). Many pieces, however, were decayed beyond recognition of species group. When this occurred, these pieces were listed as unknowns.*

[**DBH Xing**]: DBH at transect crossing point, measured with calipers perpendicular to piece just as if it were a standing tree deb measurement. ONLY Pieces with DBH Xing of >= 4.6" will be measured, smaller pieces will not be measured.

[**DBH SE**]: DBH at small end of piece, measured with calipers perpendicular to piece just as if it were a standing tree deb measurement.

[**DBH LE**]: DBH at large end of piece, measured with calipers perpendicular to piece just as if it were a standing tree deb measurement.

[**Piece Length**]: Measured length of piece based on straight line distance from large end to small end, using Haglof or loggers tape

[**Decay Class**]: 1, 2, 3, or 4 (See protocol below for class descriptions) -Adapted from Fraver et al. 2002-

1. Wood is sound and cannot be penetrated with thumbnail; bark is intact; smaller to medium sized branches are present; and log is often suspended by its own branches.
2. Wood is sound to somewhat rotten; bark may or may not be attached; branch stubs are firmly attached but only larger stubs are present; and log retains round shape and lies on duff.
3. Wood is substantially rotten, enough that branch stubs pull out easily (softwoods) and thumbnail penetrates readily; wood texture is soft and may be "squishy" if moist; bark is lightly attached, sloughing off or detached; and bole may assume a slightly oval shape and may be partly buried in duff.
4. Wood is mostly rotten, "fluffy" when dry and "doughy" when wet; branch stubs are rotted down; bark is detached or absent (except *Betula*); and log is decidedly oval in cross section and usually substantially buried in duff. The lower cut-off point for this class occurs when the top of the log has been lowered by decay to the general duff level at its sides making it indistinguishable, except for traces of decayed wood or plant covering, from the surrounding duff.

[**DDW Origin**]: Assessment of the origin of the DDW. (ie. What caused the mortality which resulted in the piece to becoming DDW.) Select from 1 of 4 categories: HARV; TIPUP; FRACT; or UNKWN

HARV. Harvest origin, piece is from bucked log or other harvest residue.

TIPUP. Clearly the result of a wind thrown, showing signs of root ball "tip up". Look for tip up mound.

FRACT. Stem was fractured by wind or some other source of disturbance. Look for nearby stump.

UNKWN. Origin of DDW cannot be determined. Most common category as origin is normally not clear.

Equipment list:

13. Paper tally sheets (TreeX2, SaplingX2, LIS DDW, Sample Info Sheet).
14. Garmin 60Csx or 76 GPS with spare AA batteries
15. Clipboards with pencils: pocket knife or pencil sharpener
16. 1x Suunto compass or mirror type sighting compass set for magnetic azimuths
17. 1x Haglof Vertex 4 Hypsometer for tree height and distance: spare AA batteries
18. 1x Haglof Transponder
19. 2x 24in Tree Calipers
20. 2x Small plastic tree calipers for small trees.
21. 2x Tree crayons for sapling plots
22. 1x 123ft (37.5 meters) flexible surveyors rope for LIS DDW transects
23. 2x Steel pins painted white to mark ends of transect and hold surveyors rope.
24. 1x Small D-tape

References:

6. Iles, K. 2003. A sampler of inventory topics. Kim Iles and Associates, Ltd. 869 p

7. Husch, B., Miller, T.W. Beers, and J. Kershaw. 2003. Forest Mensuration. 4th Edition. Wiley. New York. 443 p.

8. Fraver S, Wagner RG, Day M (2002) Dynamics of coarse woody debris following gap harvesting in the Acadian forest of central Maine, USA. Can J Res 32:2094–2105. doi:10.1139/x02-131

9. Jordan, G.J., M.J. Ducey and J.H. Gove. In press. Comparing line-intersect, fixed-area, and point relascope sampling for dead and downed coarse woody material in a managed northern hardwood forest. *Canadian Journal of Forest Research* 0:000-000.

10. Ducey, M.J., J.H. Gove, and H.T. Valentine. In press. A walkthrough solution to the boundary overlap problem. *Forest Science* 0:000-000.

Appendix: A

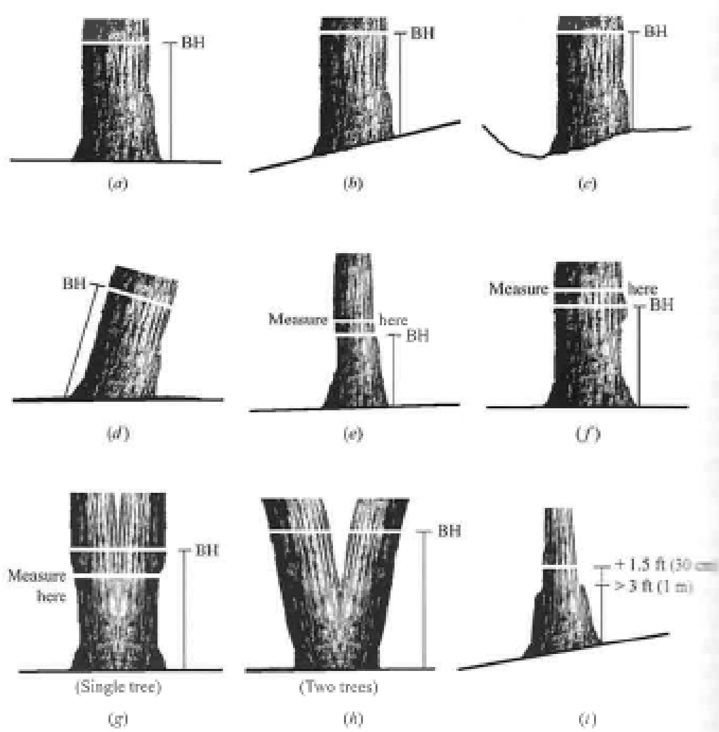


FIG. 5-3. Standard points for measurement of dbh: (*a*) level ground; (*b*) sloping ground; (*c*) uneven ground; (*d*) leaning tree; (*e*) crook at breast height; (*f*) defect at breast height; (*g*) forks at breast height; (*h*) forks below breast height; (*i*) buttressed tree. BH, breast height (4.5 ft in the English system, 1.3 m in the metric system).

bark but not through the wood. When the instrument's sliding cross arm is pressed against the bark, its thickness can be read on a scale without removing the instrument. When the bark is thick and tough, its thickness may be obtained by boring to the wood surface with an increment borer or a brace and bit and measuring from the bark surface to the wood with a small ruler.

In the United States, tree diameters have generally been measured and recorded in inches. (However, there is a growing use of metric system measurements, especially in research activities.) In countries where the metric system is used, diameters are measured in centimeters (occasionally, in millimeters).

In measuring at breast height in the field (dbh or *d*), the following standard procedures are recommended:

- When trees are on slopes or uneven ground, measure 4.5 ft (for dbh) or 1.3 m (for *d*) above the ground on the uphill side of the tree (Fig. 5-3*b* and *c*).
- When a tree is leaning, breast height is measured parallel to the lean on the high side of the tree. The diameter is measured perpendicular to the longitudinal axis of the stem (Fig. 5-3*d*).
- When a tree has a limb, bulge, or some other abnormality, such as a crook, at breast height, measure diameter above the abnormality; strive to obtain the diameter the tree would have had if the abnormality had not been present (Fig. 5-3*e* and *f*).
- When a tree consists of two or more stems forking below breast height, measure each stem separately (Fig. 5-3*h*). When a tree forks at or above breast height, measure it as one tree. If the fork occurs at breast height, or slightly above, measure the diameter below the enlargement caused by the fork (Fig. 5-3*g*).
- When a tree has a buttress that extends higher than 3 ft or 1 m, it is common to measure the stem at a fixed distance above the top of the buttress, usually at 1.5 ft or 30 cm (Fig. 5-3*i*).
- When a tree has a paint mark to designate the breast height point, assume that the point of measurement is at the top of the paint mark.

5-2.1 Instruments for Measuring Diameter

The most commonly used instruments for measuring dbh and *d* are calipers and diameter tape. Less precise measurements can be made with a Biltmore stick and Bitterlich's sector fork. Multipurpose laser-based instruments can also be used to measure tree diameters.

Calipers. Calipers are often used to measure tree dbh or *d* when diameters are less than about 24 in. or 60 cm. Calipers of sufficient size to measure large trees, or those with high buttresses (commonly found in tropical regions), are awkward to carry and handle, particularly in dense undergrowth. A beam caliper (Fig. 5-4*a*) may be constructed of metal, plastic, or wood, and consists of a graduated beam with two perpendicular arms. One arm is fixed at the origin of the scale and the other arm slides. When the beam is pressed against the tree and the arms closed, the tree diameter can be read on the scale. For an accurate reading, the beam of the caliper must be pressed firmly against the tree with the beam perpendicular to the axis of the tree stem and the arms parallel and perpendicular to the beam.

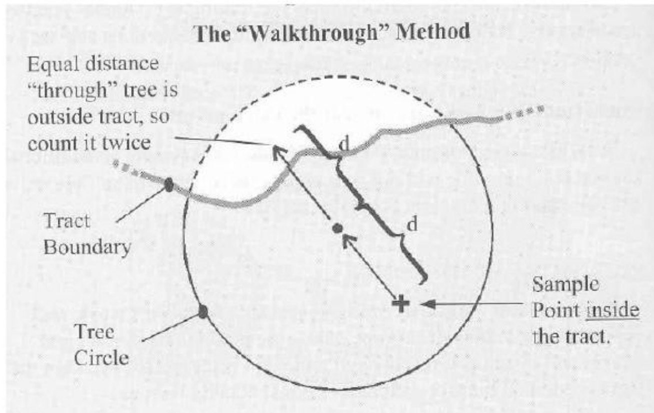
A more advanced and precise form of calipers is the Mantax computer caliper (Fig. 5-4*b*), developed by the Swedish firm Haglöf. With this instrument the diameter is measured in either the English or metric system and stored in the instrument, eliminating the need for recording the measurement on a field sheet or entering it in a field computer. The stored data can be read from the instrument or downloaded to a computer or to a printer.

Husch, Beers, and Kershaw, 2003

Appendix: B VRP "Walkthrough" Edge Correction Method

5. Walkthrough Method

- Generally the best method for dealing with edge bias
- To use the method:
  - measure the distance from the sample point to a border tree
  - go an equal distance beyond the border tree
  - if you fall outside the polygon, count tree a second time



5. Walkthrough Method

A Walkthrough Solution to the Boundary Overlap Problem

Mark J. Ducey, Jeffrey H. Gove, and Harry T. Valentine

Table 1. A decision key for field implementation of the walkthrough method. The key is entered whenever a tallied object appears close to the boundary.

I. Is it possible that the tallied object is closer to the boundary, than to the sample point?
- Ia. NO—No action needed. Tally the object normally.
- Ib. YES—Proceed to II.

II. Measure the distance from the sample point to the object—call this distance *x*. Now measure the distance from the object to the boundary, continuing on the same bearing. Call this distance *y*. Is *y* less than *x*?
- IIa NO—No action needed. Tally the object normally.
- IIb. YES—Proceed to III.

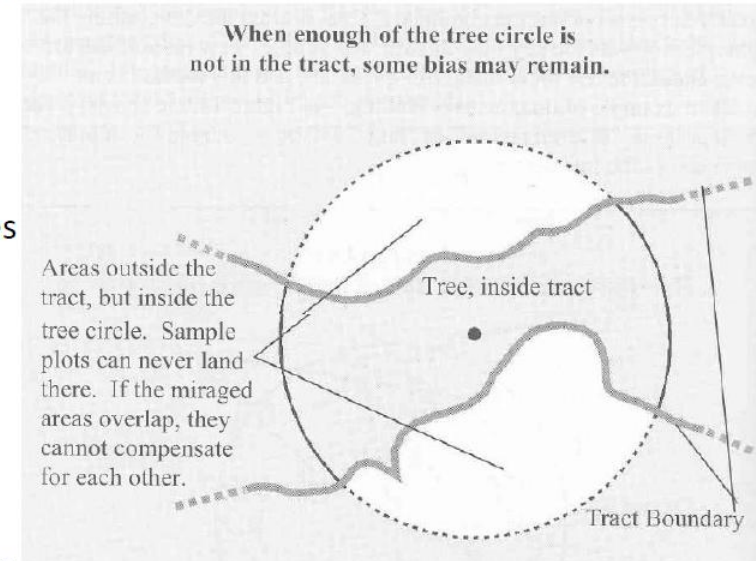
III. Does the boundary curve back across the walkthrough line?
- IIIa. NO—Walkthrough point must be outside the tract. Double-tally the object.
- IIIb. YES—Proceed to IV.

IV. Move to the walkthrough point, so that the distance to the object equals the previously measured distance *x* along the same bearing, or to a point where that location can be clearly identified. Is the walkthrough point inside the tract?
- IVa. NO—Double-tally the object.
- IVb. YES—Tally the object normally.

5. Walkthrough Method

- Advantages
  - more flexible than folding plots (i.e. straight boundary not required)
  - can be used with any symmetric plot such as square plots
  - easy to implement and requires no additional plots

- Disadvantages
  - must deal with each individual 'in' tree near the border
  - prone to bias in situations where the plots are near a corner or narrow section of the stand



Appendix: C LIS “Bounce-Back” Correction Method

Transects are often put in as an "L" shape, or in the form of a triangle. Sometimes the ends of the transects are connected, but not necessarily. This simple technique of compensating angles can sometimes greatly increase the efficiency of a transect sample used to measure oriented materials. With a triangle, you also end up back at your starting point. It is not critical that the 3 legs "close" perfectly, but you would hope that the difference is not large.

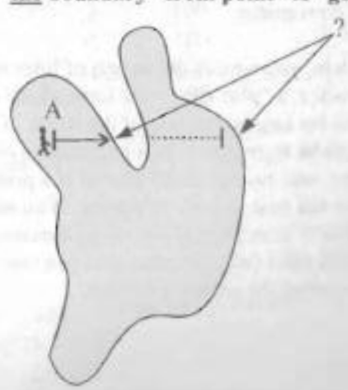
Is there a problem if transects cross the same item more than once? No. The probabilities are still correct. If you cross the piece another time, just record it again at that new crossing point as if it were a different piece.

WHAT IF YOU RUN INTO THE BOUNDARY?

This is a practical issue that becomes more important as areas get smaller and more wiggley. First of all, what is "the" boundary. In the case of the illustration below, if you start at point "A", and proceed due East, when would you strike the boundary? I would suggest that the boundary should ignore narrow intrusions from the edge, when possible. In figure 10.11, you would continue the rest of the line transect measurements after you cross the gap and reenter the polygon. Because polygons are chopped up by roads, protection strips, small removal areas, etc., this problem will increase in the future.

Figure 10.11

Where is "the boundary" from point "A" going Eastward?



This is only a suggestion, and if crossing the area that divides the polygon is very tedious, (rivers, in winter, come to mind - as do swamps too long to go around quickly) then you could define the border as the actual polygon boundary[22]. **The main thing is that you have to be able to recognize the boundary when you encounter it, and know what to do when you get to it.** This process is important to insure that each area in the polygon is covered by a line with equal frequency in the long run. You need a plan when you run into the border, what should it be?

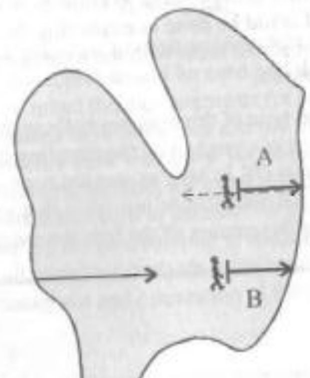
METHOD #1 : THE BOUNCE-BACK METHOD

This is illustrated as method "A", in figure 10.12.

Figure 10.12

What to do when you encounter a boundary?

Two Methods (Bounce-back or Reenter methods)



[22] If a river (or other significant barrier) divides the polygon, perhaps you should simplify life by treating it as 2 polygons for sampling purposes. It is perfectly appropriate to define polygon borders for convenience as well as for any change in vegetation characteristics. Technically, you should decide this treatment before you choose the transect location.

If you strike a boundary, you could simply stop and retrace part of your transect. If the distance to the boundary is short, you might come back far enough to cross the original starting point of the transect and continue in the opposite direction. In very narrow situations, you might actually go over the same area several times. I believe that this method is unbiased for any configuration of the polygon [23], and probably the most practical alternative.

Do not used this refraction method BAD!!!!!!!!

An incorrect alternative

You might be tempted to "reflect off the boundary" at the angle you encountered it, or at a right angle to your present direction. You would therefore explore some new territory with the remainder of the transect. *I would not recommend this.* In addition to the extra effort, it is very unlikely that continuing the transect in this way would make the probabilities of crossing each point equal.

I suspect that this alternative is biased under virtually any practical circumstances, but it is impossible to know how large that bias might be. The best that could be done in estimating the bias would be to use simulations of actual areas with the locations and orientations of all of the items known.

The amount and type of this bias has nothing to do with the intent of the field staff. It is a product of the sampling design. The concept that "you are always OK as long as you are consistent and follow a rule" is not true. All that attitude insures is that you do not *personally change* the amount of the bias the *method creates* [24].

[23] A proof of this unbiasedness is too technical to cover in this book. I am unaware of another reference that proves this point. It puts the right amount of line over any point in the polygon, which is necessary to make the process unbiased.

[24] The quote "a *foolish* consistency is the hobgoblin of little minds ..." (Emerson) has great merit.

METHOD 2 : THE WRAP-AROUND METHOD
(illustrated as "B" in figure 10.12)

You could "wrap the line around the polygon" and continue the line by re-entering the polygon at the opposite edge with the same line orientation. This would be unbiased. In this case you are covering new ground, but the practical problems and effort of correctly navigating to the other edge are not trivial.

These are the only 2 methods that I would suggest for this problem of running into the boundary in transect sampling. It is also possible, in very narrow areas, to simply measure the full length across the polygon and weight it differently, based on the length relative to the other transects. I think it is always more simple to avoid any complications of weighting (or of any potential bias) rather than solve (and explain) them.

SUMMARY

Transect methods use some geometric ideas that are clever and efficient. The exact form of transect that should be used will depend upon the equipment available to make the measurements (or counts). It will also depend upon the questions to be answered and the field conditions. Knowing how the systems work will allow you to make modifications to the process. Like any sampling method, the exact definitions and field procedures are important and hard to perfect. As usual, thoughtful and motivated field crews are the best solution to identifying and solving those problems. As with all sampling methods there is no recovery from a bad sample selection. Placement and orientation of the lines must be done correctly.

In this chapter we have described sampling methods that are based on points, lines and areas. All of them offer different advantages in efficiency, flexibility, or the kind of information gathered. The data generated along a line transect is often limited and specific, but the field simplicity makes it an appealing alternative. When the questions are well defined, and particularly when they involve area percentages, a technique of sampling with some form of transect is often appropriate.